Allard Affidavit: Attachment A

AGREEMENT

BETWEEN

THE UNITED STATES NUCLEAR REGULATORY COMMISSION

AND

THE COMMONWEALTH OF PENNSYLVANIA FOR THE DISCONTINUANCE OF CERTAIN COMMISSION REGULATORY AUTHORITY

AND

RESPONSIBILITY WITHIN THE COMMONWEALTH PURSUANT TO SECTION 274 OF THE ATOMIC ENERGY ACT OF 1954, AS AMENDED

WHEREAS, The United States Nuclear Regulatory Commission (hereinafter referred to as the Commission) is authorized under Section 274 of the Atomic Energy Act of 1954, as amended, 42 U.S.C. § 2011 et seq. (hereinafter referred to as the Act), to enter into agreements with the Governor of any State/Commonwealth providing for discontinuance of the regulatory authority of the Commission within the State/Commonwealth under Chapters 6, 7, and 8, and Section 161 of the Act with respect to byproduct materials as defined in Sections 11e.(1), 11e.(2), 11e.(3), and 11e.(4) of the Act, source materials, and special nuclear materials in quantities not sufficient to form a critical mass; and,

WHEREAS, The Governor of the Commonwealth of Pennsylvania is authorized under the Pennsylvania Radiation Protection Act of July 10, 1984, P.L. 688, No. 147, as amended, 35 P.S. § 7110.101 et seq., to enter into this Agreement with the Commission; and,

WHEREAS, The Governor of the Commonwealth of Pennsylvania certified on November 9, 2006, that the Commonwealth of Pennsylvania (hereinafter referred to as the Commonwealth) has a program for the control of radiation hazards adequate to protect public health and safety with respect to the materials

within the Commonwealth covered by this Agreement, and that the Commonwealth desires to assume regulatory responsibility for such materials; and,

WHEREAS, The Commission found on February 12, 2008, that the program of the Commonwealth for the regulation of the materials covered by this Agreement is compatible with the Commission's program for the regulation of such materials and is adequate to protect public health and safety; and,

WHEREAS, The Commonwealth and the Commission recognize the desirability and importance of cooperation between the Commission and the Commonwealth in the formulation of standards for protection against hazards of radiation and in assuring that Commonwealth and Commission programs for protection against hazards of radiation will be coordinated and compatible; and,

WHEREAS, The Commission and the Commonwealth recognize the desirability of the reciprocal recognition of licenses, and of the granting of limited exemptions from licensing of those materials subject to this Agreement; and,

WHEREAS, This Agreement is entered into pursuant to the provisions of the Act;

NOW, THEREFORE, It is hereby agreed between the Commission and the Governor of the Commonwealth acting on behalf of the Commonwealth as follows:

ARTICLE I

Subject to the exceptions provided in Articles II, IV, and V, the Commission shall discontinue, as of the effective date of this Agreement, the regulatory authority of

the Commission in the Commonwealth under Chapters 6, 7, and 8, and Section 161 of the Act with respect to the following materials:

1. *Byproduct materials as defined in Section 11e.(1) of the Act;*

2. *Byproduct materials as defined in Section 11e.(3) of the Act;*

3. *Byproduct materials as defined in Section 11e.(4) of the Act;*

4. *Source materials;*

5. *Special nuclear materials in quantities not sufficient to form a critical mass;*

6. *The regulation of the land disposal of all byproduct, source, and special nuclear waste materials covered by this Agreement.*

ARTICLE II

This Agreement does not provide for discontinuance of any authority and the Commission shall retain authority and responsibility with respect to the following:

1. *The regulation of the construction and operation of any production or utilization facility or any uranium enrichment facility;*

2. *The regulation of the export from or import into the United States of byproduct, source, or special nuclear material, or of any production or utilization facility;*

3. *The regulation of the disposal into the ocean or sea of byproduct, source, or special nuclear materials waste as defined in the regulations or orders of the Commission;*

4. *The regulation of the disposal of such other byproduct, source, or special nuclear materials waste as the Commission from time to time determines by regulation or order should, because of the hazards or potential hazards thereof, not be disposed without a license from the Commission;*

5. *The evaluation of radiation safety information on sealed sources or devices containing byproduct, source, or special nuclear materials and the registration of the sealed sources or devices for distribution, as provided for in regulations or orders of the Commission;*

6. *Byproduct materials as defined in Section 11e.(2) of the Act.*

ARTICLE III

With the exception of those activities identified in Articles II, paragraphs 1 through 4, this Agreement may be amended, upon application by the Commonwealth and approval by the Commission, to include one or more of the additional activities specified in Article II, paragraphs 5 and 6, whereby the Commonwealth may then exert regulatory authority and responsibility with respect to those activities.

ARTICLE IV

Notwithstanding this Agreement, the Commission may from time to time by rule, regulation, or order, require that the manufacturer, processor, or producer of any

equipment, device, commodity, or other product containing source, byproduct, or special nuclear material shall not transfer possession or control of such product except pursuant to a license or an exemption from licensing issued by the Commission.

ARTICLE V

This Agreement shall not affect the authority of the Commission under Section 161b or 161i of the Act to issue rules, regulations, or orders to protect the common defense and security, to protect restricted data, or to guard against the loss or diversion of special nuclear material.

ARTICLE VI

The Commission will cooperate with the Commonwealth and other Agreement States in the formulation of standards and regulatory programs of the Commonwealth and the Commission for protection against hazards of radiation and to assure that Commission and Commonwealth programs for protection against hazards of radiation will be coordinated and compatible. The Commonwealth agrees to cooperate with the Commission and other Agreement States in the formulation of standards and regulatory programs of the Commonwealth and the Commission for protection against hazards of radiation and to assure that the Commonwealth's program will continue to be compatible with the program of the Commission for the regulation of materials covered by this Agreement.

The Commonwealth and the Commission agree to keep each other informed of proposed changes in their respective rules and regulations and to provide each other the opportunity for early and substantive contribution to the proposed changes.

The Commonwealth and the Commission agree to keep each other informed of events, accidents, and licensee performance that may have generic implications or otherwise be of regulatory interest.

ARTICLE VII

The Commission and the Commonwealth agree that it is desirable to provide reciprocal recognition of licenses for the materials listed in Article I licensed by the other party or by any other Agreement State. Accordingly, the Commission and the Commonwealth agree to develop appropriate rules, regulations, and procedures by which such reciprocity will be accorded.

ARTICLE VIII

The Commission, upon its own initiative after reasonable notice and opportunity for hearing to the Commonwealth, or upon request of the Governor of the Commonwealth, may terminate or suspend all or part of this Agreement and reassert the licensing and regulatory authority vested in it under the Act if the Commission finds that (1) such termination or suspension is required to protect public health and safety, or (2) the Commonwealth has not complied with one or more of the requirements of Section 274 of the Act. The Commission may also, pursuant to Section 274j of the Act, temporarily suspend all or part of this Agreement if, in the judgment of the Commission, an emergency situation exists requiring immediate action to protect public health and safety and the Commonwealth has failed to take necessary steps. The Commission shall periodically review actions taken by the Commonwealth under this Agreement to ensure compliance with Section 274 of the Act which requires a Commonwealth program to be adequate to protect public health and safety with respect to the materials covered by this Agreement and to be compatible with the Commission's program.

ARTICLE IX

This Agreement shall become effective on March 31, 2008, and shall remain in effect unless and until such time as it is terminated pursuant to Article VIII.

Done at Rockville, Maryland, in triplicate, this 10th day of March, 2008.

FOR THE UNITED STATES NUCLEAR REGULATORY COMMISSION

Dale E. Klein, Chairman

Done at Harrisburg, Pennsylvania, in triplicate, this 26th day of March, 2008.

FOR THE COMMONWEALTH OF PENNSYLVANIA

Edward G. Rendell, Governor

Allard Affidavit: Attachment B

Pennsylvania Department of Environmental Protection

909 Elmerton Avenue
Harrisburg, PA 17110-8200
January 28, 2010

Southcentral Regional Office

717-705-4703
FAX – 717-705-4890

NOTICE OF VIOLATION

PRIORITY MAIL DELIVERY CONFIRMATION NO. [redacted]

[redacted]
Core Laboratories, L.P.- ProTechnics Division
[redacted]

Re: License No. [redacted]

Dear [redacted]

The Department is aware that the services of Core Laboratories, L.P. - ProTechnics Division (ProTechnics) were enlisted by [redacted] in order to conduct a radioactive tracer study at the [redacted], located along [redacted]. On December 10, 2009, ProTechnics injected a gel solution, which was comprised of water, sand and [redacted] under Pennsylvania Reciprocity License No. [redacted] and [redacted]. After the injection of [redacted] the ProTechnics' field technician left the well site.

Following ProTechnics' departure from the well site, [redacted] pumped sand and water, which were contaminated with [redacted] to the surface. [redacted] removed the radioactive material from an on-site tank on December 21, 2009 and transported the radioactive material to the [redacted], in turn, transported a roll-off container, which included the radioactive material to Modern Landfill for disposal on December 22, 2009. Upon entering the scale at Modern Landfill, a radiation monitor was alarmed and Modern Landfill notified the Department of this event.

The following violation is noted:

- 25 Pa. Code § 217.1(a) requires that a person may not receive, possess, use, transfer, own or acquire radioactive material except as authorized under a specific license. Specifically, [redacted] require that the released radioactive material be possessed, handled and/or disposed in a manner outlined in the procedures submitted with the license application.

  ProTechnics failed to ensure proper handling and disposal of the radioactive material after it had been pumped to the surface and sent for disposal at an off-site location.

The Department is in receipt of an incident report, which described the corrective actions taken. Be advised that no additional response is necessary at this time.

This Notice of Violation is neither an order nor any other final action of the Department. It neither imposes nor waives any enforcement action available to the Department under any of its statutes.

Thank you for your cooperation. If you have any questions, please call me at 717-705-4898.

Sincerely,

Lisa A. Forney
Compliance Specialist
Radiation Protection Program

cc: [redacted] Core Laboratories, L.P.- Protechnics Division

Allard Affidavit: Attachment C

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION
RADIATION PROTECTION PROGRAM

June 15, 2010

NOTICE OF VIOLATION

PRIORITY MAIL DELIVERY CONFIRMATION NO. [redacted]

[redacted]
ProTechnics, a Division of Core Laboratories, LP
[redacted]

Re: License No. [redacted]
EFACTS Inspection ID No. [redacted]
EFACTS Enforcement ID No: [redacted]

Dear [redacted]

The Department is aware that ProTechnics, a Division of Core Laboratories, LP (ProTechnics) was enlisted by [redacted] to conduct a radioactive tracer study at [redacted] (well site/ temporary job site), located in [redacted] Under License [redacted], ProTechnics injected [redacted] into the ground to measure the effectiveness of the fracture stimulation.

Flow-back, which is the surface flow of the injected material, occurred. Materials including, but not limited to geo-synthetic fabric and a pond liner (residual waste) were contaminated by this process. The contaminated residual waste was transported to the McKean County Landfill (MCL) in Sergeant Township, McKean County. Upon entering the landfill, an alarm was signaled and MCL notified the Department.

On June 1, 2010, two roll off containers containing the radioactive residual waste were transported from MCL to the well site. The radioactive residual waste remains in storage for *in situ* decay.

The following violations were observed:

1. 25 Pa. Code § 217.1(a) states, in part, "A person may not receive, possess, use, transfer, own or acquire radioactive material except as authorized under a specific license or general license."

ProTechnics failed to transfer radioactive material to an authorized entity. Specifically, residual waste containing [redacted] (licensed material) was transferred to a facility that was not licensed to handle or dispose of the radioactive material. Be advised that this is a repeat violation since ProTechnics was previously cited in a Notice of Violation dated January 28, 2010.

2. License [redacted] states, in part "Licensed material may be used or stored only at temporary job sites in Pennsylvania."

   ProTechnics failed to comply with the terms of License [redacted] since control of the licensed material was lost. Specifically, licensed material was transported from the temporary job site to MCL, where it was stored from May 21, 2010 to May 28, 2010.

3. License [redacted] states, in part, "The licensee is authorized to store for *in situ* decay radioactive material listed in Items 6.A., 6.B., and 6.C that is released during an uncontrolled well reversal or "flowback" in accordance with procedures listed in the application dated January 6, 2010."

   ProTechnics failed to comply with the terms of License [redacted], since they did not adhere to the Section IV of the Emergency and Operating Procedures provided on January 6, 2010. Specifically, Section IV, Part 7.2.2 requires that ProTechnics inform the well owner/operator of well reversal procedures prior to the tracer operation and that the material from the well reversal be directed toward an earthen barrier. Furthermore, Part 7.4.1 requires that the activity not only be placed in the earthen barrier, but that it be covered with a minimum of 2 feet of clean soil. ProTechnics did not adhere to their Operating and Emergency Procedures, since the residual waste was not directed to the earthen barrier and covered with clean soil.

You are hereby notified of the existence of violations as well as the need to provide prompt corrective action. Failure to correct the violations may result in legal proceedings under the Radiation Protection Act. Under the Act, each day of violation is considered a distinct and separate offense and will be handled accordingly.

The violations described above constitute a public nuisance under Section 309 of the Radiation Protection Act, 35 P.S. § 7110.309, and may subject you, under Section 308(e) of the Radiation Protection Act, 35 P.S. § 7110.308(e), to civil penalty liability of up to TWENTY-FIVE THOUSAND DOLLARS ($25,000) for each violation plus up to FIVE THOUSAND DOLLARS ($5,000) per day for each continuing day of violation.

You are requested to attend an informal administrative conference with Department representatives on July 7, 2010 at 10:30 AM at the Southcentral Regional Office, 909 Elmerton Avenue, Harrisburg, PA 17110. Options for settlement of the above-described violations will be discussed at that time. Finally, we recommend that you correct any outstanding violations at the Site prior to this conference and that you bring documentation of the corrective actions to the conference.

Please notify this office by June 28, 2010 to confirm your attendance at the conference described above. Also, please inform us if your attorney will be attending the meeting.

This Notice of Violation is neither an order nor any other final action of the Department. It neither imposes nor waives any enforcement action available to the Department under any of its statutes.

Thank you for your cooperation.

Sincerely,

Lisa A. Forney

Lisa A. Forney
Compliance Specialist
Radiation Protection Program

cc: [redacted] ProTechnics
[redacted] ProTechnics

Allard Affidavit: Attachment D

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION
RADIATION PROTECTION PROGRAM

November 2, 2010

PRIORITY MAIL DELIVERY CONFIRMATION NO. [redacted]

[redacted]
ProTechnics Division of Core Laboratories LP
[redacted]

Re: License No. [redacted]

Dear [redacted]

Enclosed is an executed copy of the Consent Order and Agreement (COA), which is dated November 2, 2010. This will also acknowledge receipt of check number 660223 in the amount of $29,000.00 in accordance with the COA.

Thank you for your cooperation. If you have any questions, please feel free to contact me at 717.705.4898.

Sincerely,

Lisa A. Forney

Lisa A. Forney
Compliance Specialist
Radiation Protection Program

Enclosures

cc: General Counsel with enclosure

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION

In the matter of:

ProTechnics Division of Core Laboratories L.P. [redacted]	:	Violations of the Radiation Protection Act of July 10, 1984, P.L. 688, No. 147, 35 P.S. § 7110.101 *et seq.* and 25 Pa. Code § 217 *et seq.*
	:	License No. [redacted]

CONSENT ORDER AND AGREEMENT

This Consent Order and Agreement (COA) is entered into this 2nd day of November, 2010, by and between the Commonwealth of Pennsylvania, Department of Environmental Protection (the "Department"), and ProTechnics Division of Core Laboratories LP ("ProTechnics"), aka ProTechnics, a Core Laboratories Company ("ProTechnics").

Findings

The Department has found and determined the following findings which ProTechnics agrees are true and correct.

A. The Department is the agency with the duty and authority to administer and enforce the Radiation Protection Act, Act of July 10, 1984, P.L. 688, No. 147, 35 P.S. § 7110.101 et seq. ("The Act") and Section 1917-A of the Administrative Code of 1929, Act of April 9, 1929, P.L. 177, as amended, 71 P.S. § 510-17 ("Administrative Code"); and the rules and regulations promulgated thereunder.

B. ProTechnics conducts business at [redacted] is the [redacted] of ProTechnics.

C. ProTechnics is contracted by well owners and/or well operators ("Well Owner/Operator") to inject radioactive material into gas wells, which are intended to extract natural gas from the Marcellus Shale Formation. The injection is necessary to determine the effectiveness of hydraulic fracturing.

D. On April 1, 2008, the Department granted the Reciprocity General License [redacted] to ProTechnics. License [redacted] authorized ProTechnics to conduct radioactive tracer studies within Pennsylvania in accordance with Texas Radioactive Material License Number [redacted] expired on April 1, 2009.

E. On April 20, 2009, the Department granted the renewal of Reciprocity General License [redacted] The license remained in effect until April 30, 2010.

F. On December 10, 2009, ProTechnics injected [redacted] containing [redacted] at the [redacted] well site in [redacted] Following ProTechnics' departure from the [redacted] a flow back incident occurred, which produced radioactive residual waste. The radioactive residual waste was transported from the site and directed for disposal by a third party.

G. On December 22, 2009, Modern Landfill notified the Department that a load of waste had alarmed their radiation monitors. The source was identified as [redacted] in residual waste from [redacted]

H. On December 30, 2009, ProTechnics attended a meeting with Department representatives and agreed to apply for a Pennsylvania Radioactive Materials License.

I. On January 26, 2010, ProTechnics submitted an incident report and affirmed their commitment to obtain a Pennsylvania Radioactive Materials License.

J. On January 28, 2010, the Department issued a Notice of Violation ("NOV") to ProTechnics for failing to adhere to the terms of Texas Radioactive Material License Number [redacted] and reciprocity general license [redacted]

K. Pennsylvania Radioactive Materials License [redacted] was issued on February 26, 2010 and remains in full effect through February 26, 2020.

L. [redacted] ("Well Owner/Operator") contracted ProTechnics to inject radioactive tracer into a series of wells located along the [redacted] in [redacted]. The injections occurred between April 17, 2010 and April 23, 2010.

M. On April 17, 2010, representatives from the Well Owner/Operator and ProTechnics signed a well tracer agreement for [redacted]. The agreement described the necessary actions to be taken in the event of a well flow back/ well reversal and authorized the placing of well returns (containing radioactive tracer material) for decay *In Situ* on Site.

N. ProTechnics conducted a Site survey on April 23, 2010 prior to their departure.

O. Between the dates of April 23, 2010 and April 27, 2010, licensed radioactive material returned to the surface or flowed back at [redacted] ("flow back incident"). Well returns, containing approximately 0.078% of the injected quantity of [redacted], were collected onto a tarped area around the well and allowed to evaporate. The tarp was cut into pieces and directed for disposal by a third party.

P. On May 21, 2010, Rustick, LLC McKean County Landfill ("McKean County Landfill") notified the Department that a load of waste had alarmed their radiation monitors. The source was identified as [redacted] in residual waste, including, but not limited to the tarp from the Site.

Q. On May 24, 2010, the Well Owner/Operator contacted ProTechnics and advised them of the flow back incident at [redacted] and subsequent radiation alarm at McKean County Landfill.

R. On June 1, 2010, the radioactive residual waste was returned to the Site for decay *In Situ*. ProTechnics posted a sign and placed a fence around the area containing the radioactive residual waste.

S. ProTechnics violated the regulatory requirements under the Act as follows:

1. ProTechnics failed to transfer radioactive material to an authorized entity that was licensed to handle radioactive material, in violation of 25 Pa. Code § 217.1(a).

2. ProTechnics failed to only use or store licensed material at temporary job sites in Pennsylvania, as required by [redacted] and 25 Pa. Code § 217.1(a).

3. ProTechnics failed to adhere to the Emergency and Operating Procedures included in License [redacted] in violation of License [redacted] Condition [redacted] and 25 Pa. Code § 217.1(a).

4. ProTechnics failed to submit a report and a signed agreement from the property owner authorizing storage for Decay *In Situ* within 30-days of an uncontrolled well reversal, in violation of License [redacted] Condition [redacted] and 25 Pa. Code § 217.1(a).

T. On June 15, 2010, the Department issued an NOV to ProTechnics, for the violations listed in Paragraph S, above.

U. On July 12, 2010, an administrative enforcement conference was held between ProTechnics and representatives of the Department. ProTechnics provided the [redacted] Site Agreement dated April 17, 2010; a draft of proposed changes to the well site agreement; as well as copies of job site survey forms.

V. On July 13, 2010, ProTechnics submitted a report to the Department, as well as a description of proposed corrective actions.

W. On July 23, 2010, the Department sent a deficiency letter requesting a 30-day report, which included all items listed in License [redacted] Condition [redacted]

X. On July 28, 2010, ProTechnics provided a response letter; a copy of the April 17, 2010 [redacted] site agreement and a copy of ProTechnics' guidelines for radioactive tracers during well stimulations.

Y. The violations described in Paragraph S, above constitute unlawful conduct under Section 307 of the Radiation Protection Act, 35 P.S. § 7110.307, a public nuisance under Section 309(a) of the Radiation Protection Act, 35 P.S. § 7110.309(a), and subjects ProTechnics to civil penalty liability under Section 308(e) of the Radiation Protection Act, 35 P.S. § 7110.308(e).

ORDER

After full and complete negotiation of all matters set forth in this COA and upon mutual exchange of the covenants herein, the parties desiring to avoid litigation and intending to be legally bound, it is hereby ORDERED by the Department and AGREED to by ProTechnics as follows:

1. Authority. This COA is an Order of the Department authorized and issued pursuant to Section 308(e) of the Radiation Protection Act, 35 P.S. § 7110.308(e) and Section 1917-A of the Administrative Code, supra. The failure of ProTechnics to comply with any term or condition of this Consent Order and Agreement shall subject ProTechnics to penalties and remedies provided by those statutes for failing to comply with an order of the Department.

2. Findings.

   a. ProTechnics agrees that the findings in paragraphs A through Y are true and correct and in any matter or proceeding involving ProTechnics and the Department, ProTechnics shall not challenge the accuracy or validity of these findings.

   b. The parties do not authorize any other persons to use the findings in the COA in any matter or proceeding.

3. Corrective Actions.

   a. ProTechnics shall provide a copy of the Radioactive Tracer Well Site Agreement in Attachment A to each Well Owner/Operator who contracts ProTechnics to conduct a radioactive tracer study within Pennsylvania.

   b. ProTechnics and the Well Owner/Operator shall sign and complete a Radioactive Tracer Well Site Agreement for each well that is traced in Pennsylvania. Within five business days of completing the form, ProTechnics shall submit a copy to the Department.

   c. Prior to tracing each well, ProTechnics shall provide an instructional session to the Well Owner/Operator which includes, but is not limited to general radiation safety principles, as well as procedures for handling flow back incidents and acceptable methods of disposal. ProTechnics shall document that training was provided and provide copies to the Department upon request.

d. Within 14 days of the execution of this COA, ProTechnics shall submit a license amendment request to the Department to amend License [redacted], as follows:

1. ProTechnics shall request that License [redacted], Condition [redacted] be amended to exclude the term "Property Owner."

2. ProTechnics shall request that License [redacted] be amended to include the submission of the completed Radioactive Tracer Well Site Agreement within five business days of signature and completion.

3. ProTechnics shall request that License [redacted] be amended to include that ProTechnics make arrangements with the Well Owner/Operator to ensure the stabilization of each earthen barrier containing radioactive residual waste for *In Situ* decay within Pennsylvania. ProTechnics shall conduct a minimum of one inspection per year which shall include, but not be limited to an assessment of the integrity of the area, markings, and fencing; the adequacy of stabilization, an indication of any maintenance that may be required; and documentation that the inspection was completed.

4. ProTechnics shall request that License [redacted] Condition [redacted] be amended to include that ProTechnics will provide notification to the Department in accordance with Paragraph 10 of this COA.

