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The Center for Nonproliferation Studies is pleased to publish a special edition of the *NIS Export Control Observer providing* a deeper look at the security of radioactive materials. This issue of the *Observer* includes special reports from Georgia, Tajikistan, and the United States that describe the type of radioactive sources available in these countries, and highlight the loopholes and weaknesses of existing legislation related to safety and security, licensing, and export/import requirements of these sources that may pose security or proliferation risks. The authors also provide suggestions for further security improvements.

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Security of Radioactive Sources in the United States

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Introduction

Radioactive sources—anything that may cause radiation exposure, such as by emitting ionizing radiation or releasing radioactive substances or materials, and can be treated as a single entity for protection and safety purposes—as defined by the IAEA, have become a focus of increasing concern in recent years because of their potential to be used by terrorists in radiological dispersion devices (RDDs) or "dirty bombs." Millions of such sources are used throughout the world in industry, health care, and research. A relatively small fraction of these, perhaps several tens of thousands of such sources, use especially potent radioactive materials, such as cobalt-60, strontium-90, and cesium-137, and would be particularly useful to terrorists seeking to cause radioactive contamination over a wide area. Since the terrorist attacks of September 11, 2001, the United States has taken a number of important steps to improve security over all radioactive sources, with special emphasis on those in the latter category, which pose higher potential risks. This article reviews a number of these initiatives, after sketching the overall system of U.S. regulation covering radioactive sources.

Inventory of Radioactive Sources and Security Requirements

For commercial radioactive sources used in medicine, scientific research, and industrial practices, security requirements are primarily intended to address radiation safety concerns. Security has always been an integral part of radioactive material safety but, in contrast to the controls applicable to safeguarded nuclear weapons-usable material, security requirements are not as stringent. Since September 11, 2001, and the subsequent heightened concern over the threat of radiological terrorism, security of radioactive sources is receiving increased attention with emphasis on protection against theft and diversion of these sources. Because security had taken a back seat to safety prior to 9/11, however, the United States does not have a precise accounting of the number and locations of its radioactive sources.

In 1998, it was estimated that in the United States there were approximately two million devices containing licensed radioactive sources.[3] Some devices contain one source, e.g., radiography cameras and teletherapy units, but others such as large irradiators, some medical devices and certain nuclear gauges, may contain multiple sources. Because there is no national inventory, the quantity of two million devices is only an estimate, and the exact number of individual sources is unknown.

The lack of a national inventory hinders reporting of numbers of radioactive devices or sources by category of use. Generally, the most prevalent uses of radioactive sources are in:

- self-luminous devices, e.g. exit signs (most are generally licensed, see below)
- gauging systems used to measure thickness, density, and levels of material
- irradiators
- industrial radiography
- well-logging
- medical therapy

In 2003, the Nuclear Regulatory Commission (NRC) completed an interim national inventory of high-risk sources in the United States. High-risk sources are radioactive materials identified by the IAEA as being at or above Category 2 thresholds in the IAEA Code of Conduct on the Safety and Security of Radioactive Sources.[4,5] According to this Code, "Category 2 sources, if not safely managed or securely protected, could cause permanent injury to a person who handled them, or were otherwise in contact with them, for a short time (minutes to hours)." It is believed that there are more than 20,000 high-risk sources in use or in storage in the United States today.

The NRC is developing a National Source Tracking System for cradle-to-grave tracking of high-risk sources. Although the NRC is aiming to complete that system within the next one to two years, coordination among the many different regulatory agencies within the United States will be difficult and will likely delay the projected completion time.

The U.S. Regulatory System

In the United States, the NRC is granted the authority to regulate the possession and use of radioactive sources, under the U.S. Atomic Energy Act, as amended.[1] This Act also provides that the Commission may delegate its regulatory authority to the governments of the 50 U.S. states, provided that these governments agree to follow standards and guidelines issued by the Commission. Thirty-three states, known as "Agreement States," have chosen to assume the regulation of radioactive sources by entering into special agreements with the NRC, but others have not. Thus, at present the regulatory organization responsible for overseeing these materials varies according to the location of the item.