5. ProTechnics shall request that License [redacted] be amended to include that ProTechnics will immediately notify the Department upon confirmation that licensed radioactive material is contained within flow back/ well returns.

e. In the event of a flow back incident, ProTechnics shall contain the well reversals containing licensed radioactive material to the on site earthen barrier, in accordance with Section 7 of the Emergency and Operating Procedures included in License [redacted] Condition [redacted]

f. Upon confirmation that licensed material has returned to the surface, ProTechnics shall immediately notify the Department in accordance with Paragraph 10 of this COA. This shall apply to all well returns / flow back containing licensed radioactive material regardless if it is controlled or uncontrolled and regardless of the quantity of licensed material that reaches the surface.

g. ProTechnics shall conduct and document a complete survey and sketch of the area surrounding the well returns / flow back containing licensed material in accordance with Section 7.1.4 of the Emergency and Operating Procedures included in License [redacted] Condition [redacted] ProTechnics shall provide copies of the completed survey form to the Department upon request.

h. ProTechnics shall submit a report, which summarizes the events that caused licensed radioactive material to flow back and all actions taken following the incident. The report shall be in accordance with the terms of License [redacted], Condition [redacted] and shall be submitted within 30 days of the flow back of licensed material.

4. Civil Penalty Settlement. Upon signing this COA, ProTechnics shall pay the civil penalty of TWENTY NINE THOUSAND DOLLARS ($29,000.00). Subject to Paragraph 5, below, this payment is in settlement of the Department's claim for civil penalties for the violations set forth in Paragraph 3., herein. The payment shall be by corporate check or the like, made payable in the following manner and to the referenced parties: (a). Payment in the amount of TWENTY NINE THOUSAND DOLLARS ($29,000.00). to the "Commonwealth of Pennsylvania, Radiation Protection Fund," and sent c/o Ms. Lisa A. Forney, Compliance Specialist, DEP Southcentral Region, Radiation Protection Program, 909 Elmerton Avenue, Harrisburg, PA 17110-8200.

5. Stipulated Civil Penalties.

a. In the event that ProTechnics fails to comply in a timely manner with the provisions of this COA, ProTechnics shall be in violation of this COA and, in addition to other applicable remedies, shall pay a civil penalty in the amount determined under the following schedule:

1. For any documented violation of Paragraph 3, ProTechnics shall pay of civil penalty of FIVE HUNDRED DOLLARS ($500.00) per day for each violation.

b. Stipulated civil penalty payments shall be payable monthly on or before the fifteenth day of each succeeding month, and shall be forwarded as described in Paragraph 4, above.

c. Any payment under this paragraph shall neither waive the duty of ProTechnics to meet their obligations under this COA, nor preclude the Department from commencing an action to compel ProTechnics with the terms and conditions of this COA. The payment resolves the liability of ProTechnics only for civil penalties arising from the violation of this COA, for which the payment is made.

d. Stipulated civil penalties shall be due automatically and without notice.

6. Additional Remedies.

a. In the event that ProTechnics fails to comply with any provision of this COA, the Department may, in addition to the remedies prescribed herein, pursue any remedy available for a violation of an order of the Department, including any action to enforce this COA.

b. The remedies provided by this paragraph and paragraph 5 are cumulative and the exercise of one does not preclude the exercise of any other. The failure of the Department to pursue any remedy shall not be deemed to be a waiver of that remedy. The payment of a stipulated penalty, however, shall preclude any further assessment of civil penalties for the violation for which the civil penalty is paid.

7. **Reservation of Rights.** The Department reserves the right to require additional measures to achieve compliance with the applicable law. ProTechnics reserves the right to challenge any action which the Department may take to require those measures.

8. **Liability of Operator.** ProTechnics shall be liable for any violations of the COA, including those caused by, contributed to, or allowed by its officers, agents, employees or contractors. ProTechnics also shall be liable for any violation of this COA caused by, contributed to, or allowed by its successors and assigns.

9. **Transfer of Site.** The duties and obligations under this COA shall not be modified, diminished, terminated, or otherwise altered by the transfer of any legal or equitable interest in any Pennsylvania Site, where ProTechnics is contracted to conduct radioactive tracer studies or any part thereof.

10. **Correspondence with the Department.** All correspondence with the Department concerning this COA shall be addressed to:

Ms. Lisa A. Forney, Compliance Specialist
DEP, Southcentral Regional Office
909 Elmerton Avenue
Harrisburg, PA 17110-8200
717-705-4898
lforney@state.pa.us

And

Mr. John Chippo, Radiation Protection Program Supervisor
PA DEP Rachel Carson State Office Building
400 Market Street
Harrisburg, PA 17105
717-787-2208
jchippo@state.pa.us

11. **Correspondence with ProTechnics.** All correspondence with ProTechnics shall be addressed to:

[redacted]
ProTechnics, a Division of Core Laboratories, L.P.
[redacted]

And

General Counsel

[redacted]

ProTechnics shall notify the Department whenever there is a change in its contact person's name, title or address. Service of any notice or any legal process for any purpose under this COA, including its enforcement, may be made by mailing a copy by first class mail to the above address.

12. **Severability.** The paragraphs of this COA shall be severable and should any part hereof be declared invalid and unenforceable, the remainder shall continue in full force and effect between parties.

13. **Entire Agreement.** This COA shall constitute the entire integrated agreement of the parties. No prior or contemporaneous communications or prior drafts shall be relevant or admissible for purposes of determining the meaning or extent of any provisions herein in any litigation or any other proceeding.

14. **Attorney Fees.** The parties shall bear their representative attorney fees, expenses and other costs in the prosecution or defense of this matter or any related matters, arising prior to the execution of this COA.

15. **Modifications.** No changes, additions, modification or amendments of this COA shall be effective unless they are set out in writing and signed by the parties hereto.

16. **Decisions Under Consent Order.** Any decision which the Department makes under the provisions of this COA shall not be deemed to be a final action of the Department, and shall not be appealable to the Environmental Hearing Board or to any court. Any objection which ProTechnics may have to the decision will be preserved until the Department enforces this COA. At no time, however, may ProTechnics challenge the content or validity of this COA, or challenge the Findings agreed to in this COA.

17. **Titles.** A title used at the beginning of any paragraph of this COA is provided solely for the purposes of identification and shall not be used to interpret that paragraph.

18. **Termination.** The obligations of Paragraphs 1-18 shall terminate when the Department deems that ProTechnics has completed the actions required in Paragraph 3, paid the civil penalty assessed in Paragraph 4, and paid any stipulated penalties due under Paragraph 5, above. Upon the Department's determination that the obligations of Paragraphs 1-19 have been satisfactorily met, the Department shall provide a written statement to conclude this COA.

IN WITNESS WHEREOF, the parties have caused the COA to be executed by their duly authorized representatives. The undersigned representatives of ProTechnics certify, under penalty of law, as provided by 18 Pa. C.S. § 4904, that they are authorized to execute this COA on behalf of ProTechnics, that ProTechnics consents to the entry of this COA as an ORDER of the Department, that ProTechnics hereby knowingly waives any right to a hearing under the statutes referenced in this COA, and that ProTechnics knowingly waives their right to appeal this COA and the foregoing Findings, which rights may be available under Section 4 of the Environmental Hearing Board Act, the Act of July 13, 1988, P.L. 530, No. 1988-94, 35 P.S. § 7514; the Administrative Agency Law, 2 Pa. C.S. § 1039a) and Chapters 5A and 7A, or any other provision of law.

FOR PROTECHNICS DIVISION OF CORE LABORATORIES LP:

[redacted] 11/1/10
Date

FOR THE COMMONWEALTH OF PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL PROTECTION:

11/2/10
Date

John F. Krueger
Radiation Protection Program

[redacted] 11/1/2010
Attorney for ProTechnics Date

11/1/10
Date

Martin R. Siegel
Assistant Counsel

Attachment A

RADIOACTIVE TRACER WELL SITE AGREEMENT

By signature below, the parties hereby agree to the requirements set out below for handling well reversal, well returns, or flowback ("Well Returns") containing radioactive tracer material. The Pennsylvania Department of Environmental Protection, Bureau of Radiation Protection ("PA DEP") has approved the placing of Well Returns containing radioactive tracer material in an on-site earthen barrier for decay *in situ* for three years from the date of radioactive tracer material injection. The following steps must be taken when handling Well Returns containing radioactive tracer material.

1. The Well Owner/Operator shall notify ProTechnics [redacted] within 24 hours of Well Returns containing any solid materials. ProTechnics shall survey such returns for the presence of radioactive tracer material within 2 business days after notification from the Well Owner/Operator.
2. All Well Returns containing radioactive tracer material shall be diverted to the on-site earthen barrier. If the Well Returns are first diverted to on-site tanks, the tanks must be surveyed prior to removal from the well site. ProTechnics shall survey all equipment, location ground site cover tarps, holding tanks, or anything else that may have come into contact with the Well Returns within 2 days after notification from the Well Owner/Operator and prior to removal from the well site. The Well Owner/Operator shall notify ProTechnics within 24 hours of any such contamination.
3. The earthen barrier will be covered with two feet of stabilized clean soil and stabilized in accordance with 25 Pa. Code § 102.1 *et seq.*, the Site's approved Erosion and Sediment Control Plan, 25 Pa. Code § 78.1 *et seq.*, and the respective Oil and Gas Permit (Oil and Gas Well Permit No._____).
4. Upon establishment, the earthen barrier shall be identified by GPS coordinates. Access to this area will be restricted by a durable fence.
5. The earthen barrier will be posted with signage: Caution – Radioactive Material – Keep Out – Do Not dig in this area before (Date:_____) – notify ProTechnics [redacted] for additional information.
6. This signed agreement between the Well Owner/Operator and ProTechnics for radioactive material decay *in situ* in the earthen barrier will be kept on file by ProTechnics and a copy sent to PA DEP to become incorporated into the ProTechnics' Radioactive Material License for the well location listed below.
7. Both the access control fence and the earthen barrier integrity must be maintained by the Well Owner/Operator for 3 years from the date of tracer material injection or approximately (Date:_____). All associated signage and fences shall be removed within 30 days of the above date.
8. Any failure by the Well Owner / Operator to promptly report solid material Well Returns which contain radioactive materials or to control such radioactive materials onsite may subject both ProTechnics and the Well Owner/Operator to regulatory enforcement by PA DEP.

ProTechnics reserves the right to supervise any necessary decontamination activities should any actions occur that result in the loss of integrity of the earthen barrier.

This agreement will be attached and incorporated into ProTechnics' Radioactive Materials License Number [redacted] which is administered by PA DEP, until the date specified in Item #7.

Printed Name
Radiation Safety Officer
ProTechnics, Division of Core Laboratories LP

Signature
Radiation Safety Officer
ProTechnics
Division of Core Laboratories LP

Date Signed

Printed Name
Well Owner/ Operator
Representative

Signature
Well Owner/ Operator
Representative

Date Signed

Company Name
Well Owner/Operator

Well Name:

Earthen Barrier / Storage Pit Location
(Approximate GPS Coordinates – Please Indicate If Not Applicable)

Company Mailing Address
Well Owner/Operator

Attachment B

ProTechnics
A Division of Core Laboratories LP

[redacted]

www.protechnics.com

TRACER WELL SITE AGREEMENT

By signature below, the parties hereby agree to the requirements set out below for handling well returns containing tracer material. The State of Pennsylvania has approved the placing of well returns containing tracer material in an on site earthen barrier for decay in situ. The following steps must be taken when handling well returns containing tracer material.

1. All well returns containing gamma emitting tracer material shall be diverted to the on site earthen barrier.
2. The earthen barrier will be covered with two feet of clean soil.
3. The earthen barrier shall be identified by GPS coordinates. This area will be restricted by the use of a durable barrier.
4. The earthen barrier will posted with signage (Caution – Radioactive Material – Keep Out – Do not dig in this area – notify ProTechnics [redacted] for additional information.
5. This signed agreement between the Company below and ProTechnics for decay in situ will be kept on file by ProTechnics.
6. Access control of the earthen barrier must be maintained by the well owner/operator until 3 Years. The signs can be removed at this time.

ProTechnics reserves the right to supervise any necessary decontamination activities should any actions occur that result in the loss of integrity of the earthen barrier.

Dated and signed April 17th, 2010

[redacted]

ProTechnics Division of Core Laboratories LP

[redacted] 4/17/10

Representative Date Signed

[redacted]

Well Owner/Operator Well Name:

Pennsylvania 2/26/2010

[redacted]

Allard Affidavit: Attachment E

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION
RADIATION PROTECTION PROGRAM

November 26, 2013

NOTICE OF VIOLATION

PRIORITY MAIL DELIVERY CONFIRMATION NO [redacted]

[redacted]
ProTechnics, a Division of Core Laboratories, L.P.
[redacted]

Re: License No. [redacted]
EFACTS Inspection ID No. [redacted]
EFACTS Enforcement ID No. [redacted]

Dear [redacted]

In response to a report of unidentified radioactive material alarming the radiation monitor at Alliance Landfill located at 398 South Keyser Avenue, Taylor Borough, Lackawanna County, Pennsylvania, Mr. Richard Croll conducted inspections on September 13, 2013 (Inspection ID [redacted]. A subsequent records review was conducted on November 14, 2013 (Inspection ID [redacted]. Based upon the inspection findings, violations of the Department of Environmental Protection's (Department) rules and regulations were revealed. The regulations are available at www.dep.state.pa.us/brp.

The following violations were observed:

1. 25 Pa. Code § 219.5(a) incorporates 10 CFR § 20.1802, which states, "The licensee shall control and maintain constant surveillance of licensed material that is in a controlled or unrestricted area and that is not in storage."

   ProTechnics, a Division of Core Laboratories, L.P. (ProTechnics) failed to maintain control and constant surveillance of licensed material. Specifically, ProTechnics was hired by [redacted] to inject licensed material into gas wells at the [redacted] to evaluate the effectiveness of hydraulic fracturing. Following the injection, licensed material returned to the surface in a flow back incident. Flow back waste materials, drill-cuttings and municipal solid waste were placed into a roll-off container and subsequently transported to Alliance Landfill on September 9, 2013 for disposal. Upon entering the scale at Alliance Landfill, radiation monitors alarmed. The load was isolated, surveyed and traced back to activities at the [redacted]

2. 25 Pa. Code § 219.5(a) incorporates 10 CFR § 20.1902(e), which states, "The licensee shall post each area or room in which there is used or stored an amount of licensed material exceeding 10 times the quantity of such material specified in appendix C to part 20 with a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, RADIOACTIVE MATERIAL(S)" or "DANGER, RADIOACTIVE MATERIAL(S)."

ProTechnics failed to post a conspicuous sign bearing the radiation symbol and the words "CAUTION, RADIOACTIVE MATERIAL(S)" or "DANGER, RADIOACTIVE MATERIAL(S)" on roll-off containers located at [redacted] and the [redacted] in [redacted]. Specifically, the [redacted] revealed a roll-off container being filled directly from the flow back auger, which was not posted as required. A subsequent inspection of the [redacted] revealed a partially filled roll-off container of drill cuttings that was not properly posted.

3. 35. P.S. 7110.309(b) states, in part, "It shall be the duty of any person to comply with any order issued under this subsection." Specifically, Paragraph 3.b. of the Consent Order and Agreement dated November 2, 2013 (COA) states, "ProTechnics and the Well Owner/Operator shall sign and complete a Radioactive Tracer Well Site Agreement for each well that is traced in Pennsylvania. Within five business days of completing the form, ProTechnics shall submit a copy to the Department."

   ProTechnics failed to provide a signed copy of the well-site agreement within 5 days of completing the form for each site where radioactive material was utilized within Pennsylvania. On September 25, 2013, the Department requested copies of all Radioactive Tracer Well Site Agreement forms completed since the execution of the COA. In correspondence dated August 26, 2013, ProTechnics indicated that licensed material was injected at five sites during the period and that proper notification had been provided. However, proper notification was not received by the parties indicated in the COA. Furthermore, the April 7, 2013 Radioactive Tracer Well Site Agreement was not completed in its entirety and Pennsylvania Radioactive Materials License Number [redacted] was listed in the place of the Oil and Gas Well Permit Number.

4. 35. P.S. 7110.309(b) states, in part, "It shall be the duty of any person to comply with any order issued under this subsection." Specifically, Paragraph 3.f. of the COA states, "Upon confirmation that licensed material has returned to the surface, ProTechnics shall immediately notify the Department in accordance with Paragraph 10 of this COA. This shall apply to all well returns / flow back containing licensed radioactive material regardless if it is controlled or uncontrolled and regardless of the quantity of licensed material that reaches the surface."

   ProTechnics failed to immediately notify the Department upon confirmation that licensed material had returned to the surface at [redacted] and [redacted]

5. 35. P.S. 7110.309(b) states, in part, "It shall be the duty of any person to comply with any order issued under this subsection." Specifically, Paragraph 3.g. of the COA states, "ProTechnics shall conduct and document a complete survey and sketch of the area surrounding the well returns / flow back containing licensed material in accordance with Section 7.1.4 of the Emergency and Operating Procedures included in License PA-1400, Condition 14.A. ProTechnics shall provide copies of the completed survey form to the Department upon request."

   ProTechnics failed to properly conduct and document a complete survey and sketch of the area surrounding the well return/flowback containing licensed materials at the [redacted]

6. 35. P.S. 7110.309(b) states, in part, "It shall be the duty of any person to comply with any order issued under this subsection." Specifically, Paragraph 3.h. of the COA states, "ProTechnics shall submit a report, which summarizes the events that caused licensed radioactive material to flow back and all actions taken following the incident. The report shall be in accordance with the terms of [redacted] and shall be submitted within 30 days of the flow back of licensed material."

   ProTechnics failed to submit a 30 day report to summarize the events that caused licensed radioactive material to flow back to the surface as well as all actions taken following to the incident at the [redacted]

You are hereby notified of the existence of violations as well as the need to provide prompt corrective action. Failure to correct the violations may result in legal proceedings under the Radiation Protection Act (Act). Under the Act, each day of violation is considered a distinct and separate offense and will be handled accordingly.

The violations described above constitute a public nuisance under Section 309 of the Act, 35 P.S. § 7110.309, and may subject you, under Section 308(e) of the Act, 35 P.S. § 7110.308(e), to civil penalty liability of up to TWENTY-FIVE THOUSAND DOLLARS ($25,000.00) for each violation plus up to FIVE THOUSAND DOLLARS ($5,000.00) per day for each continuing day of violation.

You are requested to attend an informal administrative conference with Department representatives on Tuesday, December 17, 2013 at 10:00 AM, at the Southcentral Regional Office, 909 Elmerton Avenue, Harrisburg, PA 17110. Options for settlement of the above-described violations will be discussed at that time. Finally, we recommend that you correct any outstanding violations prior to this conference and that you bring documentation of the corrective actions to the conference.

Please notify this office by December 4, 2013 to confirm your attendance at the conference described above. Also, please inform us if your attorney will be attending the meeting.

This Notice of Violation is neither an order nor any other final action of the Department. It neither imposes nor waives any enforcement action available to the Department under any of its statutes.

Thank you for your cooperation. If you have any questions, please feel free to contact me at 717.705.4898.

Sincerely,

Lisa A. Forney, MEPC
Compliance Specialist
Radiation Protection Program

cc: General Counsel
[redacted]

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION
RADIATION PROTECTION PROGRAM

May 7, 2014

PRIORITY MAIL DELIVERY CONFIRMATION NO. [redacted]

[redacted]
ProTechnics Division of Core Laboratories, LP
[redacted]

Re: License No. [redacted]

Dear [redacted]

Enclosed is an executed copy of the Addendum to Paragraphs 3 and 11 of the Consent Order and Agreement dated November 2, 2010. If you have any questions, please call me at 717.705.4898.

Sincerely,

Lisa A. Forney, MEPC
Compliance Specialist
Radiation Protection Program

Enclosure

cc: [redacted]

ADDENDUM TO PARAGRAPHS 3 AND 11 OF THE CONSENT ORDER AND AGREEMENT DATED NOVEMBER 2, 2010 BY AND BETWEEN THE COMMONWEALTH OF PENNSYLVANIA, DEPARTMENT OF ENVIRONMENTAL PROTECTION ("DEPARTMENT") AND PROTECHNICS DIVISION OF CORE LABORATORIES, LP ("PROTECHNICS")

3. **Corrective Actions.**

a. ProTechnics shall provide a copy of the revised "Instructions for Handling Well Returns Containing ProTechnics [redacted] Acknowledgement Form" ("Acknowledgement Form") in Attachment A to each Well Owner/Operator who contracts ProTechnics to conduct a radioactive tracer study within Pennsylvania. The revised Acknowledgement Form shall supersede the use and submission of the Well Site Agreement included in the Consent Order and Agreement dated November 2, 2010.

b. ProTechnics and the Well Owner/Operator shall sign and complete an Acknowledgement Form for each well that is traced in Pennsylvania. Within five business days of completing the form, ProTechnics shall submit a copy to the Department.

i. Within 14 days of the execution of this Addendum, ProTechnics shall submit a license amendment request to the Department to amend License [redacted] to include the submission of the completed Acknowledgement Form within five business days of signature and completion.

11. **Correspondence with ProTechnics.** All correspondence with ProTechnics shall be addressed to:

[redacted]
ProTechnics, a Division of Core Laboratories, L.P.
[redacted]

And

General Counsel
[redacted]

ProTechnics shall notify the Department whenever there is a change in its contact person's name, title or address. Service of any notice or any legal process for any purpose under this COA, including its enforcement, may be made by mailing a copy by first class mail to the above address.

IN WITNESS WHEREOF, the parties have caused the COA to be executed by their duly authorized representatives. The undersigned representatives of ProTechnics certify, under penalty of law, as provided by 18 Pa. C.S. § 4904, that they are authorized to execute this COA on behalf of ProTechnics, that ProTechnics consents to the entry of this COA as an ORDER of the Department,

that ProTechnics hereby knowingly waives any right to a hearing under the statutes referenced in this COA, and that ProTechnics knowingly waives their right to appeal this COA and the foregoing Findings, which rights may be available under Section 4 of the Environmental Hearing Board Act, the Act of July 13, 1988, P.L. 530, No. 1988-94, 35 P.S. § 7514; the Administrative Agency Law, 2 Pa. C.S. § 1039a) and Chapters 5A and 7A, or any other provision of law.

FOR PROTECHNICS DIVISION OF CORE LABORATORIES, LP:

[redacted] Date

[redacted] 5-1-14

Attorney for ProTechnics Date

FOR THE COMMONWEALTH OF PENNSYLVANI DEPARTMENT OF ENVIRONMENTAL PROTECTION:

5/6/14

Robert M. Zaccano Date
Radiation Protection
Program

5/6/14

Stevan Kip Portman Date
Assistant Counsel

Attachment A

April 2014 (Rev. 1)

Instructions for Handling Well Returns Containing ProTechnics [redacted] Acknowledgement Form

In some flowback situations, special handling of flowback materials may be required.

ProTechnics must be notified within 24 hours of well returns containing solids. ProTechnics will then survey the solids for elevated gamma readings. If a ProTechnics survey finds that the level requires special disposal, the Well Owner/Operator shall consult with ProTechnics prior to disposing of the waste.

Please indicate the pre-decided disposal option that will be utilized in the event of well returns requiring special handling:

☐ Option 1: On-site earthen barrier for decay *in situ* for 3 years.

☐ Option 2: Temporary onsite tank storage, then shipment to a licensed disposal facility.

Well Owner/Operator Name	Well Name
	Well Permit Number
Well Owner/Operator Address	Storage Pit Location (Approximate GPS Coordinates - Option 1 only)
Owner/Operator Representative (Printed Name & Job Title)	ProTechnics Site Supervisor (Printed Name)
Owner/Operator Representative (Signature) Date	ProTechnics Site Supervisor (Signature) Date

☐ Owner/Operator Declined to Sign Acknowledgement Form

Only complete this section following a flowback incident

Date of Flowback Event: _____ Date Elevated Level Confirmed: _____

Date ProTechnics was Notified: _____ Date of Notification to PaDEP: _____

April 2014 (Rev. 1)

Instructions for Handling Well Returns Containing ProTechnics [redacted]

1. The Well Owner/Operator shall notify ProTechnics [redacted] within 24 hours of Well Returns containing any solid materials. ProTechnics shall survey such returns for the presence of radioactive tracer material within 2 business days of notification from the Well Owner/Operator.

2. All Well Returns containing radioactive tracer material shall be diverted to the on-site earthen barrier. If the Well Returns are first diverted to on-site tanks, the tanks must be surveyed prior to removal from the well site. ProTechnics shall survey all equipment, ground cover tarps, holding tanks, or anything else that may have come into contact with the Well Returns within 2 days after notification from the Well Owner/Operator and prior to removal from the well site. The Well Owner/Operator shall notify ProTechnics within 24 hours of any such contamination.

3. The earthen barrier will be covered with 2 feet of stabilized clean soil and stabilized in accordance with 25 Pa. Code § 102.1 *et seq.*, the Site's approved Erosion and Sediment Control Plan, 25 Pa. Code § 78.1 *et seq.*, and the respective Oil and Gas Permit.

4. Upon establishment, the earthen barrier shall be identified by GPS coordinates. Access to the area will be restricted by durable fence.

5. The earthen barrier will be posted with signage: Caution – Radioactive material – Keep Out – Do Not Dig in This Area before Date: _____ - Notify ProTechnics [redacted] for additional information.

6. This signed acknowledgement form will be kept on file by ProTechnics and a copy sent the PA DEP for incorporation into ProTechnics Radioactive Materials License [redacted] or the well location indicated on page 1 of the acknowledgement form.

7. Both the access control fence and the earthen barrier integrity must be maintained by the Well Owner/Operator for 3 years from the date of the tracer material injection or Date: _____. All associated signage and fences shall be removed within 30 days of the date listed in paragraphs 5 and 7.

8. Any failure by the Well Owner/Operator to promptly report solid material Well Returns that contain radioactive materials or to control such radioactive materials or to control such radioactive materials onsite may subject both ProTechnics and the Well Owner/Operator to regulatory enforcement by PADEP.

ProTechnics reserves the right to supervise any necessary decontamination activities should any actions occur that result in the loss of integrity of the earthen barrier.

Allard Affidavit: Attachment G

United States Government Accountability Office

GAO

Testimony
Before the Permanent Subcommittee on Investigations, Committee on Homeland Security and Governmental Affairs, U.S. Senate

For Release on Delivery
Expected at 9:00 a.m. EDT
Thursday, July 12, 2007

NUCLEAR SECURITY

Actions Taken by NRC to Strengthen Its Licensing Process for Sealed Radioactive Sources Are Not Effective

Statement of Gregory D. Kutz, Managing Director
Forensic Audits and Special Investigations

Gene Aloise, Director
Natural Resources and Environment

John W. Cooney, Assistant Director
Forensic Audits and Special Investigations

G A O
Accountability * Integrity * Reliability

GAO-07-1038T

July 12, 2007

GAO
Accountability · Integrity · Reliability

Highlights

Highlights of GAO-07-1038T, a testimony before the Permanent Subcommittee on Investigations, Committee on Homeland Security and Governmental Affairs, U.S. Senate

NUCLEAR SECURITY

Actions Taken by NRC to Strengthen Its Licensing Process for Sealed Radioactive Sources Are Not Effective

Why GAO Did This Study

The Nuclear Regulatory Commission (NRC) regulates domestic medical, industrial, and research uses of sealed radioactive sources. Organizations or individuals attempting to purchase a sealed source must apply for a license and gain the approval of either NRC or an "agreement state." To become an agreement state, a state must demonstrate to NRC that its regulatory program is compatible with NRC regulations and is effective in protecting public health and safety. NRC then transfers portions of its authority to the agreement state.

In 2003, GAO reported that weaknesses in NRC's licensing program could allow terrorists to obtain radioactive materials. NRC took some steps to respond to the GAO report, including issuing guidance to license examiners. To determine whether NRC actions to address GAO recommendations were sufficient, the Subcommittee asked GAO to test the licensing program using covert investigative methods.

What GAO Recommends

GAO recommends that NRC develop improved screening criteria to evaluate new license applications, conduct periodic reviews of license examiners to ensure the criteria are properly applied, and explore options to prevent license counterfeiting.

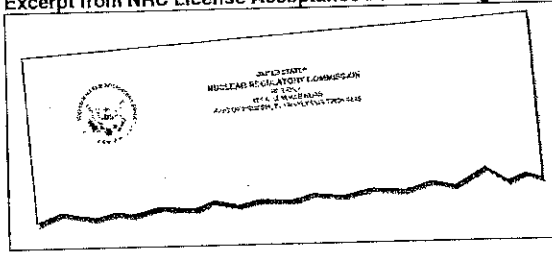
www.gao.gov/cgi-bin/getrpt?GAO-07-1038T.

To view the full product, including the scope and methodology, click on the link above. For more information, contact Gregory D. Kutz at (202) 512-7455 or kutzg@gao.gov or Gene Aloise at (202) 512-3841 or aloisee@gao.gov.

What GAO Found

By using the name of a bogus business that existed only on paper, GAO investigators were able to obtain a genuine radioactive materials license from NRC. Aside from traveling to a non-agreement state to pick up and send mail, GAO investigators did not need to leave their office in Washington, D.C., to obtain the license from NRC. Further, other than obtaining radiation safety officer training, investigators gathered all the information they needed for the license from the NRC Web site.

Excerpt from NRC License Acceptance Letter for Bogus Business



"This refers to your application dated February 2, 2007, for an NRC license. Enclosed with this letter is the license. Please review the enclosed document carefully and be sure that you understand all conditions..."

Source: GAO.

After obtaining a license from NRC, GAO investigators altered the license so it appeared that the bogus company could purchase an unrestricted quantity of radioactive sealed sources rather than the maximum listed on the approved license. GAO then sought to purchase, from two U.S. suppliers, machines containing sealed radioactive material. Letters of intent to purchase, which included the altered NRC license as an attachment, were accepted by the two suppliers. These suppliers gave GAO price quotes and commitments to ship the machines containing radioactive materials. The amount of radioactive material we could have acquired from these two suppliers was sufficient to reach the International Atomic Energy Agency's (IAEA) definition of category 3. According to IAEA, category 3 sources are dangerous if not safely managed or securely protected. Importantly, with patience and the proper financial resources, we could have accumulated substantially more radioactive source material.

GAO also attempted to obtain a license from an agreement state, but withdrew the application after state license examiners indicated they would visit the bogus company office before granting the license. An official with the licensing program told GAO that conducting a site visit is a standard required procedure before radioactive materials license applications are approved in that state.

As a result of this investigation, NRC suspended its licensing program until it could determine what corrective actions were necessary to resolve the weaknesses GAO identified. On June 12, 2007, NRC issued supplemental interim guidance with additional screening criteria. These criteria are intended to help a license examiner determine whether a site visit or face-to-face meeting with new license applicants is required.

Mr. Chairman and Members of the Subcommittee:

Thank you for the opportunity to discuss our covert testing of the Nuclear Regulatory Commission's (NRC) licensing process for sealed radioactive sources. Under the Atomic Energy Act of 1954, NRC regulates domestic medical, industrial, and research uses of sealed radioactive sources through a combination of regulatory requirements, licensing, inspection, and enforcement. Organizations or individuals attempting to purchase a sealed source must apply for a license and gain the approval of either NRC or an "agreement state." To become an agreement state, a state must first demonstrate to NRC that its regulatory program is compatible with NRC regulations and is effective in protecting public health and safety. Through an agreement between NRC and the state governor, NRC then transfers portions of its regulatory and licensing authority to the state. According to NRC, there are approximately 22,000 licenses in the United States—NRC administers about 4,400 licenses, and the rest are administered by regulatory authorities in the 34 agreement states.

Given that terrorists have expressed an interest in obtaining nuclear material, the Congress and the American people expect licensing programs for these materials to be secure. However, in 2003, we reported that weaknesses in the licensing program could allow terrorists to obtain radioactive materials. We recommended that NRC close this vulnerability by modifying its licensing process.[1] Among other things, we recommended that "NRC modify its process for issuing specific licenses to ensure that sealed radioactive sources cannot be purchased before NRC's verification—through inspection or other means—that the materials will be used as intended." NRC agreed with this recommendation and referred the issue to a working group composed of NRC and state representatives to coordinate NRC's response. In December 2005, the working group delivered its recommendations to NRC senior management. In December 2006, NRC issued new guidance to agreement states and NRC regional offices meant to strengthen the radioactive materials licensing process.[2] Although these are important steps forward, the Subcommittee remained concerned about whether, almost 6 years after September 11, 2001,

[1]GAO, *Nuclear Security: Federal and State Action Needed to Improve Security of Sealed Radioactive Sources*, GAO-03-804 (Washington, D.C.: Aug. 6, 2003).

[2]The guidance was also sent to officials in New Jersey, Pennsylvania, and Virginia—states that are not yet agreement states but have filed statements of intent with NRC to achieve agreement state status.

terrorists could still exploit weaknesses in the government's licensing process and obtain radioactive material. To determine whether NRC actions to address our 2003 recommendations were sufficient, the Subcommittee asked us to use covert investigative methods to test the licensing program.

To perform this investigation, we incorporated two bogus businesses—one in a non-agreement state and one in an agreement state. We selected these two states based on their proximity to the Washington, D.C., metro area. Using the names of the bogus businesses, we then prepared and submitted one application for a byproduct materials license to NRC and a second application to the department of the environment of the agreement state. In creating these applications, we only used publicly available information. Our investigators did not actually purchase radioactive materials for several reasons—first, the primary intent of our work was to test the licensing process rather than the purchasing process; second, we did not think the cost borne by the government would be necessary to prove the point of our work; and third, we did not have the proper facilities to safely store the radioactive materials. In performing research for this work, we reviewed our previous reports on nuclear security and learned about the licensing process from NRC's Web site. We altered the license we received from NRC, which enabled us to obtain agreements to purchase more radioactive material than the original license permitted. We conducted our investigative work from October 2006 through June 2007 in accordance with standards prescribed by the President's Council on Integrity and Efficiency.

In summary, we found the following:

- The license application we submitted to NRC was approved. We received a license in the mail from NRC about 4 weeks after submitting the application. Aside from traveling to a non-agreement state to pick up and send mail, our investigators did not need to leave their office in Washington, D.C., to obtain the license from NRC. Further, other than obtaining radiation safety officer training, investigators gathered all the information they needed for the license from the NRC Web site.

- After obtaining a license from NRC, we sought to purchase, from two U.S. suppliers, machines containing sealed radioactive material. Our letters of intent to purchase, which included an altered version of the NRC license as an attachment, were accepted by the suppliers. These suppliers gave us price quotes and commitments to ship the machines containing radioactive materials. The amount of radioactive material

we could have acquired from these two suppliers was sufficient to reach the International Atomic Energy Agency's (IAEA) definition of category 3. According to IAEA, category 3 sources are dangerous if not safely managed or securely protected and "could cause permanent injury to a person who handled them, or was otherwise in contact with them, for some hours. It could possibly—although it is unlikely—be fatal to be close to this amount of unshielded radioactive material for a period of days to weeks."[3] Importantly, with patience and the proper financial resources, we could have accumulated from other suppliers substantially more radioactive source material than what the two suppliers initially agreed to ship to us.

- We withdrew our second application from the agreement state department of the environment after license examiners indicated they would visit our company office before granting the license. Since we did not have a company office or the proper storage equipment, we asked the state to withdraw our application to obtain a license in this state. According to an official with the licensing program for this state, the completion of a site visit is a standard procedure before the state department of the environment approves a radioactive materials license application.

Background

Since the September 11, 2001, terrorist attacks there has been concern that certain radioactive material could be used in the construction of a radiological dispersion device (RDD). An RDD disperses radioactive material over a particular target area, which could be accomplished using explosives or by other means.[4] The major purpose of an RDD would be to create terror and disruption, not death or destruction. Depending on the type, form, amount, and concentration of radioactive material used, direct radiation exposure from an RDD could cause health effects to individuals in proximity to the material for an extended time; for those exposed for shorter periods and at lower levels, it could potentially increase the long-

[3]International Atomic Energy Agency, *Code of Conduct on the Safety and Security of Radioactive Sources* (Vienna, Austria: 2004).

[4]According to NRC, a dirty bomb is one type of RDD that combines a conventional explosive, such as dynamite, with radioactive material. The terms dirty bomb and RDD are often used interchangeably in the media. Most RDDs would not release enough radiation to kill people or cause severe illness—the conventional explosive itself could be more harmful to individuals than the radioactive material. However, depending on the scenario, an RDD explosion could create fear and panic, contaminate property, and require potentially costly cleanup.

term risks of cancer. In addition, the evacuation and cleanup of contaminated areas after dispersal could lead to panic and serious economic costs on the affected population. In 2003, a joint NRC/Department of Energy (DOE) interagency working group identified several radioactive materials (including Americium-241 and Cesium-137) as materials at higher risk of being used in an RDD, describing these as "materials of greatest concern."[5]

In its risk-based approach to securing radioactive sources, NRC has made a commitment to work toward implementing the provisions of IAEA's Code of Conduct. This document provides a framework that categorizes the relative risk associated with radioactive sources.[6] While NRC has recently focused on upgrading its capacity to track, monitor, and secure category 1 and 2 sources, which are considered high risk, category 3 sources are not a primary focus of NRC regulatory efforts. Category 3 sources include byproduct material, which is radioactive material generated by a nuclear reactor, and can be found in equipment that has medical, academic, and industrial applications. For example, a standard type of moisture gauge used by many construction companies contains small amounts of Americium-241 and Cesium-137. According to NRC, it would take 16 curies of Americium-241 to constitute a high-risk category 2 quantity, and 1.6 curies of Americium-241 is considered a category 3 quantity.

Results of Investigation

In October and November 2006, using fictitious names, our investigators created two bogus companies—one in an agreement state and one in a non-agreement state. After the bogus businesses were incorporated, our investigators prepared and submitted applications for a byproduct materials license to both NRC and the department of the environment for the selected agreement state. The applications, mailed in February 2007,

[5]The DOE/NRC Interagency Working Group on Radiological Dispersal Devices, *Radiological Dispersal Devices: An Initial Study to Identify Radioactive Materials of Greatest Concern and Approaches to Their Tracking, Tagging, and Disposition* (Washington, D.C.: 2003).

[6]NRC has endorsed the IAEA *Code of Conduct* and is working toward the implementation of its various provisions. On November 8, 2006, NRC issued a rule to require licensees to report information on the manufacture, transfer, receipt, disassembly, and disposal of all category 1 and 2 sources throughout their entire life cycle in the National Source Tracking System (NSTS). NRC's latest estimate is that the NSTS will be operational in May 2008. NRC told us that it has plans to consider including category 3 sources in the NSTS after the system becomes operational.

were identical except for minor differences resulting from variations in the application forms. Using fictitious identities, one investigator represented himself as the company president in the applications, and another investigator represented himself as the radiation safety officer. The license applications stated that our company intended to purchase machines with sealed radioactive sources.

According to NRC guidance finalized in November 2006 and sent to agreement states in December 2006, both NRC and agreement state license examiners should consider 12 screening criteria to verify that radioactive materials will be used as intended by a new applicant.[7] For example, one criterion suggests that the license examiner perform an Internet search using common search engines to confirm that an applicant company appears to be a legitimate business that would require a specific license. Another screening technique calls for the license examiner to contact a state agency to confirm that the applicant has been registered as a legitimate business entity in that state. If the examiner believes there is no reason to be suspicious, he or she is not required to take the steps suggested in the screening criteria and may indicate "no" or "not applicable" for each criteria. If the license examiner takes additional steps to evaluate a criterion, he or she should indicate what publicly available information was considered. If there is concern for a potential security risk, the guidance instructs license examiners to note the basis for that concern.

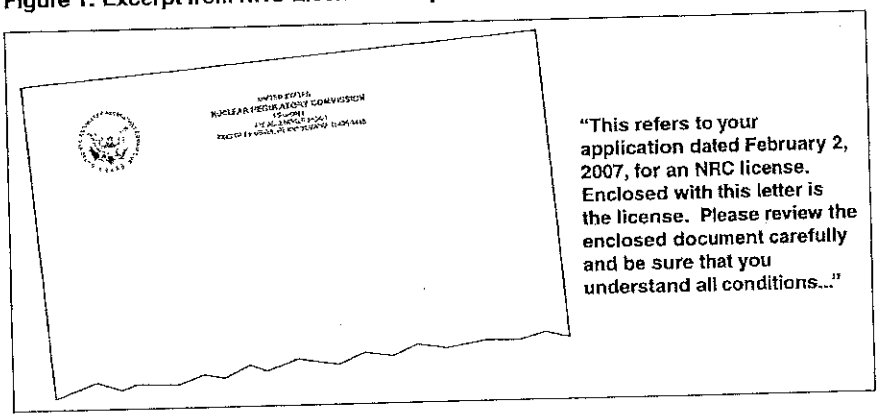
Application to NRC

Nine days after mailing their application form to NRC, our investigators received a call from an NRC license examiner. The NRC license examiner stated that the application was deficient in some areas and explained the necessary corrections. For example, the license examiner asked our investigators to certify that the machines containing sealed radioactive source material, which are typically used at construction sites, would be returned to the company office before being transported to a new construction site. The license examiner explained that this was a standard security precaution. Even though we did not have a company office or a construction site, our investigators nevertheless certified their intent to bring the machines back to their office before sending them to a new location. They made this certification via a letter faxed to NRC. Four days

[7]Nuclear Regulatory Commission, *Checklist to Ensure that Radioactive Materials Will Be Used As Intended*, NUREG-1556, Vol. 20, C (Washington, D.C.: Nov. 2006).

after our final correction to the license application, NRC approved our application and mailed the license to the bogus business in the non-agreement state. It took a total of 4 weeks to obtain the license. See figure 1 for the first page of the transmittal letter we received from NRC with our license.

Figure 1: Excerpt from NRC License Acceptance Letter for Bogus Business



Source: GAO.

The NRC license is printed on standard 8-1/2 x 11 inch paper and contains a color NRC seal for a watermark. It does not appear to have any features that would prevent physical counterfeiting. We therefore concluded that we could alter the license without raising the suspicion of a supplier. We altered the license so that it appeared our bogus company could purchase an unrestricted quantity of sealed source materials rather than the small amounts of Americium-241 and Cesium-137 listed on the original license. We determined the proper language for the license by reviewing publicly available information.

Next, we contacted two U.S. suppliers of the machines specified in our license. We requested price quotes and faxed the altered license to the suppliers as proof that we were certified to purchase the machines. Both suppliers offered to sell us the machines and provided us price quotes. One of these suppliers offered to provide twice as many machines as we requested and offered a discount for volume purchases. In a later telephone call to one of the suppliers, a representative of the supplier told us that his company does not check with NRC to confirm the terms listed on the licenses that potential customers fax them. He said that his company checks to see whether a copy of the front page of the license is faxed with the intent to purchase and whether the requested order

exceeds the maximum allowable quantity a licensee is allowed to possess at any one time.

Although we had no legitimate use for the machines, our investigators received, within days of obtaining a license from NRC, price quotes and terms of payment that would have allowed us to purchase numerous machines containing sealed radioactive source materials. These purchases would have substantially exceeded the limit that NRC approved for our bogus company. If these radioactive materials were unsealed and aggregated together, the machines would yield an amount of Americium-241 that exceeds the threshold for category 3 materials.

As discussed previously, according to IAEA, category 3 sources are dangerous if not safely managed or securely protected and "could cause permanent injury to a person who handled them, or was otherwise in contact with them, for some hours. It could possibly—although it is unlikely—be fatal to be close to this amount of unshielded radioactive material for a period of days to weeks." Importantly, with patience and the proper financial resources, we could have accumulated, from other suppliers, substantially more radioactive source material than what the two suppliers initially agreed to ship to us—potentially enough to reach category 2. According to IAEA, category 2 sources, if not safely managed or securely protected, "could cause permanent injury to a person for a short time (minutes to hours), and it could possibly be fatal to be close to this amount of unshielded material for a period of hours to days."

Application to the Agreement State

Ten days after mailing their application form to the agreement state's department of environment, our investigators received a call from a department license examiner. The license examiner stated that the application was deficient in some areas and said that she would send us a letter outlining what additional information the state required before approving the license. The examiner further stated that before the license was granted, she would conduct a site visit to inspect the company office and storage facilities cited in our application. Our investigators subsequently decided not to pursue the license in this state and requested that their application be withdrawn. According to an official in the department of environment for this state, the license examiner followed the required state procedure in requesting a site visit. The official told us that as a matter of long-standing state policy, license examiners in this state conduct site visits and interview company management (especially radiation safety officers) before granting new licenses for radioactive materials. This state policy is more stringent than the guidance NRC

provided agreement states in December 2006. The NRC guidance identified a site visit as one possible screening criterion to use in evaluating a new license application, but, as discussed above, a site visit is not required under the NRC guidance.

Corrective Action Briefing

On June 1, 2007, we contacted NRC and discussed the results of our work. An NRC official indicated that NRC would take immediate action to address the weaknesses we identified. After this meeting, we learned that NRC suspended its licensing program for specific licenses until it could determine what corrective actions were necessary to resolve the weaknesses. NRC also held a teleconference with a majority of the 34 agreement states to discuss our work. On June 12, 2007, NRC issued supplemental interim guidance with additional screening criteria. These criteria are intended to help a license examiner determine whether a site visit or face-to-face meeting with new license applicants is required. NRC told us that it planned to convene a working group to develop improved guidance addressing the weaknesses we identified.

Conclusions and Recommendations for Executive Action

NRC's goal is to provide licenses to only those entities that can demonstrate that they have legitimate uses for radioactive materials. However, our work shows that there continues to be weaknesses in the process NRC uses to approve license applications. In our view, a routine visit by NRC staff to the site of our bogus business would have been enough to reveal our lack of facilities and equipment. Furthermore, if NRC license examiners had conducted even a minimal amount of screening—such as performing common Web searches or making telephone calls to local government or business offices—they would have developed serious doubts about our application. Once we received our license, the ease with which we were able to alter the license and obtain price quotes and commitments to ship from suppliers of radioactive materials is also cause for concern. Accordingly, we are making the following three recommendations to the Chairman of the NRC:

- First, to avoid inadvertently allowing a malevolent individual or group to obtain a license for radioactive materials, NRC should develop improved guidance for examining NRC license applications. In developing improved screening criteria, NRC should consider whether site visits to new licensees should be mandatory. These improved screening criteria will allow NRC to provide reasonable assurance that licenses for radioactive materials will only be issued to those with legitimate uses.

- Second, NRC should conduct periodic oversight of license application examiners so that NRC will be assured that any new guidance is being appropriately applied.
- Third, NRC should explore options to prevent individuals from counterfeiting NRC licenses, especially if this allows the purchase of more radioactive materials than they are approved for under the terms of the original license.

Mr. Chairman, this concludes our statement. We would be pleased to answer any questions that you or other Members of the Subcommittee may have at this time.

Contacts and Acknowledgments

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The Washington Post

Sting Reveals Security Gap at Nuclear Agency

Advertisement
WGL Energy

By Kathleen Day
Washington Post Staff Writer
Thursday, July 12, 2007

Undercover congressional investigators posing as West Virginia businessmen obtained a license with almost no scrutiny from the Nuclear Regulatory Commission that enabled them to buy enough radioactive material from U.S. suppliers to build a "dirty bomb," a new government report says.

The investigators obtained the license within 28 days from officials at the NRC, the federal agency that in addition to regulating nuclear power plants oversees radioactive materials used in health care and industry, the report by the Government Accountability Office says. NRC officials approved the request with a minimal background check that included no face-to-face interview or visit to the purported company to ensure it existed and complied with safety rules, the report says.

Using a post-office box at Mail Boxes Etc., a telephone and a fax machine, the undercover investigators from the GAO obtained the license "without ever leaving their desks," the report says.

After counterfeiting copies of the license, the GAO undercover agents ordered portable moisture density gauges, which contain radioactive americium-241 and cesium-137 and are commonly used at construction sites to analyze the properties of soil, water and pavement. The investigators ordered 45 gauges -- enough to build a bomb with enough radioactive material to qualify as a level-3 threat on the International Atomic Energy Agency's scale of 1 to 5, with 1 being the most hazardous.

The GAO investigators never took possession of the radioactive material, in part because they lacked the means to handle it safely. But the report notes that, armed with an arsenal of phony licenses, they could have secured contracts to buy much more than they did -- enabling them to make an even more lethal bomb.

"We altered the license so that it appeared our bogus company could purchase an unrestricted quantity" of radioactive material, the report says. A dirty bomb is designed to use conventional explosives to cause immediate injury to people nearby but also to cause a long-lasting threat by contaminating a wider area with radioactive material.

The GAO undertook the sting operation at the request of Sen. Norm Coleman (R-Minn.), the top minority member of the Senate permanent subcommittee on investigations, which since 2003 has been examining security gaps at the NRC and other federal agencies that could leave the country

vulnerable to biological or nuclear attack. The report is to be the subject of hearings today before the subcommittee .

The GAO study is the latest of several government reports following the Sept. 11, 2001, terrorist attacks to warn of serious security gaps in NRC licensing procedures. A year ago, undercover GAO officials successfully bought enough radioactive material abroad to make two dirty bombs and smuggled them into the United States at two points, one on the Canadian border and one on the border with Mexico.

"It was as easy to get his material as a DVD at Netflix," Coleman said of the most recent investigation. "If al-Qaeda had set up a phony corporation in the U.S., they could have gathered enough material to make a dirty bomb. The problem is that the NRC is still operating on a pre-9/11 mentality. It boggles my mind that the NRC doesn't readily understand the threat we face."

NRC commissioner Edward McGaffigan Jr. said in an interview yesterday that the agency, while concerned about any security weakness, has had to allocate finite resources to what it thinks are the biggest potential threats to public safety. He said terrorists have looked for relatively simple ways to cause massive death and damage. Devices such as the moisture gauges, he said, pose a relatively low-level risk because they require a vast amount of work to fashion into a dangerous weapon.

"My sole concern, our sole concern, has been the safety of the American people," he said.

After the GAO presented the NRC with the results of its undercover operation, NRC officials on June 1 ordered an immediate, temporary halt in new licenses to handle radiation risks of 3 or lower. The agency lifted the ban two weeks later after modifying its procedures to require either a face-to-face meeting or site visit, McGaffigan said. The NRC already requires site visits before issuing licenses to handle material with risk levels of 1 and 2.

McGaffigan, who is to testify on behalf of the NRC at the hearing, acknowledged that one serious hurdle remains. "We have to fix the problem of people taking our licenses and counterfeiting them," he said.

In a report in 2006 and again this year, the NRC's inspector general criticized NRC officials for failing to detect and understand security flaws in its licensing process.

Coleman and other critics say the NRC essentially has ignored warnings for years and has done too little to remedy problems that would make it easier for someone to make a dirty bomb. Coleman called the NRC's efforts since June 1 "baby steps" that are insufficient and particularly outrageous because the agency has taken so long to act despite having been warned of serious flaws for more than four years.

When GAO investigators briefed Coleman on the results of the most recent operation, they said they focused the sting on West Virginia in part to show how close to the nation's capital a terrorist could build a bomb. Such proximity would reduce the chance of detection during transport to a target, the GAO briefers said, according to Senate staff members who heard the briefing.

In addition, by operating from West Virginia, the GAO undercover investigators were required to deal directly with the NRC. That's because West Virginia is one of more than a dozen states, including Virginia and the District of Columbia, that don't have their own system for issuing licenses for the handling of radioactive material and monitoring those who apply for them.

During the sting operation, an NRC official speaking to one of the phony businessmen on the phone said the agency needed to speak to the man's boss. The GAO agent put him on hold for a minute or two, then picked up the call without disguising his voice but pretending to be his boss, according to people familiar with the GAO investigation. The NRC reviewer accepted the calls at face value.

By contrast, the GAO investigators failed to obtain a license in Maryland, which is one of 34 states that under agreement with the NRC conduct their own licensing. Maryland officials told the disguised GAO employees that state inspectors would have to visit their company and perform other checks, which would take at least seven months. At that point, the phony businessmen withdrew their application, the report says.

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U.S.

GAO Sting Uncovers Nuclear Security Shortcomings

Updated July 12, 2007 · 10:43 AM ET
Published July 12, 2007 · 10:16 AM ET

Hear NPR's David Kestenbaum

Embed

A undercover sting exposed major problems with Nuclear Regulatory Commission procedures, when investigators operating a bogus company obtained a license to buy enough radioactive material to make a small "dirty bomb."

The investigators from the Government Accountability Office demonstrated that security measures put in place after the Sept. 11, 2001, attacks are insufficient, according to a report scheduled for release on Thursday.

Sen. Norm Coleman (R-MN), who will ask the NRC about the incident at a Senate hearing Thursday, said the sting operation raises concerns about terrorists obtaining such material just as easily.

Nobody at the NRC checked to determine whether the company was legitimate, and an agency official even helped the investigators fill out the application form, Coleman said Wednesday.

Nuclear Regulatory Commission officials acknowledged that more checks are needed before licenses are issued, and the agency has tightened procedures since learning of the GAO sting.

"We've fixed the problem," said NRC Commissioner Edward McGaffigan on Wednesday. He said that such licenses now will require visits to the company or, in some cases, company officials will have to come to NRC offices.

The license obtained by the bogus company allowed for the purchase of up to five portable moisture density gauges widely used in construction, in which are encased small amounts of cesium-137 and americium 241, two highly radioactive isotopes.

Individually, these devices pose little threat because of the small amount of radioactive material, radiation experts said. Still, the devices require an NRC license to be purchased and must be closely safeguarded by companies that use them to avoid theft.

But the investigators from the GAO, Congress' investigative arm, found a way to purchase as many as 45 of the gauges and could have bought many more because they duplicated the NRC-issued license and removed the restrictions on the amount that could be purchased.

"With patience and the proper financial resources, we could have accumulated from other suppliers substantially more radioactive source material than what the two supplies initially agreed to ship to us," said the GAO in a report.

Coleman, the ranking Republican on the Homeland Security and Governmental Affairs investigations subcommittee, said the NRC "still has this good-faith assumption. The problem is there are bad-faith people out there."

He said "there is no question" they could have obtained enough radioactive material to make a dirty bomb because the GAO was able to duplicate the certificate, and no one checked on the company or whether the counterfeit license was legitimate.

A so-called dirty bomb could spread radiation by a conventional explosion but does not have a nuclear detonation. While experts believe such a bomb would not cause casualties beyond those affected by the explosion, such an attack could have significant psychological impact and have serious economy consequences because of cleanup problems.

In testimony to be presented to the Senate subcommittee, McGaffigan will acknowledge that NRC licensing officers "were allowed to exercise judgment" on whether to require company site visits when considering licenses for moisture gauges and other devices with relatively small amounts of radioactive material.

The GAO sting operation "has raised issues about the adequacy of these procedures," McGaffigan will say. The NRC is considering enhancements to assure license documents can't be easily altered.

The GAO said that investigators operated the sting from their Washington office, although they provided a postal box in West Virginia. At one point, an NRC license examiner called them to caution that the gauges are subject to special security at the construction site.

The GAO said that it contacted two suppliers of the gauges and that one "offered to provide twice as many machines as we requested and offered a discount for volume purchases." The investigators also were told that the supplier does not check with NRC to confirm the terms on the license, a copy of which was sent to the supplier along with the purchase order.

The GAO investigators never finished the deal because they didn't have the money to buy the machines - which cost about $5,000 apiece - and also didn't have a place to safely store them.

The GAO also tried to get a license from the state of Maryland, one of 34 states that the NRC has given authority to handle such licensing. Unlike the NRC, the Maryland officials said they wanted to visit the company, so the investigators withdrew their application.

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Nuclear terrorist threat bigger than you think

By Joe Cirincione

Updated 5:53 PM ET, Fri April 1, 2016

Were Brussels terrorists trying to build 'dirty bomb'? 03:54

Story highlights

Joe Cirincione: I don't know a single nuclear expert who thinks threat of nuclear terrorism is shrinking

Editor's Note: Joe Cirincione is the president of Ploughshares Fund, a global security foundation. He is the author of "Nuclear Nightmares: Securing the World Before It Is Too Late," and "Bomb Scare: The History and Future of Nuclear Weapons." He serves on the secretary of state's International Security Advisory Board. The views expressed are his own.

Nations need to do more to reduce and better protect nuclear reactors and spent nuclear fuel

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(CNN) — Nuclear policy experts can seem like Cassandra, constantly prophesizing apocalyptic futures. In case you haven't noticed, we don't live in a Mad Max world devastated by nuclear war. Terrorists have not blown up New York with a makeshift nuclear bomb. We haven't bankrupted ourselves, despite the trillions of dollars spent on Cold War weapons.

Cassandra's curse, however, was not that she was wrong, but that no one believed her. I don't know a single nuclear expert who thinks that the threat of nuclear terrorism is shrinking. I don't know a single one who thinks that the actions taken by world leaders at this week's Nuclear Security Summit are enough. We are fearful. And you should be, too.

Joe Cirincione

Chills went down a lot of experts' spines last month when we saw the news that the Brussels bombers, the ISIS terrorists who blew up the airport and attacked the metro, were secretly videotaping a Belgian nuclear official. This official worked at a facility that had radiological material that terrorists could use for a "dirty bomb." We do not know if they were filming him or his family, if there was a kidnap plot in motion, or what their exact plans were. But this is not some Hollywood fantasy. This is real. A nuclear terrorist event may be closer than you think.

What are the risks? First, that terrorists could steal a complete nuclear weapon, like SPECTRE in the James Bond thriller, "Thunderball." This is hard, but not impossible. The key risk is that the outside terrorists get insider help: For example, a radical jihadist working at a Pakistan weapon storage site. Or the Belgian base just outside Brussels where we still stash a half-dozen nuclear weapons left over from Cold War deployments. Or the Incirlik air base in Turkey where we keep an estimated 50 weapons just 200 miles from the Syrian border.

Second, terrorists could steal the "stuff" of a bomb, highly enriched uranium or plutonium. They cannot make this themselves -- that requires huge, high-tech facilities that only nations can construct. But if they could get 50 or 100 pounds of uranium -- about the size of a bag of sugar -- they could construct a crude Hiroshima-style bomb. ISIS, with its money, territory and global networks, poses the greatest threat to do this that we have ever seen. Such a bomb brought by truck or ship or FedEx to an urban target could kill hundreds of thousands, destroy a city and put the world's economy and politics into shock.

Third, there is the possibility of a dirty bomb. Frankly, many of us are surprised this has not happened already. I spoke to Jon Stewart on his show 15 years ago about the danger. This is not a nuclear explosion unleashed by splitting atoms, but simply a conventional explosive, like dynamite, laced with radioactive material, like cesium or strontium. A 10-pound satchel of dynamite mixed with less than 2 ounces of cesium (about the size of a pencil eraser) could spew a radioactive cloud over tens of square blocks. No one would die, unless they were right next to the explosion. But the material would stick to the buildings. Inhaling just a speck would greatly increase your risk of getting cancer. You could go into the buildings, but no one would. There would be mass panic and evacuations, and the bomb would render a port, financial district, or government complex unusable and uninhabitable for years until scrubbed clean. Economic losses could be in the trillions.

Opinion +

Fourth, terrorists could just attack a nuclear power reactor, fuel storage or other site to trigger a massive radioactive release that could contaminate hundreds or thousands of square miles, like Chernobyl or Fukushima. While nuclear reactors are hardened against outside attack, including by the intentional crash of a medium-sized jet plane, larger planes could destroy them. Or a series of suicide truck bombers. But it might not even take a physical explosion. This week, it was reported the United States and the United Kingdom are to simulate a cyberattack on a nuclear power plant.

Related Article: North Korea doesn't have an H-bomb (Opinion)

Can we prevent these attacks? Yes, by eliminating, reducing and securing all supplies of nuclear materials so that terrorists would find it too difficult to get them. And by reducing and better protecting nuclear reactors and spent nuclear fuel.

Are we doing enough? No. "The capabilities of some terrorist groups, particularly the Islamic State, have grown dramatically," says Harvard scholar and former Bush Administration official William Tobey, "In a net calculation, the risk of nuclear terrorism is higher than it was two years ago."

The United States spends about $35 billion on nuclear weapons every year. This year, we will spend $1.8 billion on all our efforts to stop the spread these weapons and stop nuclear terrorism. You don't have to be a nuclear expert to know something is out of whack here.

It is time we put our money where our threats are.

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Report to Congressional Requesters

June 2014

NUCLEAR NONPROLIFERATION

Additional Actions Needed to Increase the Security of U.S. Industrial Radiological Sources

GAO-14-293

June 2014

GAO Highlights

NUCLEAR NONPROLIFERATION

Additional Actions Needed to Increase the Security of U.S. Industrial Radiological Sources

Highlights of GAO-14-293, a report to congressional requesters

Why GAO Did This Study

In 2012, GAO identified security weaknesses at U.S. medical facilities that use high-risk radiological sources, such as cesium-137. This report addresses potential security risks with such sources in the industrial sector. Radioactive material is typically sealed in a metal capsule called a sealed source. In the hands of a terrorist, this radioactive material could be used to construct a "dirty bomb." NRC is responsible for licensing and regulating the commercial use of radiological sources. NNSA provides voluntary security upgrades to facilities with such sources. GAO was asked to review the security of sources at industrial facilities. This report examines (1) the challenges in reducing security risks posed by industrial radiological sources and (2) the steps federal agencies are taking to improve security of the sources. GAO reviewed relevant laws, regulations, and guidance; interviewed federal agency and state officials; and visited 33 of about 1,400 U.S. industrial facilities selected based on, among other things, geographic location and type of device using the radiological source.

What GAO Recommends

GAO recommends, among other things, that NRC assess the T&R process to determine if it provides reasonable assurance against insider threats. In addition, GAO recommends that NNSA, NRC, and DHS review their collaboration mechanism for opportunities to enhance it, especially in the development of new technologies. NRC generally agreed with GAO's recommendations, and NNSA agreed with the one recommendation directed to it. DHS did not comment on the report.

View GAO-14-293. For more information, contact David C. Trimble at (202) 512-3841 or trimbled@gao.gov.

What GAO Found

GAO found that challenges exist in reducing the security risks faced by licensees using high-risk industrial radiological sources. Specifically, licensees face challenges in (1) securing mobile and stationary sources and (2) protecting against an insider threat. Regarding mobile sources, their portability makes them susceptible to theft or loss, as the size of some of these sources is small enough for them to be easily concealed. The most common mobile source is contained in a device called a radiography camera. GAO identified four incidents from 2006 to 2012 where such cameras that use high-risk sources to test pipeline welds were stolen. These thefts occurred even though the Nuclear Regulatory Commission (NRC) has established increased security controls. Licensees also face challenges in determining which employees are suitable for trustworthiness and reliability (T&R) certification to have unescorted access to high-risk radiological sources. GAO found two cases where employees were granted unescorted access, even though each had extensive criminal histories, and one had been convicted for terroristic threats, which include a range of violent threats. In this case, NRC said that the person was convicted not of a threat against the United States, but of making violent verbal threats against two individuals. It is unclear whether these cases represent isolated incidents or a systemic weakness in the T&R process established by NRC. Without an assessment of the process, NRC may not have reasonable assurance that access decisions made by licensees can prevent threats to high-risk radiological sources, particularly by a determined insider.

Federal agencies responsible for securing radiological sources—including NRC, the National Nuclear Security Administration (NNSA), and the Department of Homeland Security (DHS)—have taken steps to improve the security of industrial radiological sources. For example, NRC is developing a best practices guide that is expected to provide licensees with practical information about how to secure their sources. Also, NNSA is developing new technology that would, if successful, improve tracking of radiological sources while in transit. However, GAO found that although the agencies have been meeting quarterly to discuss, among other things, radiological security, this mechanism did not always help them collaborate and draw on each agency's expertise during research, development, and testing of a new technology for a mobile source tracking device. By not collaborating consistently, the agencies have missed opportunities to leverage resources and expertise in developing this new technology to track radiological sources. This technology could aid in the timely recovery of a lost or stolen radiological source and support the agencies' common mission. As GAO has previously reported, when responsibilities cut across more than one federal agency—as they do for securing industrial radiological sources—it is important for agencies to work collaboratively to deliver results more efficiently and in a way that is consistent with the federal government's multiple demands and limited resources.

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Abbreviations

DHS	Department of Homeland Security
DOE	Department of Energy
DOT	Department of Transportation
FBI	Federal Bureau of Investigation
GPS	Global Positioning System
GTRI	Global Threat Reduction Initiative
IAEA	International Atomic Energy Agency
NNSA	National Nuclear Security Administration
NRC	Nuclear Regulatory Commission
NSTS	National Source Tracking System
PNNL	Pacific Northwest National Laboratory
T&R	trustworthiness and reliability
USDA	United States Department of Agriculture

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GAO U.S. GOVERNMENT ACCOUNTABILITY OFFICE
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June 6, 2014

The Honorable Thomas R. Carper
Chairman
The Honorable Tom Coburn, M.D.
Ranking Member
Committee on Homeland Security and Governmental Affairs
United States Senate

The Honorable Claire McCaskill
Chairman
Subcommittee on Financial and Contracting Oversight
Committee on Homeland Security and Governmental Affairs
United States Senate

The Honorable Robert P. Casey, Jr.
United States Senate

Radioactive material is used worldwide for legitimate commercial purposes, including industrial processes in the oil and gas, aerospace, and food sterilization sectors. Material used for these purposes is typically sealed in a metal capsule, such as stainless steel, titanium, or platinum, to prevent its dispersal and is commonly called a sealed source.[1] Some of these sources are highly radioactive and are found in a wide variety of devices, ranging from mobile industrial radiography sources containing hundreds of curies of iridium-192 to larger irradiators with thousands, or even millions, of curies of cobalt-60.[2] The facilities where these sources are contained include, among other things, warehouses, commercial facilities, and research buildings.

In the hands of terrorists, these sources could be used to produce a simple and crude, but potentially dangerous weapon, known as a radiological dispersal device or dirty bomb, whereby conventional

[1]Such material includes americium-241, cesium-137, cobalt-60, and iridium-192.

[2]A curie is a unit of measurement of radioactivity. In modern nuclear physics, it is precisely defined as the amount of substance in which 37 billion atoms per second undergo radioactive disintegration. In the international system of units, the becquerel is the preferred unit of radioactivity. One curie equals 3.7×10^{10} becquerels.

explosives are used to disperse radioactive material. Previous incidents involving radiological sources provide a measure of understanding for what could happen in the case of a dirty bomb attack. For example, in 1987, an accident involving an abandoned teletherapy machine, which is used to treat cancer by focusing a beam of radiation from a highly active radiological source at affected tissue, killed four people and injured more in central Brazil. The radiological source in the teletherapy device contained about 1,400 curies of cesium-137. The accident and its aftermath caused about $36 million in damages to the region, according to an official from Brazil's Nuclear Energy Commission. The accident significantly contaminated 85 houses and created environmental and medical problems. The decontamination process required the demolition of homes and other buildings and generated 3,500 cubic meters of radioactive waste. Furthermore, over 8,000 persons requested monitoring for contamination in order to obtain certificates stating they were not contaminated.

Concerns about thefts of radiological sources and the possible consequences of a dirty bomb attack persist. Their potential vulnerability to theft was highlighted in December 2013 when a truck in Mexico carrying a cobalt-60 source formerly used in medical treatment was stolen. Although the source was recovered 2 days later, officials from the National Nuclear Security Administration (NNSA), a separately organized semiautonomous agency within the Department of Energy (DOE), said that it was opened by the thieves, and they were uncertain whether the intended target of the theft was the truck or the source.

Furthermore, the Mexico case is not unique. According to the International Atomic Energy Agency (IAEA), there have been 615 confirmed incidents involving theft or loss of nuclear and radioactive materials around the world since 1993.[3] IAEA's Code of Conduct on the Safety and Security of Radioactive Sources serves as a guide to define high-risk radiological sources that warrant enhanced security and protection beyond what was applied before September 11, 2001. This includes Category 1 and Category 2 quantities of 16 radionuclides listed

[3]IAEA is an independent organization based in Vienna, Austria, that is affiliated with the United Nations and has the dual mission of promoting the peaceful uses of nuclear energy and verifying that nuclear materials intended for peaceful purposes are not diverted to military purposes.

in the Code of Conduct that pose the highest risk and thus warrant enhanced security and protection.[4]

The threat of an individual stealing a radiological source includes both an outsider and potential insider threat. According to the Federal Bureau of Investigation's (FBI) website, a company can often detect an outsider (nonemployee) and mitigate the threat of them stealing company property. However, the individual who is harder to detect is the insider—the employee with legitimate access.

The Nuclear Regulatory Commission (NRC) is responsible for licensing the commercial use of and regulating the security of radiological sources in the United States, including at industrial facilities. As part of its security role, NRC also issues legally binding requirements in the form of orders and regulations governing, among other things, the security of radiological sources. These controls address the need to secure these materials from outsider and insider threats. NRC may take enforcement actions against licensees who are found to have violated its regulations.[5] The actions may include notices of violation, monetary fines, or modifying, suspending, or revoking a license. In addition, 37 states are responsible for implementing licensing programs for industrial radiological sources, including security inspections—these states are referred to as "Agreement States."[6]

NNSA develops and implements policy and programs to prevent the proliferation of nuclear and radiological materials around the world. In 2008, NNSA established the Global Threat Reduction Initiative (GTRI)

[4]Within its categorization system, IAEA considers sources in Category 1 to be the most dangerous because they can pose a very high risk to human health if not managed safely and securely. Although the curie amount is less for Category 2 sources, they are also considered dangerous by IAEA.

[5]A licensee is a company, organization, institution, or other entity to which NRC or state agencies have granted a general license or specific license to construct or operate a nuclear facility, or to receive, possess, use, transfer, or dispose of source material, by-product material, or special nuclear material.

[6]42 U.S.C. § 2021(b) (2013). These states have entered into an agreement with NRC, whereby NRC has relinquished authority, and they have assumed regulatory authority over certain byproduct, source, and small quantities of special nuclear materials. Agreement States typically oversee radiological security through their state health or environment departments, and they inspect licensees to ensure compliance with state regulations that are generally compatible with NRC regulations.

domestic program, which among other things, provides security upgrades, such as motion sensors and alarms, to U.S. facilities with high-risk radiological sources beyond what NRC requires.[7] NNSA's program provides security upgrades only when requested by licensees and, as such, is a voluntary program. When requested, and subject to funding, NNSA assesses existing security conditions, recommends security enhancements, and funds the procurement and installation of jointly agreed-upon security measures that are consistent with best practices NNSA has identified. NNSA officials said that they would typically recommend that licensees (1) implement access controls, cameras, and critical remote monitoring systems; (2) relocate radiological sources to more secure locations at facilities; (3) install reinforced glass on interior windows that are in proximity to the source; and (4) cover or reinforce exterior openings such as skylights. Licensees are not required to implement NNSA's recommendations.

In addition to NRC and NNSA, the Department of Homeland Security (DHS) also plays a role in nuclear and radiological security. DHS is the primary federal agency for implementing domestic nuclear detection efforts for a managed and coordinated response to radiological and nuclear threats.

This report responds to your request that we review the security of radiological sources at U.S. industrial facilities. For this report, we evaluated (1) the challenges in reducing the security risks posed by high-risk industrial radiological sources and (2) the steps federal agencies are taking to ensure that high-risk industrial radiological sources are secured.

To conduct this work, we reviewed laws, regulations, and guidance related to the security of industrial radiological sources. We interviewed agency officials at NRC, NNSA, DHS, the Department of Transportation (DOT), and the United States Department of Agriculture (USDA). We also interviewed state government officials in three states, and safety and

[7]According to NNSA documents, the GTRI program partners with more than 100 countries to reduce and protect vulnerable nuclear and radiological material located at civilian sites worldwide. The program works to prevent terrorists from acquiring materials that could be used in a weapon of mass destruction, a crude nuclear bomb, a radiological dirty bomb, or other acts of terrorism. GTRI achieves its mission through three goals: convert research reactors and isotope production facilities from highly enriched uranium to low enriched uranium, remove and dispose of excess nuclear and radiological materials, and protect high-risk nuclear and radioactive materials from theft.

security personnel at 33 industrial facilities in six states, to obtain their views on how radiological sources are secured and what challenges they face in securing them. To identify thefts and incidents involving radiological sources we reviewed relevant documentation and spoke to federal and state officials. To determine the risks faced by industrial licensees of radiological sources, we visited 33 of about 1,400 industrial facilities in California, Colorado, Hawaii, Pennsylvania, Texas, and Wyoming. These facilities included 15 industrial radiography companies, 6 commercial or sterilization companies, 5 academic research facilities, 3 well logging companies, 2 manufacturing and distribution companies, and 2 USDA facilities. We selected these states and industrial facilities based on whether they were NRC states or Agreement States, the amount of curies contained in the devices using radiological sources, and the types of radiological devices. The facility information is not generalizable to all industrial facilities but provides illustrative examples. At the facilities, we observed the security measures in place and spoke to officials in charge of implementing NRC and Agreement State security controls and overseeing the security measures.

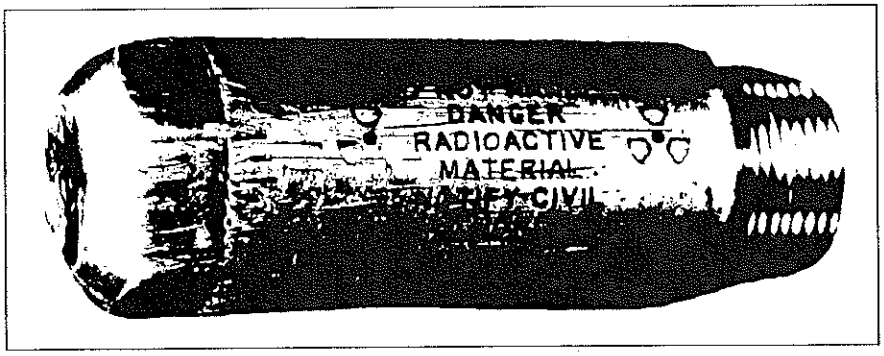
To evaluate the steps federal agencies are taking to ensure the radiological sources are secured at industrial facilities, we obtained information from and interviewed agency officials at NRC, NNSA, DOT, DHS, and USDA who are involved in securing sources and undertaking studies evaluating technologies related to source security. We also obtained information from Agreement States and NRC regions by reviewing documentation and interviewing officials at four Agreement States and one NRC regional office with responsibility for overseeing high-risk radiological sources. We selected these states and the NRC region based on the amount of curies and number of devices in the state containing radiological sources, the types of devices used, and geographic dispersion. We also interviewed officials at DOE's Pacific Northwest National Laboratory (PNNL) about the status of GTRI efforts made to strengthen remote tracking of mobile devices containing radiological sources. We visited industrial facilities that received NNSA funded upgrades and security assessments in California, Hawaii, and Pennsylvania. To determine the costs of these security upgrades, we obtained cost data from NNSA and interviewed the agency officials who manage the GTRI program. We discussed the reliability of these data with knowledgeable NNSA officials and questioned them about the system's controls to verify the accuracy and completeness of the data. We also analyzed these data for missing information and obvious outliers. We found the data sufficiently reliable for our reporting purposes. Appendix I presents a more detailed description of our scope and methodology.

We conducted this performance audit from November 2012 to June 2014 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

Radiological sources are used throughout the world for medical and industrial purposes. Until the 1950s, only naturally occurring radioactive materials, such as radium-226, were available for use in radiological sources. Since then, sources containing radioactive material produced artificially in nuclear reactors and accelerators have become widely available, including cesium-137, cobalt-60, and iridium-192. Sealed sources vary in size from the size of a grain of rice to rods up to several inches in length. Figure 1 provides an image of an americium-241 sealed radiological source.

Figure 1: Sealed Radiological Source That Contains Americium-241



Source: DOE.

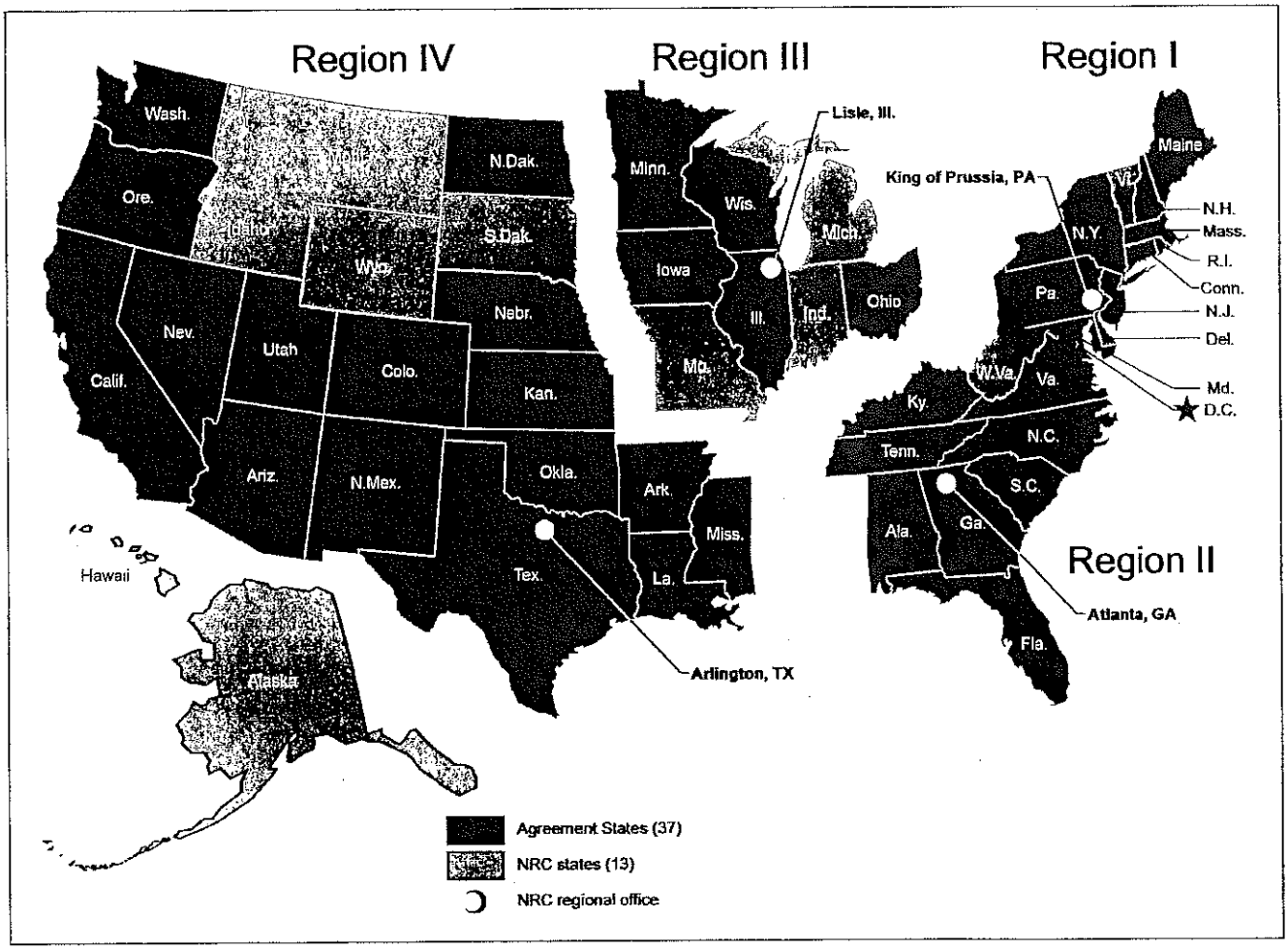
Note: This sealed source is not sized to scale.

According to IAEA, the level of protection provided by users of radioactive materials should be commensurate with the safety and security risks that the material presents if improperly used. For example, radioactive materials used for certain diagnostic imaging may not present a significant safety or security risk due to their low levels of activity. However, high-risk sealed radiological sources that contain cobalt-60, cesium-137, or iridium-192 could pose a greater threat to the public and the environment and a potentially more significant security risk, particularly if acquired by terrorists to produce a dirty bomb. Industrial

radiological sources are used in, among other things: (1) industrial radiography devices for testing the integrity of welds, (2) well logging devices in oil and gas production, (3) research irradiators in the aerospace sector, and (4) panoramic and underwater irradiators used to sterilize industrial products.

NRC oversees licensees through three regional offices located in Pennsylvania, Illinois, and Texas. NRC has relinquished regulatory authority for licensing and regulating radiological sources to 37 Agreement States that have entered into an agreement with NRC. Figure 2 shows which states are overseen by NRC and which are Agreement States.

Figure 2: Map of Nuclear Regulatory Commission (NRC) Regions and 37 Agreement States



Sources: GAO; Map Resources (map).

Note: Although the figure depicts NRC's four regions, three of the four regions oversee licensees with radiological sources. Region I, located in Pennsylvania, oversees industrial facilities within Region II that have radiological sources. Regions III and IV oversee such facilities within their respective regions.

Prior to 2003, NRC did not have specific orders intended to address security, but its safety regulations included general provisions that licensees "secure from unauthorized removal or access" radiological sources in storage, and to "control and maintain constant surveillance"

over materials not in storage.[8] Following the attacks of September 11, 2001, NRC determined that certain licensed material should be subject to specific security requirements.[9] The security of radioactive materials, or sources, is a stated top priority for the agency to prevent the use of such sources by terrorists. NRC has issued multiple orders and guidance documents that direct licensees possessing high-risk radiological sources to implement security measures. For the purposes of this report, we refer to these NRC security orders and implementation guidance as "NRC security controls" or "security controls." NRC's security controls apply to all types of high-risk industrial radiological sources, including mobile and stationary sources. These security controls include the following:

- A 2003 security order requiring increased security measures for licensees with panoramic and underwater irradiators.[10]
- A 2003 security order requiring increased security measures for licensees that manufacture and distribute radiological sources.[11]
- A 2005 security order directing all licensees possessing certain types of radiological materials, including those commonly used in industrial processes, to implement increased security measures, such as conducting employee background checks.[12] Implementation guidance was provided with the security order.[13]

[8]10 C.F.R. §§ 20.1801, 20.1802 (2014).

[9]NRC refers to the security controls as "increased" or "enhanced" controls, indicating an increased level of security after September 11, 2001, as compared with the safety requirements that provided some security.

[10]Order Imposing Compensatory Measures for All Panoramic and Underwater Irradiators Authorized to Possess Greater than 10,000 Curies of Byproduct Material in the Form of Sealed Sources. NRC Order EA-02-249.

[11]Order Imposing Additional Security Measures for all Licensees Authorized to Manufacture or Initially Transfer Items Containing Radioactive Material for Sale or Distribution and Possess High-Risk Radioactive Material of Concern. NRC Order EA-03-225.

[12]Order Imposing Increased Controls. NRC Order EA-05-090. NRC issues security orders to require licensees to implement interim security measures beyond what is currently required by NRC regulations and as conditions of licenses.

[13]Order Imposing Increased Controls. NRC Order EA-05-090, including Enclosures, Attachments, and Supplemental Questions and Answers.

- A 2007 security order requiring criminal background checks and fingerprinting for individuals needing unescorted access to radiological material for their jobs. Fingerprints are required to be sent to NRC, which forwards them to the FBI for criminal background checks.[14] Implementation guidance was also provided with this order.[15]

NRC officials told us that they have adopted a risk-based approach to security in which the level of security should be commensurate with the type and amount of sources that licensees are attempting to protect. According to NRC officials, the intent of the security controls is to develop a combination of people, procedures, and equipment that will delay and detect an intruder and initiate a response to the intrusion—not to provide absolute certainty that theft or unauthorized access will not be attempted, but to recognize and address such efforts should they occur. The security controls provide minimum requirements that must be met to ensure adequate security, and licensees may go beyond the minimum requirements.

NRC has recently taken action to codify its security orders and guidance into federal regulation. In March 2012, NRC approved the publication of final regulations to, among other things, establish requirements for security measures for medical and industrial radiological sources into NRC regulations, replacing the existing security orders. The final regulations, found in 10 C.F.R. Part 37 (commonly known as Part 37), were published in the *Federal Register* in March 2013, and they went into effect 60 days later.[16] NRC licensees were required to comply with the regulations by March 2014, while Agreement States are to promulgate compatible regulations by March 2016, with their licensees being required to comply at a subsequent date determined by each state. The current security orders remain in place until the new regulations are implemented. NRC has also developed and provided licensees with implementation

[14]Order Imposing Fingerprints. NRC Order EA-07-305.

[15]Order Imposing Fingerprints. NRC Order EA-07-305, including Supplemental Questions and Answers.

[16]NRC, Physical Protection of Byproduct Material; Final Rule, 78 Fed. Reg. 16,922 (Mar. 19, 2013) (amending and supplementing 10 C.F.R. Parts 20, 30, 32, et al.).

guidance for Part 37.[17] NRC officials said that a new round of security inspections would occur once the new regulations were in effect.

In September 2012,[18] we reported that, at the 26 selected hospitals and medical facilities we visited, NRC's requirements did not consistently ensure the security of high-risk radiological sources. One reason for this is that the requirements, which are contained in NRC security controls, are broadly written and do not prescribe specific measures that licensees must take to secure their equipment containing high-risk radiological sources. We recommended, among other things, that NRC strengthen its security controls by providing medical facilities with specific measures they must take to develop and sustain a more effective security program, including specific direction on the use of cameras and alarms. NRC disagreed that its security controls needed strengthening through more prescriptive security measures, stating that its approach provides adequate protection and gives licensees flexibility to tailor effective security measures across a wide variety of licensed facilities.

In contrast to NRC's flexible approach that allows licensees to determine which security measures to implement to meet the security controls, NNSA's voluntary program for radiological source security uses a prescriptive approach to upgrade the security of facilities—once a facility agrees to participate—to a level beyond NRC's minimum requirements. According to NNSA's physical security guidelines, which were established in 2010, the curie amounts for devices using high-risk radioactive material such as iridium-192, americium-241, and cesium-137 determine the level of protection required. For example, NNSA recommends that facilities using devices containing at least 10 curies of these materials upgrade, at a minimum, the security of doors, locks, windows, walls, and ventilation ducts. By comparison, NRC does not require security controls for some devices containing only 10 curies of iridium-192, americium-241, and cesium-137.[19] In addition, NNSA's guidelines for 10 curies and above

[17] *Implementation Guidance for 10 CFR Part 37, "Physical Protection of Category 1 and Category 2 Quantities of Radioactive Material"*, NUREG-2155.

[18] GAO, *Nuclear Nonproliferation: Additional Actions Needed to Improve Security of Radiological Sources at U.S. Medical Facilities*, GAO-12-925 (Washington, D.C.: Sept. 10, 2012).

[19] The NRC adopted the Category 1 and 2 threshold quantities from the IAEA Code of Conduct.

also call for video cameras, bullet resistant glass, hardened doors, cages, and security grating, and if possible, armed on-site response. For high-risk material totaling at least 1,000 curies, or when multiple smaller sources are located in the same storage facility with a combined curie level of 1,000 curies or more, NNSA recommends biometric access control devices, critical alarm remote monitoring systems, and enhanced barriers to delay an adversary's pathway to the radiological sources.

Challenges Exist in Reducing Security Risks for Different Types of Industrial Radiological Sources

Challenges exist in reducing the security risks faced by licensees using high-risk industrial radiological sources, even when they follow NRC's security controls. Specifically, licensees face challenges, in (1) securing mobile and stationary sources and (2) protecting against an insider threat.

Challenges in Reducing Risks for Mobile and Stationary Industrial Radiological Sources

We identified two main types of industrial radiological sources during the course of our review: mobile sources used for testing pipeline welds in the oil and gas sector, and stationary sources used for, among other things, aerospace research, oil and gas production, and food safety. Some of the stationary sources pose unique security challenges due to either how they are stored or their large curie levels. According to NNSA data, there are approximately 1,400 industrial facilities in the United States that house either mobile or stationary high-risk radiological sources, containing a combined total of approximately 126 million curies of radioactive material.[20]

Mobile Industrial Sources

The portability of some industrial radiological sources makes them susceptible to theft or loss. According to NRC, as of December 2013, there are approximately 498 radiography licensees with 4,162 radiological sources in the United States. These sources have a cumulative total of about 214,000 curies of primarily iridium-192 and cobalt-60. In 2007, we

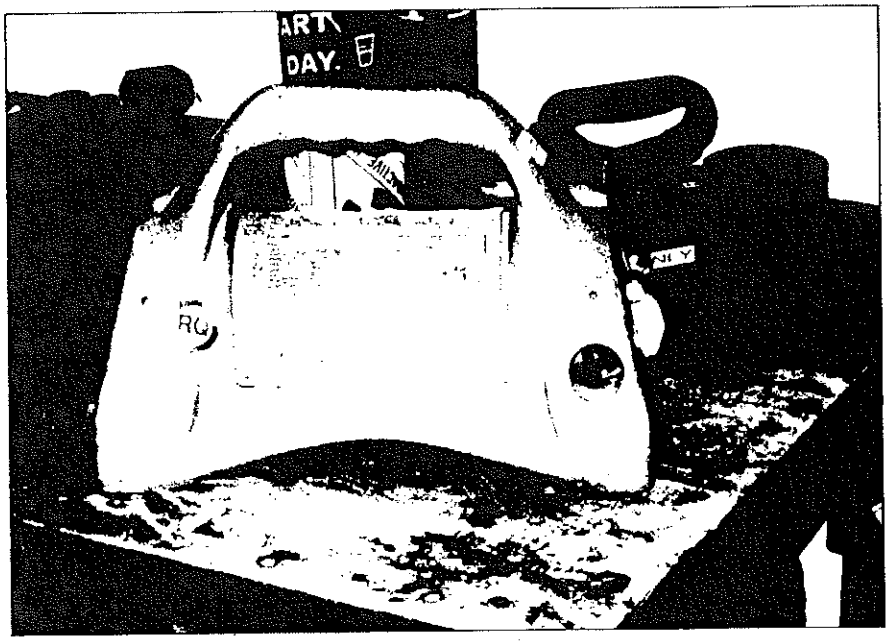
[20]Regarding the number of industrial radiological sources in the United States, NRC bases its totals for sources and curie amounts on the number of licensees it has approved as of September 2013. They calculate that there are 793 total industrial licensees in the United States, containing approximately 129 million curies. NNSA bases its totals for sources and curie amounts on individual industrial facilities, i.e. buildings where the sources are located.

reported that IAEA officials said that transportation of high-risk radiological sources is the most vulnerable part of the nuclear and radiological supply chain.[21] Furthermore, according to IAEA documents, the size of some of these mobile sources could make it easier for unauthorized removal by an individual as the source is small enough to be placed into the pocket of a garment. The most common mobile source, iridium-192, is contained inside a small device called a radiography camera.[22] NRC officials said that the device is about the size of a gallon paint can and is transported in specially designed trucks to remote locations where it can remain in the field for days or even months. Figure 3 shows an example of a radiography camera.

[21]GAO, *Nuclear Nonproliferation: DOE's International Radiological Threat Reduction Program Needs to Focus Future Efforts on Securing the Highest Priority Radiological Sources*, GAO-07-282 (Washington, D.C.: Jan. 31, 2007).

[22]Radiographers use radiography devices, or cameras, to produce images used in the examination of structures such as pipelines. The cameras contain radioactive sealed sources. When the source is exposed, radiation penetrates the material and produces a shadow image on film or some other detection medium. Radiography cameras use sources that, if unshielded, are dangerous.

Figure 3: Industrial Radiography Camera



Source: GAO.

NRC's security controls call for two independent physical measures—such as two separate chains or steel cables locked and separately attached to the vehicle—when securing a mobile device containing a high-risk source to a truck.[23] The controls also call for licensees to maintain constant control and/or surveillance during transit, as well as disabling the truck containing such devices when not under direct control and constant surveillance by the licensee.[24] While the controls call for

[23]EA-05-090. For example, licensees may store their radiological sources in a box secured using two separate chains or steel cables that are locked and attached independently to the vehicle; the box also can be locked in a trunk or similar enclosure and secured further with a single locked chain or steel cable.

[24]NRC officials noted that NRC safety regulations for sealed sources in industrial radiography require the device and/or its container to be kept locked when not under the direct surveillance of a radiographer or assistant, and that when radiography is performed other than at a permanent radiographic installation, the radiographer must be accompanied by at least one other qualified individual. See 10 C.F.R. §§ 34.21(a), 34.41(a) (2014).

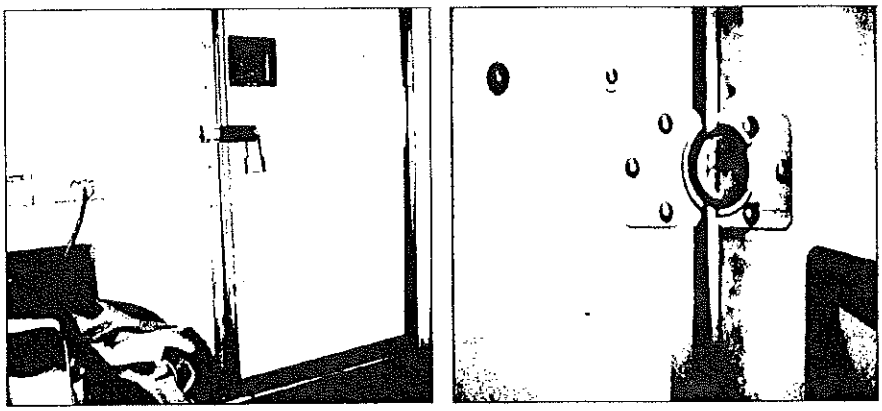
certain security measures, they do not include specific requirements for trucks to have alarm systems or specify the strength or robustness of the locks that must be used to secure the source inside the trucks. The controls also do not include requirements for a Global Positioning System (GPS) on the trucks.[25]

According to NRC officials, the agency's controls provide licensees with flexibility to meet the security requirements. For example, all of the 15 industrial radiography companies we visited implement different measures to secure their sources,[26] even though they use trucks with similar designs. Specifically, the trucks are distinguishable by a fiberglass enclosure sitting on the truck bed, which is known as a darkroom. At least one radiographer met NRC's controls with, among other things, a simple padlock on the door to the darkroom as the first security control, and an army surplus container chained to a cradle on the floor of the darkroom with a padlock as the second control. However, we also observed that other radiographers used high-security locks to control access to the darkroom, and reinforced metal containers that were bolted to the floor of the truck and secured using high-security locks. Of the 15 radiography companies we visited, 13 also had security alarms installed on their vehicles. However, we were told by 3 radiographers that the chemicals used inside the darkrooms to develop photographs of potential cracks in pipes can corrode the alarm systems, causing them to fail and requiring frequent service. Figures 4 and 5 show different methods radiographers we visited used to secure both the door to the darkroom and the radiological source while on the truck.

[25]GPS is a space-based satellite system that provides positioning, navigation, and timing data to users worldwide. As noted above, in 2013, NRC codified its security orders into regulation, with some revisions. The regulations, which licensees were not required to meet at the time of our visits, include a requirement that licensees use a telemetric position monitoring system or an alternative tracking system (such as, but not limited to, GPS) when transporting Category 1 quantities of radioactive material. 78 Fed. Reg. at 16924, 16937, 17018 (2013) (establishing 10 CFR § 37.79(a)(1)(iii). However, it should be noted that iridium-192 sources contained in radiography cameras are Category 2 and would not be covered under the tracking requirements contained in the new regulations.

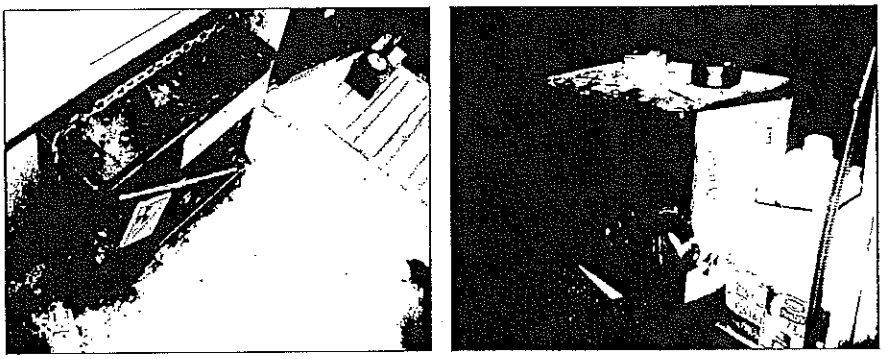
[26]All of the 15 facilities we visited had implemented NRC's security controls according to the licensees and accompanying NRC or Agreement State inspector.

Figure 4: Standard Padlock for Darkroom Door and High-Security Lock for Door



Source: GAO.

Figure 5: Radiography Camera Box Padlocked within Its Cradle and High-Security Box Bolted to the Floor of the Truck



Source: GAO.

The risks associated with mobile sources are underscored by a series of incidents involving both theft and unauthorized individuals attempting to gain access to the sources. We identified four cases in which radiological sources were stolen while on trucks since NRC's increased controls

security order was issued in December 2005.[27] We also identified two cases of individuals impersonating state radiological safety and security inspectors at remote worksites where the mobile sources were being used.

Specifically regarding the theft of sources, according to NRC and Agreement State event reports we reviewed and interviews with NRC and Agreement State officials, we found that:

- In August 2012, a radiography camera containing 81 curies of iridium-192 was stolen from a truck parked outside of a company's facility in one state. An individual broke into five trucks, taking various items, including one radiography camera that had been left in one of the trucks rather than being returned to the storage facility. A surveillance camera identified the truck used by the individual, and police recovered the radiography camera from the individual's residence. Agreement State officials initially proposed fining the licensee $10,000, but the licensee and the state office ultimately settled on a fine of $1,000 to address the administrative penalty.

- In July 2011, a radiography camera containing 33.7 curies of iridium-192 was stolen from a truck parked in a hotel parking lot in the same state. Although the door to the truck's darkroom was locked and the device secured using cables and padlocks, the truck's alarm system was not activated. During the early morning hours, multiple individuals broke into the truck while it was parked at a motel and ripped the cables securing the container holding the radiography camera out of the wall of the darkroom enclosure. The radiological source was never recovered. The state initially proposed a $5,000 fine for the administrative penalty, but the penalty was reduced to $500 due to the efforts and expenses made by the company to recover the device.

- In September 2006, a radiography camera with approximately 100 curies of iridium-192 was stolen along with a radiography truck, which was parked at a gas station in the same state. The truck was stolen when the radiographer went into the gas station to talk with his supervisor and left the keys to the truck and the darkroom in the cab

[27]The trucks were generally equipped with security devices, such as locks, intended to meet NRC's security controls, and some had additional theft protection measures such as alarms.

of the truck. The truck was recovered 2 days later by the police at a nearby business park along with the radiological source. The state decided not to assess a fine against the company for the administrative penalty, noting that the device was recovered.

- In August 2006, a radiography camera with approximately 75 curies of iridium-192 was stolen along with a radiography truck from a hotel parking lot in another state. Although the truck was equipped with an alarm, the alarm was not activated. In addition, the radiographer left the vehicle's keys in the truck's door. The truck was abandoned and found the next day along with the radiological source by the police in a nearby strip mall parking lot. According to an Agreement State official, they do not have statutory authority to impose monetary fines for security violations, so no fine was assessed.[28]

Concerning individuals impersonating safety and security inspectors at remote worksites, according to incident reports we reviewed and state officials we spoke to, we found that:

- In September 2010, a radiography crew was approached at a temporary worksite by an individual who identified himself as an inspector. The individual became confrontational with the crew and approached the worksite. When the radiographers prevented him from entering the worksite, he accused them of violating proper procedures in their operation. The radiographers asked the individual to provide identification, but he refused and later left the worksite. The individual, who was a licensed radiographer, was identified as having multiple convictions on his record, including assault, forgery, and terroristic threats. The individual no longer practices radiography in the state.

- In March 2010, radiographers working at a temporary worksite were approached by an individual wearing a jacket with the state logo who identified himself as a safety and security inspector. The individual opened and closed the radiographer's truck doors, went into the darkroom, and then observed the radiographers as they performed operations. He asked the radiographers questions regarding the amount of curies in the radiography camera. After the radiographers

[28]An NRC official told us that several Agreement States do not legislatively empower their enforcement units to levy civil fines or penalties for violations.

contacted their superior, the individual left with two accomplices and was never apprehended.

Two radiography licensees, as well as an Agreement State and several NRC inspectors, told us that the existing security controls were adequate and that the industrial sources they use or monitor were adequately protected. For example, one licensee told us that—given the small size of his company, the company's limited financial resources, and the marginal risks associated with the radiological sources—additional security requirements were not necessary. In contrast, another Agreement State inspector told us that the security controls should be more prescriptive, as more specific controls would make selecting security measures clearer for licensees and evaluating the adequacy of such measures clearer for inspectors. He said that nonprescriptive controls require additional evaluation to determine if something is acceptable or not. In addition, a senior security official at a large radiography company told us that, prior to the July 2011 theft of the source that was never recovered, he believed that NRC's security controls were adequate. However, after the source was stolen, he concluded that NRC's controls needed to be more prescriptive. He told us that the controls are too general, which makes them largely ineffective. This official also said that the current playing field is not level and that some smaller radiography companies are doing a disservice to the radiography industry by installing security measures that meet NRC's security controls but are generally very weak. He cited several examples of security measures he has seen that he believes are substandard, including cheap locks, ineffective alarms, and darkroom doors that can be easily breached. This official recommended that industrial radiographers install common sense security measures, such as high-security locks, which cost approximately $50 each, reinforced doors, and GPS.

In addition, in 2007, the governor of Washington State requested that GPS should be required for licensees with highly radioactive mobile sources. Specifically, in 2006, the theft of a radiography camera in her state prompted the governor to petition NRC to consider requiring GPS for vehicles carrying high-risk sources, such as radiography cameras, or allow states the flexibility to implement more stringent security measures than those required by NRC. In the petition, the governor pointed to a separate incident where a smaller radioactive source in a portable gauge was stolen, but it was quickly recovered due to a GPS tracking feature on the phone of the operator. In response to the petition, NRC informed Washington State that the issues raised in the petition would be considered in the ongoing Part 37 rulemaking. However, in March 2013,

NRC denied the petitioner's request and did not require GPS tracking in the final Part 37 rule. NRC also stated in the *Federal Register* that, with respect to mobile radiological sources, existing security controls provide adequate protection for mobile devices and that GPS was "neither justified nor necessary."[29] An official from the Washington State's Department of Health stated in its response to NRC that his agency was very disappointed that the Part 37 rule did not follow through on the recommendation made by the governor and asserted that GPS tracking is inexpensive and an easy way to help with the rapid recovery of a stolen industrial radiological source should preventative measures fail.

Notwithstanding NRC's decision, some licensees that we met with during the course of our audit have installed GPS on their trucks. Of the 15 industrial radiography companies we visited, 8 had installed GPS on their fleet of trucks. Of these 8 companies, 4 also provided their radiographers with vibrating key fobs to alert them when the vehicle alarm goes off. In the view of the radiographers from these 8 companies, GPS is an effective security control. A senior security official at a large radiography company told us that, after learning about a theft in 2011, his company installed GPS in all 120 of its trucks at a cost of approximately $50 to $100 per installation and from $29 to $39 per truck for monthly service.

Stationary Industrial Sources

Securing stationary high-risk radiological sources also poses challenges for licensees. Facilities housing these sources include aerospace manufacturing and research plants, storage warehouses, and panoramic irradiators used to sterilize industrial products. Similar to the mobile sources, NRC's security controls for stationary sources provide a general framework that is implemented by the licensee. However, as we reported in September 2012,[30] the security controls are broadly written and do not provide specific direction on the use of cameras, alarms, and other relevant physical security measures.

The challenge that licensees face as a result of the broadly written security controls is that they may select from a menu of security measures, which allows them to meet NRC's controls but not necessarily address all potential security vulnerabilities. According to the licensees

[29]NRC, Physical Protection of Byproduct Material; Final Rule, 78 Fed. Reg. 16,922 (Mar. 19, 2013) (amending and supplementing 10 C.F.R. Parts 20, 30, 32, et seq.).

[30]GAO-12-925.

and inspectors that accompanied us, all of the industrial facilities with Category 1 and Category 2 high-risk radiological sources we visited had measures in place to meet NRC's security controls, such as locks and motion detectors, and the sources themselves were located within the interior of the building. While these facilities met NRC's security controls, we noted that some facilities appeared to continue to have certain vulnerabilities. For example, many of the facilities we visited did not have security measures of the type often recommended by NNSA as part of their voluntary security upgrades.[31] Examples of facilities we visited that met NRC's security controls but still had potential security vulnerabilities include the following:

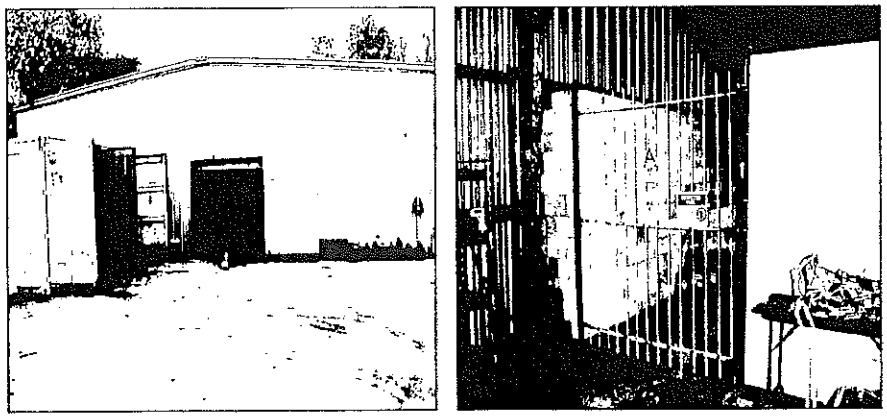
- At one facility, we observed that a warehouse storing 25 iridium-192 radiography cameras had an exterior rolltop door that was open and unattended (see fig. 6). Once inside the warehouse, we also observed that the wall acting as one of the barriers to the sources did not go from the floor to the ceiling. When we asked the NRC security inspector who accompanied us about the barrier, the inspector told us that the licensee was in compliance with NRC's security controls because the sources were secured through other measures—such as locks and a motion detector. The inspector told us that while the security measures in place were not optimal, there were no apparent security violations.

- At another facility, we observed a cesium-137 irradiator with approximately 800 curies that was on wheels and in close proximity to a loading dock rollup door that was secured with a simple padlock (see fig. 7). The irradiator was stored in a vault that had a reinforced sliding door and a motion detector that was activated after normal working hours. The licensee told us that the wheels on the irradiator were needed to move the device to different parts of the facility when conducting research. During our visit, we observed that the sliding door to the vault—which is one of the security measures used by the licensee—was left open for ease of access. In our September 2012 report, we identified a similar situation at a medical facility and concluded that although the facility met NRC's security controls, it

[31]This is similar to the findings we reported in 2012 for medical facilities. All of the 26 medical facilities we visited at that time had implemented NRC's security controls and undergone inspections by either NRC or Agreement State inspectors. Although all of the facilities met NRC's security controls, more than half of these facilities had also received NNSA security upgrades or were in the process of receiving them for other vulnerabilities.

could be vulnerable because of the limited security we observed and the mobility of the irradiator.[32]

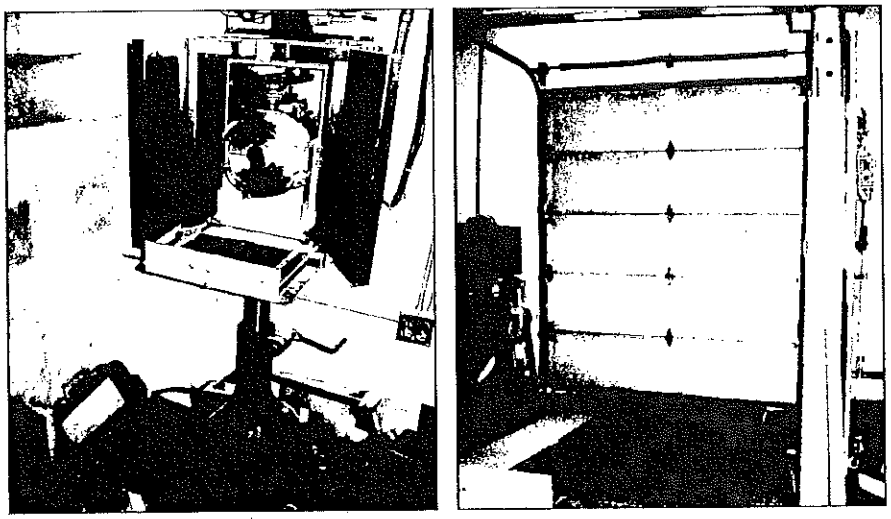
Figure 6: Open Rolltop Door and Barrier Not Extending to Ceiling



Source: GAO.

[32]GAO-12-925.

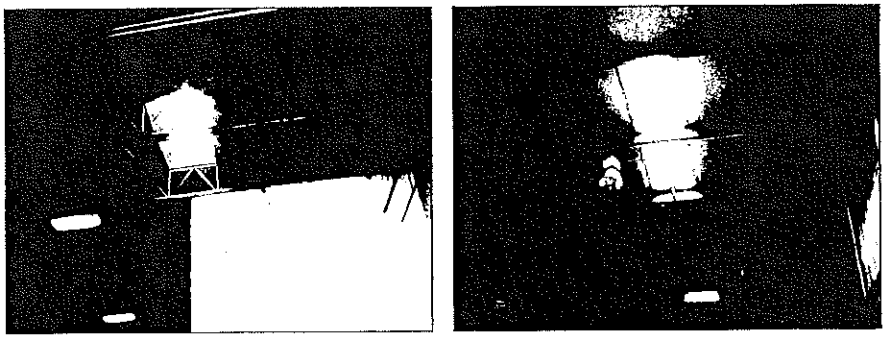
Figure 7: Irradiator on Wheels and Loading Dock



Source: GAO.

We also observed unsecured exterior skylights at a number of warehouses that contained radiological sources ranging from iridium-192 radiography cameras to higher curie levels of cobalt-60 and cesium-137 used for industrial research and manufacturing. Of the 33 industrial facilities we visited, 9 had unsecured skylights. When we questioned an NRC safety and security inspector who accompanied us on the visit about the unsecured skylights, he noted that the licensees met NRC's security controls because the sources were secured in a locked container, and he said that these skylights did not pose a security vulnerability. Figure 8 shows examples of unsecured skylights.

Figure 8: Unsecured Skylights at Industrial Facilities



Source: GAO.

We also identified two types of stationary sources that pose unique security challenges due to (1) how americium-241 sources are currently being stored at some well logging facilities and (2) the large curie levels of cobalt-60 sources found in panoramic irradiators.

Well Logging Storage Facilities

Well logging is a process used to determine whether a well has the potential to produce oil. Some well logging storage facilities with large amounts of americium-241, including two facilities that we visited, are potentially more vulnerable to theft as they have not implemented NRC's security controls.[33] Under NRC's security controls, increased security measures are triggered by the type and amounts of curies of radiological sources. For example, licensees with americium-241 are required to implement NRC's security controls when the radiological sources in their possession total 16 curies or more. Under the security controls, multiple sources of the same type are added together for regulatory purposes only

[33]According to NNSA, there are approximately 1,736 well logging sources in the United States, with almost 13,000 curies of primarily americium-241 and cesium-137—2 of the 16 radiological sources posing the highest risk and thus warranting enhanced security.

if they are "collocated."[34] NRC considers these sources to be collocated if someone could gain access to them by breaching a single physical barrier. However, some well logging licensees do not come under NRC's security controls because they separate their americium-241 into quantities that are not considered collocated. For example, these licensees may store quantities of this source in multiple separately locked containers, which function as barriers, so they do not meet the definition of being collocated. Figure 9 shows an example how licensees could store americium-241 in separate containers that would not be considered collocated, and therefore, not under NRC's controls. As a result, a segment of facilities with large quantities of radiological sources falls outside of NRC's increased security controls, including security inspections for the increased controls.[35] As mentioned earlier, NRC has identified the security of radioactive sources as a top agency priority to prevent the use of such sources by terrorists. Thus, NRC's definition of collocation may have the unintended consequence of placing a segment of these sources at greater risk of theft or loss.

[34]The 2013 regulations continue this distinction. See, e.g., 78 Fed. Reg. at 17,007 (adding § 37.5 defining aggregated), 17014 (adding §37.41(a)(1) incorporating aggregated quantities into the applicability of physical protection requirements). NRC has explained, "[a] licensee may choose to store radioactive materials, in any form, in separate locations to avoid being subject to the proposed security requirements. Such action would not conflict with the intent of the proposed rule, which is to limit access to an aggregated category 2 [i.e., high-risk] quantity of radioactive material." 78 Fed. Reg. at 16,997.

[35]All licensed material is subject to NRC's and Agreement State requirements for storage and control of licensed materials. (See 10 C.F.R. 20.1801 and 20.1802.) The level of security and type of security inspection varies based on the type of material the licensee possesses and how the licensee stores the material.

Figure 9: Well Logging Storage Facility with Multiple Containers for Storing Radiological Sources

Source: National Nuclear Security Administration.
Note: As figure 9 shows, the multiple in-ground containers store the radioactive materials, which in some cases can contain americium-241 below the levels that require increased security controls.

We visited two well logging storage facilities and observed quantities of americium-241 totaling greater than 16 curies that were stored in such a way as not to be considered collocated—and therefore not subject to NRC's security controls or their enforcement by either NRC or Agreement State inspectors. NRC and Agreement State officials told us that well logging licensees are not purposely avoiding NRC's security controls. Furthermore, in their view, the security controls are adequate. Notwithstanding those views, an NNSA official stated that the security measures employed by some well loggers could put the sources at risk. NNSA is planning to evaluate the potential risks posed by these sources and determine how best to secure them.

Panoramic Irradiator Facilities

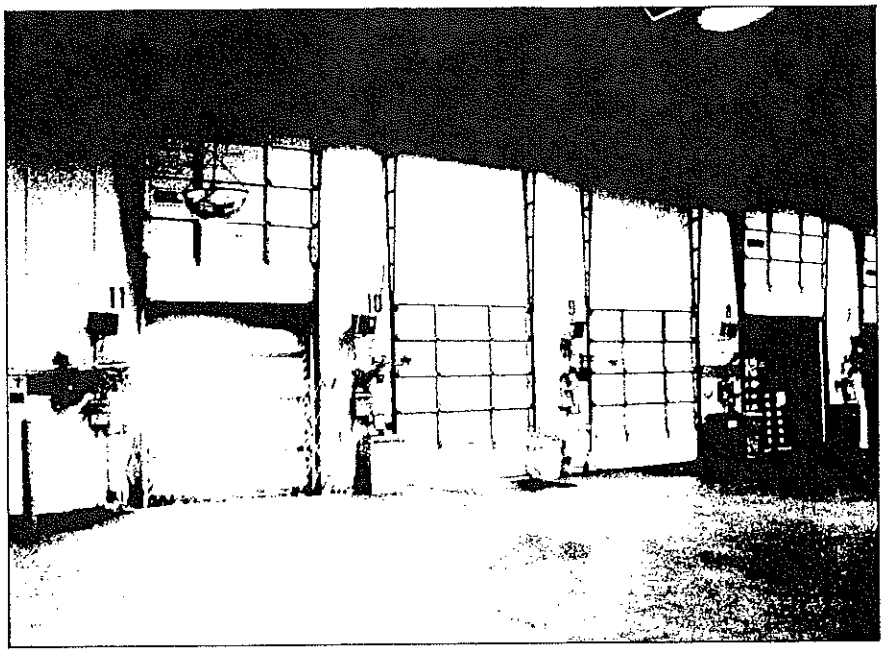
Many panoramic irradiators used to sterilize industrial products have high curie levels of cobalt-60 and are located near urban areas. According to NNSA officials, there are currently 55 panoramic irradiators in the United States. Panoramic irradiators generally utilize "source racks" that hold hundreds of thousands to millions of curies of cobalt-60. The source rack is composed of individual source "pencils" containing several thousand

curies of cobalt-60 each. NNSA officials told us that when in use (raised out of a pool of water used to shield the source) the radiation produced by the entire source rack is strong enough to incapacitate a human in a matter of minutes. When not in use (lowered into the pool of water), individual pencils could potentially be targeted for theft.

In one state, we visited two facilities operated by the two largest panoramic irradiator companies in the United States. One of the facilities had two cobalt-60 panoramic irradiators, one with 5 million curies and one with 2.2 million curies. The other facility had one panoramic irradiator with 2 million curies of cobalt-60. Both of these facilities were located near large urban areas. NRC has security controls in place for industrial facilities with large-scale irradiators to specify minimum security controls.[36] To meet these controls, the companies we visited have installed, among other things, video cameras, motion detectors, and key pad locks. Nevertheless, NNSA officials, who have visited similar facilities at both companies, told us that the large curie levels used in the irradiators and proximity to urban areas still creates potential security risks despite the security measures already implemented. As a result, NNSA has recommended a number of security upgrades for panoramic irradiators, including: (1) installing alarmed pool covers; (2) installing enhanced access controls including biometric devices and alarm systems focused on the irradiator; and (3) installing remote monitoring systems. Figure 10 shows a photograph of exterior doors at a panoramic irradiator facility we visited.

[36]Order Imposing Compensatory Measures for All Panoramic and Underwater Irradiators Authorized to Possess Greater than 370 TerraBecquerels (10,000 Curies) of Byproduct Material in the Form of Sealed Sources. EA-02-249.

Figure 10: Loading Dock with Roll up Doors



Source: GAO.

Licensees Face Challenges Protecting Against an Insider Threat

Licensees of mobile and stationary radiological sources face challenges in determining which of their employees are suitable for trustworthiness and reliability (T&R) certification, as required by NRC's security controls.[37] Such certification allows for unescorted access to high-risk radiological sources. Officials at almost half of the facilities we visited told us that they face challenges in making T&R determations. These challenges include limited security experience and training and incomplete information to determine an employee's suitability for unescorted access.

Before a licensee can grant an employee unescorted access to high-risk radiological sources, NRC security controls require the licensee, among other things, to: (1) conduct employment and education background

[37]As noted above, our report focuses on the security controls that were in place during our 2013 visits to licensees. With respect to T&R certification, the Part 37 regulations now in effect continue the same approach as the prior security controls. Where appropriate, we reference the Part 37 regulations and implementing guidance.

checks; (2) perform an identification and criminal history check that includes taking the employee's fingerprints and sending them to NRC, which forwards the fingerprints to the FBI; and (3) determine that the individual is trustworthy and reliable. These controls are intended to mitigate the risk of an insider threat—an employee or someone else with authorized access who might be trying to steal, tamper with, or sabotage radiological sources. NNSA officials told us that they consider an insider threat to be the primary threat to facilities with radiological sources. According to an NNSA Fact Sheet, almost all known cases of theft of nuclear and radiological material involved an insider. The document states that skills, knowledge, access, and authority held by some insiders make the threat difficult to mitigate. As a result, great care must be taken in determining the T&R of employees who are granted unescorted access in facilities with high-risk radiological sources.

Under NRC's security controls, the criminal history check is performed by the FBI, submitted to NRC, and forwarded to the licensee. NRC's controls place the responsibility on the licensee to evaluate all the information and determine whether the employee is trustworthy and reliable. In its Part 37 regulations, NRC codified the process for criminal history check and review generally as established in the orders. In response to its proposal for these regulations, NRC received comments stating that it should provide specific criteria—such as disqualifying convictions—for use by licensees with respect to the T&R determination. However, NRC declined to provide specific criteria, stating that it is the licensee's responsibility to consider all information and make a determination. An NRC official told us that this was a policy choice by the Commission. The official said that NRC's role in the T&R determinations is limited, but NRC inspectors may review a licensee's records during a site inspection. However, the official told us that such a review is limited to whether the licensee obtained the required types of information, not the merits of the licensee's determination to grant unescorted access to an individual.

NRC has provided licensees with a number of indicators to consider when evaluating an individual's T&R. Some of these include the following:

- conduct that warrants referral for criminal investigation or results in arrest or conviction;
- uncontrolled anger, violation of safety or security procedures, or repeated absenteeism;
- attempted or threatened destruction of property or life; and

- the frequency and recency of the conduct.

NRC implementation guidance states that these indicators are not meant to be all inclusive or be disqualifying factors. Moreover, NRC's guidance states that it is a licensee's business decision as to what criteria it uses for the basis of the T&R determination.[38] NRC guidance—as well as its new regulations—does not specify how a licensee should evaluate an individual's T&R. For example, NRC's current and former implementation guidance do not include indicators that would disqualify an employee from receiving unescorted access. Instead, each case must be judged on its own merits, and final determination remains the responsibility of the licensee. NRC's implementation guidance also states that the requirements are not intended to stop determined adversaries intent on malevolent action from gaining access to the radioactive sources. Rather, this implementation guidance is designed to provide reasonable assurance that individuals with unescorted access to the radiological sources are trustworthy and reliable and that facilities have a reliable means to monitor events that are potentially malevolent and have a process for prompt police response.

Under NRC's security controls, it is left to the licensee to decide whether to grant unescorted access, even if an individual has been indicted or convicted for a violent crime or terrorism, and the licensee is not required to consult with NRC before granting T&R access. Officials at 7 of the 33 licensees we reviewed said that they have granted unescorted access to high-risk radiological sources to individuals with criminal histories. We found two cases where employees of industrial radiographers in two different states were granted unescorted access despite having serious criminal records.

- *Case 1: Individual with numerous criminal convictions.* In one case, a T&R official told us that she granted unescorted access to an individual in 2008 with an extensive criminal history, some of which was included on the FBI report the company received from NRC, and

[38]The current guidance similarly states, "it should be left to the licensee's judgment whether criminal arrests indicate poor judgment, unreliability, or untrustworthiness." Implementation Guidance for Part 37, "Physical Protection of Category 1 and Category 2 Quantities of Radioactive Material," NUREG-2155, pp.120-121. Prior to this guidance, which accompanied the new 2013 regulation, NRC had provided licensees with similar guidance in various documents.

some that was absent. This criminal history included two convictions for terroristic threat that occurred in 1996, which were not included in the background information provided to the T&R official by NRC. While NRC's security orders do not preclude granting unescorted access to radiological sources to persons with convictions for terroristic activity (or other serious crimes), the T&R official said that had she been aware of the individual's convictions for terroristic threat, she would not have granted him unescorted access. Based on available documents, we identified that the individual had been arrested and convicted multiple times between 1996 and 2008. These convictions included the following: terroristic threat (twice), assault, forgery, failure to appear in court, driving while intoxicated, and driving with a suspended license. According to that state's statute, a terroristic threat includes any offense involving violence to any person or property with intent to, among other things: place the public or a substantial group of the public in fear of serious bodily injury; place any person in fear of imminent serious bodily injury; or prevent or interrupt the occupation or use of a building, place of assembly, place of employment or occupation, aircraft, automobile, or other form of conveyance.[39] According to NRC officials, identification of a criminal history through the FBI or a discretionary local criminal history check does not automatically indicate unreliability or untrustworthiness of an individual. The licensee may authorize individuals with criminal records for unescorted access to radioactive materials notwithstanding the individual's criminal history.

In 2010, the individual was declared to be a substantial threat by the Agreement State's licensing agency after he impersonated a radiography inspector and was hostile toward radiographers in the field, as previously discussed. An investigation performed by the state health department concluded that the individual was a threat to public health and safety, and he subsequently surrendered his state radiography license. It was not clear from available information why the terroristic threats and other convictions did not appear on the FBI criminal background check or why the official deemed the individual trustworthy and reliable. We brought this case to NRC's attention after learning about it in February 2014. In response, NRC officials said

[39]NRC indicated that the terroristic threat convictions were based on a violent verbal threat that the individual made against two other individuals, not the United States. Making this type of "terroristic threat" is a misdemeanor offense.

that they contacted the Agreement State office to gather relevant information and independently evaluate whether the situation represented an isolated incident or if it was indicative of a programmatic issue. Based on their initial review, the officials said that they believed the event was an isolated incident. However, without an assessment of the T&R process, NRC will not be able to determine the extent to which this case may represent a larger problem or if corrective actions are needed.

- *Case 2: Individual caught stealing from company.* In another case, an industrial radiographer in charge of making T&R determinations told us that an individual with an extensive criminal record was granted unescorted access to radiological sources. The T&R official told us that he considered the individual a risk and objected to granting him unescorted access, but he was overruled by his supervisor. The employee who had been granted access was subsequently arrested for stealing from the company.

Without more complete information and specific guidance on how to evaluate an individual's T&R, licensees could continue to face challenges in making decisions about the suitability of personnel who are granted unescorted access to high-risk radiological sources, elevating the risk of an insider threat, which NNSA has identified as being responsible for almost all known cases of theft of nuclear and radiological material. As noted above, NRC's approach to providing reasonable assurance to an insider threat is to require licensees to collect and to consider various types of information, including an FBI criminal history, and to make a determination based on the licensee's judgment, without any NRC-identified disqualifying criteria. Therefore, nothing in the NRC controls or guidance precluded the licensees in these two examples from approving access. Moreover, according to an NRC official, NRC's role is limited to providing guidance and inspecting that the licensee has accumulated all appropriate information when making T&R determinations—not the merits of any particular decisions.

Federal Agencies Are Taking Steps to Improve Security of Radiological Sources but Are Not Always Effectively Collaborating

Federal agencies are taking steps to better secure industrial radiological sources. Specifically, NRC is developing a Best Practices Guide for licensees of high-risk radiological sources and planning to provide additional training to NRC inspectors. In addition, NNSA has two initiatives under way to improve industrial radiological source security. However, NRC, NNSA, and DHS—agencies that play a role in nuclear and radiological security—are not effectively collaborating to achieve the common mission of securing mobile industrial sources.

NRC Is Developing a Best Practices Guide and Planning Additional Security Training for Inspectors

NRC plans to develop a Best Practices Guide for licensees of high-risk radiological sources in response to a recommendation in our September 2012 report.[40] According to NRC officials, the guide is expected to be issued in spring 2014 and will include information for licensees on physical barriers; locks; monitoring systems, such as cameras and alarms; as well as examples of how to secure mobile sources and sources in transit. NRC officials told us that the guide will serve as a layperson's source of practical information about security and have minimal technical language. However, the Best Practices Guide remains in draft form, and it is not clear that it will provide specific direction on cameras, alarms, and other relevant physical security measures. For example, the officials said that the guide will not be a catalogue for specific makes and models of security devices such as cameras and locks.

During development of the Best Practices Guide, an NRC official told us that they are relying on a working group that includes, among others, representatives from NNSA, four inspectors from NRC's regional offices, one Agreement State inspector, and one Agreement State manager to provide insight into challenges licensees face in complying with NRC's security controls. However, the official also told us that they have not directly reached out to licensees during the development of the Best Practices Guide. NRC data show that there are almost 800 industrial licensees in the United States.

[40]GAO-12-925.

As we reported in 2013, active engagement with program stakeholders is a critical factor to success.[41] Furthermore, in 2012, we reported that programs are most likely to succeed when they involve stakeholders in establishing shared expectations for the outcome of the process.[42] According to professional practices, project managers should identify and prioritize stakeholders to include those who will be directly affected (positively and negatively) by the project.[43] Once the stakeholders are identified, continuous communication is needed to ensure that their needs are understood, issues are addressed as they come up, and they are engaged in the project decisions and activities. Although developing the guide is a step in the right direction, without including the views of licensees, NRC cannot be certain that the guide will be as useful as it could for those who will be directly affected by the process.

NRC also plans to provide additional security training for NRC and Agreement State inspectors to improve security awareness and reinforce a security culture. For example, NRC began revising the inspector training course in May 2013 and moved the training facility from Sandia National Laboratories to the NRC Technical Training Center in Chattanooga, TN. NRC officials told us that the course will provide information on physical protection systems and NRC security controls, including the identification of threats, an introduction to physical protection systems, and the identification of critical components of physical security, such as detection and access control. NRC officials also said that they have built a mock security laboratory at the Technical Training Center, which includes examples of security equipment such as security sensors, alarms, locks, and cameras. In addition, NRC plans to take inspectors on facility tours to introduce them to security practices at an irradiator site that has installed the voluntary NNSA security upgrades, a small mobile radiography company, and a local emergency response center.

[41]GAO, *Information Technology: Leveraging Best Practices to Help Ensure Successful Major Acquisitions*, GAO-14-183T (Washington, D.C.: Nov. 13, 2013).

[42]GAO, *DHS Strategic Workforce Planning: Oversight of Departmentwide Efforts Should Be Strengthened*, GAO-13-65 (Washington, D.C.: Dec. 3, 2012).

[43]"A Guide to the Project Management Body of Knowledge," Project Management Institute, 2013. "Eight Strategies for Research to Practice," fhi 360, September 2012.

NNSA Efforts to Address Security Risks Posed by Industrial Radiological Sources

NNSA has two initiatives under way to address security risks posed by industrial radiological sources: (1) testing and developing tracking technology for mobile sources, and (2) upgrading the physical security of industrial facilities.

Testing and developing technology for tracking mobile sources. In 2013, NNSA officials reported spending approximately $800,000 for a project to develop tracking systems for mobile devices containing radiological sources. Under cost-sharing arrangements, NNSA officials told us that they are collaborating with industry partners from both the industrial radiography and well logging industries who have agreed to provide support for development, design reviews, and field testing of prototype systems. According to the officials, this technology, if successful, would allow for (1) real-time tracking and monitoring of the source in storage, during transport, and during temporary storage within the transport vehicle, (2) immediate notification of a potential loss or theft situation to a central monitoring location, and (3) assistance in recovering a source that is lost or stolen. NNSA officials said that they plan to complete the development of the tracking systems and transfer the technology to one or more vendors for commercial manufacture and sale by summer 2015. Individual industrial radiography and well logging companies would be able to purchase the systems directly from the commercial manufacturer. To encourage use of the technology, NNSA is also evaluating if the government should subsidize all or a portion of the cost of the systems and, if so, for all potential users, or a particular group of users meeting certain criteria. NNSA officials told us that they expect the systems to cost in the range of $300 to $500 for each radiography device, and $500 to $750 for each well logging truck.

Security upgrades at facilities. As of June 2013, NNSA had completed security upgrades at 20 industrial facilities at a cost of $5.5 million. Included in the 20 industrial facilities with completed upgrades are 7 USDA sites with irradiators containing cobalt-60 and cesium-137 that are used for research and pest irradiation. Upgrade of these 7 facilities cost $3.8 million. NNSA has also completed security upgrades at one mobile radiography facility but, according to NNSA officials, the agency decided not to upgrade any additional facilities because higher priority facilities were scheduled for completion first. In addition, NNSA officials said that their current plans are to complete the development of the electronic mobile source tracking system prior to implementing security upgrades at additional radiography storage facilities. They told us that security at storage facilities for mobile sources would only address half the risk, as the sources also travel into the field.

NNSA's activities include working with federal, state, and local agencies, as well as private industry to install sustainable security enhancements for high-priority nuclear and radiological materials located at civilian sites in the United States. However, an NNSA official told us that, in light of their available funds for these efforts, many of these civilian sites with industrial radiological sources have not received security upgrades, and it is uncertain when or if such upgrades will be made. To date, NNSA has focused most of its attention and planning—and expended the majority of available funds for making such upgrades—on U.S. medical facilities. As of June 2013, NNSA had completed security upgrades at approximately one-quarter of all U.S. hospitals and medical facilities with high-risk radiological sources at a total cost of $135 million. NNSA officials said that the agency's focus on medical facilities is due primarily to the large number of facilities that, in their view, pose a more immediate risk because they are located in and around urban areas, contain large quantities of high-risk sources, and include buildings that are generally more accessible to the general public. However, these officials said that, as the number of medical facilities left to upgrade decreases, the program has begun to focus on industrial facilities and is finding that these facilities (particularly in the panoramic irradiation, industrial radiography, and well logging industries) may require unique security solutions and an updated budget estimate.

Federal Agencies Are Not Always Effectively Collaborating on Technology Development

Although DHS, NNSA, and NRC have an interagency mechanism for collaborating on, among other things, radiological security, they were not always doing so effectively. By not having effective ways to ensure consistent collaboration, the agencies may be missing opportunities to achieve the common mission of securing radiological sources. Our previous work has identified that when responsibilities cut across more than one federal agency—as they do for securing industrial radiological sources—it is important for agencies to work collaboratively.[44] Taking into account the nation's long-range fiscal challenges, we noted that the federal government must identify ways to deliver results more efficiently and in a way that is consistent with its multiple demands and limited resources. In addition, we have previously reported on the need for collaboration in securing radiological sources. For example, we reported

[44]GAO, *Practices That Can Help Enhance and Sustain Collaboration among Federal Agencies*, GAO-06-15 (Washington, D.C.; Oct. 21, 2005).

in 2007, that while DOE has improved coordination with the Department of State and NRC to secure radiological sources worldwide, DOE has not always integrated its efforts efficiently, and coordinated efforts among the agencies have been inconsistent.[45]

During this review, we found that the agencies involved in securing radiological sources—DHS, NNSA, and NRC—meet quarterly, along with the FBI, for "trilateral" meetings that include, among other things, discussions of radiological security. However, these meetings did not help DHS, NNSA, and NRC collaborate and draw on each agency's expertise during research, development, and testing of new technology for a mobile source tracking device. Specifically, we found that DHS contracted with Sandia National Laboratories in October 2011 to study commercially available technologies for tracking mobile radiological sources.[46] The cost of the study was $271,000. The study concluded that it is physically possible to tag some radiography and oil well logging devices. However, existing technology such as GPS—as opposed to developing a new technology—has limitations that would prevent reliable or effective tracking. DHS collaborated with NRC and several DOE national laboratories to develop the study but did not share the results with key NNSA officials who are directly involved in radiological source security. According to DHS officials, they made NNSA aware of the report through their quarterly meetings of senior officials, but NNSA officials with responsibility for securing radiological sources told us that they were not aware of the report until we brought it to their attention during the course of our review. NNSA officials told us that it would have been helpful to have the report earlier. As a result, the officials had to quickly evaluate the report's findings to ensure there were no "show stoppers" that would negatively impact their current activities in the same area of technology development.

[45]GAO-07-282.

[46]R.K. Patel and B.K. Smith, DNDO Feasibility Study of Electronically Tagging and Tracking Portable Radiation Radiography and Oil Well Logging Sources. SAND2010-6905, Sandia National Laboratories, Albuquerque, NM, 2010. DOE oversees the largest laboratory system of its kind in the world. The mission of DOE's 23 national laboratories has evolved over the last 55 years. Originally created to design and build atomic bombs under the Manhattan Project, these national laboratories have since expanded to conduct research in many disciplines—from high-energy physics to advanced computing at facilities throughout the nation. Nine of DOE's laboratories are large, multiprogram national laboratories that dominate DOE's science and technology activities.

NNSA is also developing a tracking system for devices containing mobile radiological sources, such as industrial radiography cameras. However, we found that NNSA has not been collaborating with DHS and NRC on the project. For example, NNSA did not reach out to DHS for input regarding tracking technologies, even though DHS had completed a related study in 2011 concerning tracking mobile radiological sources (see above). Regarding NRC, NNSA officials told us that they have no plans to coordinate with the NRC division in charge of regulating and licensing radiological sources—the division that has regulatory authority for radiological security. NNSA officials stated that they would reach out to the NRC technical division that approves and certifies changes in the design of the packaging and transportation of the device. However, the officials noted that coordination would only occur if NNSA determined that recertification of the device is required, which they believed was not likely.

As we have previously found, collaborating agencies should identify the human, information technology, physical, and financial resources needed to initiate or sustain their collaborative effort.[47] The current collaboration mechanism employed by DHS, NNSA, and NRC appears to not always be effective, and it may contribute to missed opportunities to leverage resources, including expertise, in developing new technology to address vulnerabilities associated with radiological sources while in transit.

Conclusions

Federal agencies are taking steps to better secure industrial radiological sources in the United States. Nevertheless, we found that licensees still face challenges in securing these sources. NRC is developing a Best Practices Guide to reduce the risks posed by the sources and thus help inform and educate licensees and other stakeholders about measures that could be taken to raise the level of security awareness and improve security. While this is a positive step, NRC has not directly reached out to licensees to obtain their views. Active engagement with key stakeholders is a leading practice on which we and others have reported. Without including the views of licensees, NRC cannot be certain that the guide will be as useful as it could for those who will be directly affected by the process.

[47]GAO-06-15.

NRC requires security controls for radiological sources commensurate with the type and amount of sources that licensees are attempting to protect. However, some well logging licensees do not come under NRC's increased security controls, because they separate their americium-241 into quantities that do not meet NRC's definition of collocation. Because these facilities fall outside of NRC's increased security controls, they do not receive security inspections for the increased controls. As a result, a segment of these sources are potentially at greater risk of theft or loss.

In addition, licensees are required to make T&R determinations regarding employee suitability to have unescorted access to high-risk radiological sources. Under NRC's security controls, even if an individual has been indicted or convicted for a violent crime, the licensee is not required to consult with NRC before granting unescorted access to high-risk sources. It is unclear whether two cases where employees were granted unescorted access, even though each had extensive criminal histories—including, in one of the cases, convictions for terroristic threats—represent isolated incidents or a systemic weakness in the T&R process. Without an assessment by NRC, the agency may not have "reasonable assurance" that the process in place to make access decisions is as robust as it needs to be to prevent the theft or diversion of high-risk radiological sources by a determined insider. NRC's security controls are also silent on what, if any, indicators would disqualify an employee from being granted unescorted access. Without more complete information and specific guidance on how to evaluate T&R, licensees could continue to face challenges in making decisions about the suitability of personnel who are granted unescorted access to high-risk radiological sources, potentially increasing the risk of an insider security threat, which NNSA has identified as being responsible for almost all known cases of theft of nuclear and radiological material.

As we have reported in the past, it is important for agencies to work collaboratively to achieve greater efficiency. An interagency mechanism exists to promote collaboration among the agencies responsible for securing radiological sources. However, DHS, NRC, and NNSA have missed the opportunity to leverage resources, including expertise, in developing a new technology to track radiological sources, which could aid in the timely recovery of a lost or stolen radiological source and support the agencies' common mission.

Recommendations for Executive Action

We are making four recommendations in this report.

To ensure that the security of radiological sources at industrial facilities is reasonably assured, we recommend that the Chairman of the Nuclear Regulatory Commission take the following three actions:

- Obtain the views of key stakeholders, such as licensees, during the development of the Best Practices Guide to ensure that the guide contains the most relevant and useful information on securing the highest risk radiological sources.
- Reconsider whether the definition of collocation should be revised for well logging facilities that routinely keep radiological sources in a single storage area but secured in separate storage containers.
- Conduct an assessment of the T&R process—by which licensees approve employees for unescorted access—to determine if it provides reasonable assurance against insider threats, including
    - determining why criminal history information concerning convictions for terroristic threats was not provided to a licensee during the T&R process to establish if this represents an isolated case or a systemic weakness in the T&R process; and
    - revising, to the extent permitted by law, the T&R process to provide specific guidance to licensees on how to review a employee's background. NRC should also consider whether certain criminal convictions or other indicators should disqualify an employee from T&R or trigger a greater role for NRC.

To better leverage resources, including expertise, to address vulnerabilities associated with radiological sources while in transit, we recommend that the Administrator of NNSA, the Chairman of NRC, and the Secretary of DHS review their existing collaboration mechanism for opportunities to enhance collaboration, especially in the development and implementation of new technologies.

Agency Comments and Our Evaluation

We provided a draft of this report to the Chairman of the NRC, the Administrator of NNSA, and the Secretary of Homeland Security for review and comment. NNSA and NRC provided written comments on the draft report, which are presented in appendices II and III, respectively. DHS did not provide comments. NRC generally agreed with our four

recommendations, and NNSA agreed with the one recommendation directed to it to enhance collaboration with other federal agencies on the development and implementation of new technologies. In its written comments, NNSA also said that it is ready to support NRC efforts with technical expertise and other assistance as required in relation to the recommendations directed toward NRC. NRC and NNSA also provided technical comments that we incorporated as appropriate. In addition, the Organization of Agreement States, which represents the 37 Agreement States responsible for overseeing regulatory compliance for radiological sources, provided technical comments.

In its written comments, NRC stated that the security and control of radioactive sources is a top priority and that its regulations provide a framework that requires licensees to develop security programs with measures specifically tailored to their facilities. NRC also noted that its inspectors have already investigated and taken action on some of our concerns identified in the report regarding the use of industrial sources, and if additional measures are needed, it will consider appropriate enhancements. NRC agreed with our recommendations to (1) obtain the views of stakeholders during development of its Best Practices Guide and (2) enhance collaboration with other federal agencies on the development and implementation of new technologies. NRC also acknowledged the merits of the two other recommendations to reconsider the definition of collocation for well logging facilities and conduct an assessment of the Trustworthiness and Reliability (T&R) process and discussed the actions it plans to take to address them. Regarding these two recommendations, NRC plans to reevaluate these issues as part of its review of the effectiveness of the recently issued security regulations under 10 C.F.R. Part 37. This review is expected to occur 1 to 2 years after the regulations are implemented. According to NRC's comment letter, this review will serve as the basis for determining whether any additional security measures, guidance documents, rulemaking changes, or licensee outreach are appropriate. To that end, NRC stated in its technical comments that it independently evaluated the case we identified of an individual granted unescorted access, even though he had an extensive criminal history and had been convicted for terroristic threats. Based on its intial review, NRC noted that the event was an isolated incident and not a programmatic issue. However, without an assessment of the T&R process, which they have agreed to consider, NRC will not be able to determine the extent to which this case may represent a larger problem or if corrective actions are needed.

We recognize that a review of the effectiveness of the recently issued regulations will take time to complete. However, due to the serious nature of the security problems identified in our report, this reevaluation of the definition of collocation and the T&R process should be conducted by NRC with a greater sense of urgency. If NRC follows its current plan to address these recommendations in the time frame outlined in its comment letter, the review will not occur until 1 to 2 years after implentation of 10 C.F.R. Part 37. In the case of the 37 Agreement States, the earliest the review would occur is 1 to 2 years afer they issue their own compatible regulations—required by March 2016. The longer it takes for licensees to implement the security upgrades, the greater the risk that potentially dangerous radiological sources remain vulnerable and could be used as terrorist weapons.

As agreed with your offices, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the report date. At that time, we will send copies of this report to the Administrator of NNSA, the Chairman of the Nuclear Regulatory Commission, the Secretary of Homeland Security, the appropriate congressional committees, and other interested parties. In addition, this report will be available at no charge on the GAO website at http://www.gao.gov.

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

David C. Trimble

David C. Trimble
Director, Natural Resources and Environment

Appendix I: Scope and Methodology

We focused our review primarily on the Nuclear Regulatory Commission (NRC) and the Department of Energy's (DOE) National Nuclear Security Administration (NNSA) because they are the principal federal agencies with responsibility for securing radiological material at industrial facilities in the United States. We also performed work at the Department of Homeland Security (DHS) because they are also involved in securing radiological sources, and we interviewed officials with responsibility for radiological security at the Department of Transportation (DOT) and United States Department of Agriculture (USDA). In addition, we interviewed an expert in the field of nuclear security, representatives from state government, and safety and security personnel at U.S. industrial facilities to discuss their views on how radiological sources are secured.

We visited 33 industrial facilities in California, Colorado, Hawaii, Pennsylvania, Texas, and Wyoming. These facilities included 15 industrial radiography companies, 6 commercial or sterilization companies, 5 academic research facilities, 3 well logging companies, 2 manufacturing and distribution companies, and 2 USDA facilities. The 33 facilities we visited are a nongeneralizable sample, selected on the basis of whether they were NRC states or Agreement States, the amount of curies contained in the devices using radiological sources, and the types of radiological devices. In addition, we considered if the site had undergone security upgrades funded by NNSA, and whether the site is located in a large urban area. At each location, we interviewed facility staff responsible for implementing procedures to secure the radiological sources, including questions about the use of security measures and if the licensee had made contact with NNSA. We also met with security personnel at sites, when available, and spoke to officials at some local law enforcement agencies responsible for security breaches.

We used NNSA's G-2 database, which aggregates data from NRC's National Source Tracking System (NSTS), to identify the location of industrial radiological sources, determine the different types of industrial devices that use radiological sources, and quantify curie amounts for different types of radiological sources. The G-2 data is based on information extracted from the NRC's 2011 NSTS database, the NRC's 2008 Sealed Source Inventory, and NNSA project team visits. G-2 contains all buildings in the United States that have risk-significant radiological sources (> 10 curies). To determine the reliability of these data, we conducted electronic testing and interviewed staff at NNSA and NRC about the reliability of these data. We tested these data to ensure their completeness and accuracy, and we determined that these data

were sufficiently reliable to use in selecting locations to visit and summarizing the total number of facilities and the total number of curies.

To evaluate the challenges industrial licensees with industrial radiological sources face in securing these sources, we reviewed laws, regulations, and guidance related to the security of industrial radiological sources. We interviewed agency officials at NRC, NNSA, DHS, DOT, and USDA. We also interviewed state government officials in three states, and safety and security personnel at 33 industrial facilities we visited in six states, to obtain their views on how radiological sources are secured and what challenges they face in securing them. To identify thefts and incidents involving radiological sources, we reviewed relevant documentation and spoke to federal and state officials. We also spoke to officials at 33 industrial facilities we visited in California, Colorado, Hawaii, Pennsylvania, Texas, and Wyoming. At the facilities, we observed the security measures in place and spoke to officials in charge of implementing NRC and Agreement State security controls and overseeing the security measures.

To learn what steps federal agencies are taking to ensure radiological sources are secured at industrial facilities, we obtained information from and interviewed agency officials at NRC, NNSA, DOT, DHS, and USDA who are involved in securing sources and undertaking studies evaluating technologies related to source security. We also obtained information from Agreement States and NRC regions by reviewing documentation and interviewing officials at four Agreement States (California, Colorado, Texas, and Washington State) and one NRC regional office (Region IV) with responsibility for overseeing high-risk radiological sources. We selected these states and the NRC region based on the amount of curies and number of devices in the state containing radiological sources and the types of devices used. We also interviewed officials at DOE's Pacific Northwest National Laboratory about the status of efforts made to strengthen remote tracking of mobile devices containing radiological sources. We visited industrial facilities that received NNSA funded upgrades and security assessments in California, Hawaii, and Pennsylvania. To determine the costs of NNSA's security upgrades for industrial facilities, we obtained cost data from NNSA and interviewed the agency official who manages NNSA's Global Threat Reduction Initiative program. These data were used to determine the number of U.S. industrial facilities that have received NNSA security upgrades, as well as the total cost for completing these upgrades. We discussed the reliability of these data with knowledgeable NNSA officials and questioned them about the system's controls to verify the accuracy and completeness of

the data. We also analyzed these data for missing information and obvious outliers. We found the data sufficiently reliable for our reporting purposes.

We conducted this performance audit from November 2012 to June 2014 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Appendix II: Comments from the National Nuclear Security Administration

Department of Energy
National Nuclear Security Administration
Washington, DC 20585
May 22, 2014

Mr. David Trimble
Director
Natural Resources and Environment
Government Accountability Office
Washington, DC 20458

Dear Mr. Trimble:

Thank you for the opportunity to review the Government Accountability Office's (GAO) draft report titled, *Additional Actions Needed to Increase the Security of U.S. Industrial Radiological Sources*, (GAO-14-293). I understand the GAO began this review after the conclusion of its 2012 study on the security of radiological sources at U.S. medical facilities, redirecting focus to examine the challenges in reducing security risks posed by industrial radiological sources and the steps federal agencies are taking to improve security.

We agree challenges exist in reducing the security risks faced by U.S. licensees using high-risk industrial radiological sources. Specifically, licensees face challenges in securing mobile and stationary sources and protecting against an insider threat.

The GAO report makes three recommendations to the Nuclear Regulatory Commission (NRC), and one joint recommendation to NRC, the National Nuclear Security Administration (NNSA) and the Department of Homeland Security (DHS). NNSA is ready to support NRC efforts with technical expertise and other assistance as required in relation to the first three recommendations. The joint recommendation suggests the three agencies review existing collaboration mechanisms for enhancement opportunities, especially in the development and implementation of new technologies. NNSA concurs and will build on the current efforts to improve coordination with NRC, DHS and other relevant interagency partners to improve the security of radiological sources.

We appreciate the GAO's efforts and will use this information to pursue additional efforts with the specific goals of leveraging resources and expertise to improve the security of industrial radiological sources.

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If you have any questions regarding this response, please contact Dean Childs, Director, Office of Audit Coordination and Internal Affairs, at (301) 903-1341.

Sincerely,

Frank G. Klotz
Under Secretary for Nuclear Security
Administrator, NNSA

Enclosure

Appendix III: Comments from the Nuclear Regulatory Commission

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

May 19, 2014

Glen Levis, Assistant, Director
Natural Resources and Environment
U.S. Government Accountability Office
Washington, DC 20548

Dear Mr. Levis:

Thank you for the opportunity to review and comment on the draft of your report GAO-14-293, "Additional Actions Needed to Increase the Security of U.S. Industrial Radiological Sources," which the Nuclear Regulatory Commission (NRC) received on April 24, 2014. The NRC appreciates the time and effort you and your staff have taken to review this topic.

Security and control of radioactive sources is a top priority for the NRC, which has a long history of ensuring radioactive source protection and security. In March 2013, the NRC issued a new rule, Title 10 of the *Code of Federal Regulations* (10 CFR) Part 37, "Physical Protection of Category 1 and Category 2 Quantities of Radioactive Material," which further enhanced security requirements for category 1 and 2 quantities of radioactive materials. The risk-informed and performance-based requirements of Part 37 represent a comprehensive, multi-layered program of security measures for radioactive materials that is focused on providing protection commensurate with the risk associated with the quantity of material possessed by the licensee.

Because the Part 37 regulations were not in effect at the time of the Government Accountability Office's (GAO) audit, the GAO report focused on the NRC security requirements that were issued to NRC licensees by order in accordance with the NRC's authority under the Atomic Energy Act of 1954, as amended. The new Part 37 rule did not simply codify the security orders, but expanded upon the security requirements in those orders. In drafting the Part 37 regulations, the NRC considered, among other things, the various orders issued, lessons learned during the implementation of the orders, experience obtained with voluntary security enhancements, and recommendations provided by and comments received from a wide variety of stakeholders. The resulting regulations provide a framework that requires licensees to develop security programs with measures specifically tailored to their facilities.

The NRC licensees were required to be in compliance with the new regulations by March 19, 2014, and Agreement States are currently in the process of implementing compatible requirements for their licensees, which must be completed by March 19, 2016. As stated below, the NRC is committed to reviewing the effectiveness of the requirements in 10 CFR Part 37 post-implementation to determine whether any additional enhancements are necessary. If additional measures are needed, the Commission will consider appropriate enhancements.

Enclosure 1 to this letter includes specific technical comments on the draft report and Enclosure 2 provides background information in support of one of our comments. The draft GAO report provided four recommendations, three of which recommend specific action by the

NRC. As discussed in Enclosure 2, NRC inspectors have already investigated and taken action on some of the GAO's concerns regarding the use of industrial sources. The NRC and the Agreement States will continue to pursue the examples in the report to ensure a complete understanding of the security concerns identified by the GAO and will incorporate any findings into the Part 37 effectiveness review.

Our comments on the recommendations are listed below:

- Recommendation: The NRC should obtain the views of key stakeholders, such as licensees, during the development of the Best Practices Guide to ensure that the guide contains the most relevant and useful information on securing the highest risk radiological sources.

  Response: The NRC agrees with the GAO's recommendation that the views of key stakeholders, such as licensees, should be obtained during the development of the guidance document, "Physical Security Best Practices for the Protection of Risk Significant Radioactive Material" (i.e., the Best Practices Guide). NRC and Agreement State inspectors interact with licensees during inspections to discuss questions and issues that the licensees have regarding the NRC's security requirements. The Best Practices Guide is being written to focus on areas of concern that licensees indicated to inspectors during the inspection process. In addition, the Department of Energy's National Nuclear Security Administration (NNSA) Global Threat Reduction Initiative, which is performing voluntary security upgrades and regularly interacts with NRC and Agreement State licensees, participated in the development of this Best Practices Guide.

  To address the concern raised by GAO in your report GAO-12-925, "Nuclear Nonproliferation: Additional Actions Needed to Improve Security of Radiological Sources at U.S. Medical Facilities," regarding improving the licensee's knowledge of acceptable security practices, the NRC is committed to publishing the Best Practices Guide in May 2014. However, during the first one to two years post implementation of 10 CFR Part 37, the NRC will assess the effectiveness of this guidance document to determine if any revisions to this document are needed, and will make revisions accordingly using our public participation process.

- Recommendation: The NRC should reconsider whether the definition of collocation should be revised for well logging facilities that routinely keep radiological sources in a single storage area but secured in separate storage containers.

  Response: The NRC acknowledges the GAO's recommendation that the definition of collocation should be reevaluated for well logging facilities that routinely keep radiological sources in a single storage area but secured in separate containers. During the first one to two year post-implementation period of 10 CFR Part 37, the NRC plans to conduct a preliminary review of the effectiveness of the requirements to determine whether any additional security measures, guidance documents (including revising NUREG-2155, "Implementation Guidance for 10 CFR Part 37 Physical Protection of Category 1 and 2 Quantities of Material" and the Best Practices Guide), rulemaking changes or licensee outreach are appropriate. The reevaluation of the definition of collocation will be included in this effort.

- Recommendation: The NRC should conduct an assessment of the Trustworthiness and Reliability (T&R) process to determine if it provides reasonable assurance against insider threat.

  Response: The NRC acknowledges the GAO's recommended assessment of the T&R process to determine if it provides reasonable assurance against an insider threat. As stated earlier, the NRC plans to conduct a preliminary review of the effectiveness of the 10 CFR Part 37 requirements to determine whether any additional security measures, guidance documents, rulemaking changes or licensee outreach are appropriate. The reevaluation of the T&R process will be conducted as part of this effort.

- Recommendation: The Administrator of the National Nuclear Security Administration, the Chairman of the NRC, and the Secretary of the Department Homeland Security should review their existing collaboration mechanism for opportunities to enhance collaboration, especially in the development and implementation of new technologies.

  Response: The NRC agrees with this recommendation and will continue to conduct periodic meetings with senior management of these agencies to enhance coordination and collaboration on overarching technical and policy issues related to source security. As the GAO is aware, the NRC routinely collaborates with these agencies on a range of topics including the security of radiation sources. Both the NNSA and the Department of Homeland Security actively participate along with other agencies and State representatives on the Radiation Source Protection and Security Task Force, which is chaired by the Chairman of the NRC, consistent with the Energy Policy Act of 2005.

The NRC appreciates the opportunity to comment and to provide information about agency actions being taken regarding the recommendations in the draft GAO report. Should you have any questions, please contact Mr. Jesse Arildsen at (301) 415-1785.

Sincerely,

for Mark A. Satorius
Executive Director
for Operations

Enclosures:
1. NRC Comments on GAO Draft Report GAO-14-293
2. Background Information

cc: David Trimble, GAO
Jeffrey Barron, GAO

Appendix IV: GAO Contact and Staff Acknowledgments

GAO Contact

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

Acknowledgments

In addition to the individual named above, Glen Levis (Assistant Director); Jeffrey Barron; Elizabeth Beardsley; Randy Cole; John Delicath; James Espinoza; Karen Keegan; Rebecca Shea; and Kiki Theodoropoulos made key contributions to this report.

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Attachment	Size
Radiological Attack Fact Sheet: Dirty Bombs and Other Devices	603.32 KB

Last Update Date: Wed, 07/08/2015

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COMMUNICATING IN A CRISIS

A fact sheet from the National Academies and the U.S. Department of Homeland Security

> *"The ease of recovery from [a radiological] attack would depend to a great extent on how the attack was handled by first responders, political leaders, and the news media, all of which would help to shape public opinion and reactions."*
>
> Making the Nation Safer
> National Research Council (2002)

RADIOLOGICAL ATTACK
DIRTY BOMBS AND OTHER DEVICES

WHAT IS IT?

A radiological attack is the spreading of radioactive material with the intent to do harm. Radioactive materials are used every day in laboratories, medical centers, food irradiation plants, and for industrial uses. If stolen or otherwise acquired, many of these materials could be used in a "radiological dispersal device" (RDD).

Radiological Dispersal Devices, a.k.a. Dirty Bombs

A "dirty bomb" is one type of RDD that uses a conventional explosion to disperse radioactive material over a targeted area. The term dirty bomb and RDD are often used interchangeably in technical literature. However, RDDs could also include other means of dispersal such as placing a container of radioactive material in a public place, or using an airplane to disperse powdered or aerosolized forms of radioactive material.

A Dirty Bomb Is Not a Nuclear Bomb

A nuclear bomb creates an explosion that is thousands to millions of times more powerful than any conventional explosive that might be used in a dirty bomb. The resulting mushroom cloud from a nuclear detonation contains fine particles of radioactive dust and other debris that can blanket large areas (tens to hundreds of square miles) with "fallout." By contrast, most of the radioactive particles dispersed by a dirty bomb would likely fall to the ground within a few city blocks or miles of the explosion.

How an RDD Might be Used

It is very difficult to design an RDD that would deliver radiation doses high enough to cause immediate health effects or fatalities in a large number of people. Therefore, experts generally agree that an RDD would most likely be used to:

- Contaminate facilities or places where people live and work, disrupting lives and livelihoods.
- Cause anxiety in those who think they are being, or have been, exposed.

Detection and Measurement

Radiation can be readily detected with equipment carried by many emergency responders, such as Geiger counters, which provide a measure of radiation dose rate. Other types of instruments are used to identify the radioactive element(s) present.

What is ionizing radiation?

When radioactive elements decay, they produce energetic emissions (alpha particles, beta particles, or gamma rays) that can cause chemical changes in tissues. The average person in the United States receives a "background" dose of about one-third of a rem* per year—about 80% from natural sources including earth materials and cosmic radiation, and the remaining 20% from man-made radiation sources, such as medical x-rays. There are different types of radioactive materials that emit different kinds of radiation:

Gamma and X-rays can travel long distances in air and can pass through the body exposing internal organs; it is also a concern if gamma emitting material is ingested or inhaled.

Beta radiation can travel a few yards in the air and in sufficient quantities might cause skin damage; beta-emitting material is an internal hazard if ingested or inhaled.

Alpha radiation travels only an inch or two in the air and cannot even penetrate skin; alpha-emitting material is a hazard if it is ingested or inhaled.

** A rem is a measure of radiation dose, based on the amount of energy absorbed in a mass of tissue. Dose can also be measured in Sieverts (1 Sievert=100 rem).*

What are some common radioactive materials used in our society?

GAMMA EMITTERS

Cobalt-60 (Co-60)—cancer therapy, industrial radiography, industrial gauges, food irradiation.

Cesium-137 (Cs-137)—same uses as Cobalt-60 plus well logging.

Iridium-192 (Ir-192)—industrial radiography and medical implants for cancer therapy.

BETA EMITTER

Strontium-90 (Sr-90)—radioisotope thermoelectric generators (RTGs), which are used to make electricity in remote areas.

ALPHA EMITTERS

Plutonium-238 (Pu-238)—research and well logging and in RTGs for space missions.

Americium-241 (Am-241)—industrial gauges and well logging.

Comparison of common radiation exposures with doses known to produce near-term health effects.

	Approx. dose (in rems)
Chest X-ray	0.03
Average annual dose from exposure to natural sources	0.2-0.3
CAT scan (whole body)	1
Recommended annual limit in occupational exposure (exclusive of medical exposures)	1 to 5 max per year
No symptoms of illness	15
No symptoms of illness; minor, temporary decreases in white cells and platelets	50
Possible acute radiation syndrome; 10% will have nausea and vomiting within 48 hours and mildly depressed blood counts;	100
Half of those exposed will die within 30 days without medical care	300-400[1]

[1]Hall, EJ. 2000. *Radiobiology for the Radiologist.* Lippincott Williams & Wilkins.

WHAT DO RDDs DO?

The Area Affected

Most dirty bombs and other RDDs would have very localized effects, ranging from less than a city block to several square miles. The area over which radioactive materials would be dispersed depends on factors such as:

- Amount and type of radioactive material dispersed.
- Means of dispersal (e.g. explosion, spraying, fire).
- Physical and chemical form of the radioactive material. For example, if the material is dispersed as fine particles, it might be carried by the wind over a relatively large area.
- Local topography, location of buildings, and other landscape characteristics.
- Local weather conditions.

Spread of a Radioactive Plume

If the radioactive material is release as fine particles, the plume would spread roughly with the speed and direction of the wind. As a radioactive plume spreads over a larger area, the radioactivity becomes less concentrated. Atmospheric models might be used to estimate the location and movement of a radioactive plume.

WHAT IS THE DANGER?

Immediate Impact to Human Health

Most injuries from a dirty bomb would probably occur from the heat, debris, radiological dust, and force of the conventional explosion used to disperse the radioactive material, affecting only individuals close to the site of the explosion. At the low radiation levels expected from an RDD, the immediate health effects from radiation exposure would likely be minimal.

Health Effects of Radiation Exposure

Health effects of radiation exposure are determined by the:

- Amount of radiation absorbed by the body.
- Radiation type (see "What is ionizing radiation?," p.1).
- Means of exposure—external or internal (absorbed by the skin, inhaled, or ingested).
- Length of time exposed.

The health effects of radiation tend to be directly proportional to radiation dose. If a reasonable estimate can be made of a person's dose, a lot is known about the health effects at that dose.

Acute Radiation Syndrome (ARS)

ARS is not likely to result from a dirty bomb. It is a short-term health effect that begins to appear when individuals are exposed to a highly radioactive material over a relatively small amount of time. The chart shows that an estimated 10% of the population may exhibit signs of ARS if they are exposed to large radiation doses of 100 rems or more. Principal signs and symptoms of ARS are nausea, vomiting, diarrhea, and reduced blood cell counts.

Psychological Impacts

Psychological effects from fear of being exposed may be one of the major consequences of a dirty bomb. Unless information about potential exposure is made available from a credible source, people unsure about their exposure might seek advice from medical centers, complicating the centers' ability to deal with acute injuries.

WHAT SHOULD PEOPLE DO TO PROTECT THEMSELVES?

Time, Distance, and Shielding

Following any radiological explosion, people should:

- Minimize the time they are exposed to the radiation materials from the dirty bomb.
- Maximize their distance from the source; walking even a short distance from the scene could provide significant protection since dose rate drops dramatically with distance from the source.
- Shield themselves from external exposure and inhalation of radioactive material.

Practical Steps

If people are near the site of a dirty bomb or release of radioactive material, they should:

1. Stay away from any obvious plume or dust cloud.
2. Cover their mouth and nose with a tissue, filter, or damp cloth to avoid inhaling or ingesting the radioactive material.
3. Walk inside a building with closed doors and windows as quickly as can be done in an orderly manner and listen for information from emergency responders and authorities.
4. Remove contaminated clothes as soon as possible; place them in a sealed container such as a plastic bag. The clothing could be used later to estimate a person's exposure.
5. Gently wash skin to remove possible contamination; people should make sure that no radioactive material enters the mouth or is transferred to areas of the face where it could be easily moved to the mouth and ingested. For example don't eat, drink, or smoke.

Questions such as when it's safe to leave a building or return home, what is safe to eat and drink and when, and how children will be cared for if they are separated from their parents would be answered by authorities who would have to make decisions on a case-by-case basis depending on the many variables of the situation.

Decisions Regarding Evacuation

Evacuation as a plume is passing could result in greater exposures than sheltering in place. The best course of action will be provided by emergency officials who may use computations from models of plume travel and potential radiation health effects.

Reducing Contamination

Contaminated individuals can expose or contaminate other people with whom they come in close contact and should avoid contact with others until they are decontaminated. People who have inhaled or ingested radioactive material require assistance by medical personnel.

Antidotes

There are no reliable antidotes once radioactive material is inhaled or ingested; however, symptoms can be treated. There are some chemicals that help cleanse the body of specific radioactive materials. Prussian blue has been proven effective for cesium-137 ingestion. Potassium iodide (KI) tablets are recommended only for exposure to iodine-131 (I-131), a short-lived radioactive element produced in nuclear power plants. Trained medical professionals will determine how to treat symptoms.

WHAT ARE THE LONG-TERM CONSEQUENCES?

Monitoring and Clean-up of Affected Areas

In the days and weeks following the use of an RDD, officials might be expected to:

- Establish a plan for careful monitoring and assessment of affected areas.
- Impose quarantines as necessary to prevent further exposures.
- Remove contamination from areas where persons might continue to be exposed.

Delayed Health Effects of Radiation

One concern of radiation exposure is an elevated risk of developing cancer later in life, although studies have shown that radiation is a relatively weak carcinogen. Exposure at the low radiation doses expected from an RDD would increase the risk of cancer only slightly over naturally occurring rates. Long-term health studies on the survivors of the 1945 nuclear bombings of Hiroshima and Nagasaki indicate that for those who received radiation doses from 0 up to 10 rems, less than 1% of cancers in that population were attributable to radiation. A long-term medical surveillance program might be established for victims of a significant radiological attack to monitor potential health effects.

Economic Impact

Such impacts might involve disruption to lives and livelihoods as the contaminated area is being cleaned up. This impact could continue even after the site has been cleaned up if people are reluctant to return to the affected area.

ADDITIONAL INFORMATION

General information on radiation and radiological emergencies:

- Centers for Disease Control and Prevention — http://www.bt.cdc.gov/radiation/index.asp
- Department of Homeland Security — http://www.ready.gov
- Nuclear Regulatory Commission — http://www.nrc.gov/what-we-do/radiation/what-is.html

Radiation protection and measurement:

- International Commission on Radiological Protection — http://www.icrp.org
- National Council on Radiation Protection and Measurements — http://www.ncrp.com

Health effects of radiation:

- Health Physics Society — http://hps.org/publicinformation/radfactsheets/
- Radiation Effects Research Foundation — http://www.rerf.or.jp

This report brief was prepared by the National Academy of Engineering and National Research Council of the National Academies in cooperation with the Department of Homeland Security. For more information or referrals to subject-matter experts, contact Randy Atkins at 202-334-1508; atkins@nae.edu; or visit www.nae.edu/factsheets. *Making the Nation Safer: Tracking the Atmospheric Dispersion of Hazardous Materials Releases* and other National Research Council reports related to this topic are available from the National Academies Press, 500 Fifth Street, NW, Washington, DC 20001; 800-624-6242; www.nap.edu.

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