The NRC and the Agreement States have issued "general" licenses for, among other things, importing, exporting, and holding title to radioactive material, as well as for certain radioactive devices that are deemed sufficiently safe for use by persons without special training in radiation safety. (See, for example, Title 10, Code of Federal Regulations (CFR), Part 110, *Export and Import of Nuclear Equipment and Material*, and Part 31, *General Domestic Licenses for Byproduct Material*.)[2] General licenses do not require an application because they are issued by a broad regulation; thus there are no governmental verifications that the end-user has a legitimate use for the material in question. This is a matter of particular concern with respect to the import and export of radioactive sources, a matter which is now being addressed by the NRC and is discussed further below. Historically, general licenses have received minimal oversight, with little or no inspections of locations in the United States where such licensed material is used.

Other licenses require applications and are reviewed to ensure the applicant is in compliance with regulatory requirements for handling the materials at issue. If regulatory officials deem the application adequate, they issue a license, which is normally active for a specific period of time. These are called "specific licenses." Specific licensees pay annual fees and are subject to routine inspections. Practically all of the radioactive sources of highest security concern require specific licenses for use within the United States.

Disposal of Disused Sources

Of the estimated two million radioactive devices in the United States, as many as one-quarter, or up to one-half million, may be no longer needed.[6,7] These are known as "disused" sources. When a radioactive source is no longer needed, it may be returned to the manufacturer, transferred to another qualified licensee who has a use for it, sent to a commercial waste disposal site, or stored. There are no requirements for prepayment of disposal costs. Disposal options are limited—very large radioactive sources and most transuranic sources (those containing elements heavier than uranium including americium, californium, and plutonium) may not be disposed at commercial low-level radioactive waste disposal sites, and access to the sites is limited to materials from certain states by interstate compact agreements. When available, disposal is expensive—often exceeding the original cost of the source or the device containing the source.

Disused sources headed for disposal are considered low-level radioactive waste. Within the United States, regulations define four classes of low-level radioactive waste. Classes A through C refer to radioactive waste that typically contains smaller quantities (concentrations) of radioactive material. Disused sources containing isotopes with relatively short half-lives of less than five years would typically not exceed the Class C standard because the radioactivity will dissipate relatively quickly. In contrast, depending on the radioactivity amounts, disused sources containing isotopes with longer half-lives could surpass the Class C level. In general, as the class increases from A to C, the amount of radioactivity also tends to increase. Consequently, Class C waste would typically pose a greater security threat than Class A. (See 10 CFR 61 for details about the U.S. waste disposal regulations as well as various radioactivity amounts and radioisotopes for these classes of waste.)[8]

Class A through C wastes may be disposed at near-surface disposal facilities. To encourage and govern the development of low-level radioactive waste disposal sites, the U.S. Congress authorized the states to form compacts for this purpose. Currently, there are three low-level waste facilities, located in Barnwell, South Carolina; Hanford, Washington; and Clive, Utah. Both Barnwell and Hanford dispose of Class A through C waste, but the Clive site is only licensed to dispose of Class A waste. Severe restrictions on states' access to the Barnwell site will take effect in 2008 when Barnwell will only receive waste from the nearby Atlantic Compact states. Hanford only accepts waste from the Northwest and Rocky Mountain Compacts. As a result, in 2008, there will be gaps in the national disposal system for Class B and C wastes. Some thirty states would then be without a repository for these wastes.

Greater Than Class C (GTCC)[9] waste may not be disposed at the commercially operated near-surface disposal facilities. GTCC waste includes large radioactive sources that are of the greatest concern from safety and security standpoints. The federal government is responsible for providing a disposal pathway for GTCC waste, under the Low-Level Radioactive Waste Policy Amendments Act of 1985. The federal government has not done this. As a result, there is currently no disposal pathway for GTCC waste.

With the construction of a permanent repository for the most dangerous U.S. radioactive wastes is still many years distant, the U.S. Department of Energy (DOE) has been storing this waste at an interim storage site at the Los Alamos National Laboratory under the Off-Site Source Recovery (OSR) project. On May 18, 2004, DOE announced that the OSR project has rounded up more than 9,500 disused sources, many of which are high-risk sources (IAEA Category 2 and above), and the Department is set to collect more than 10,000 disused sources by mid-summer 2004.[10] Thousands of additional disused sources, including high-risk sources, are registered on the OSR database awaiting recovery.[11] An OSR project scientist predicted that another 10,000 disused sources will end up on the OSR registry during this decade.

According to another DOE official interviewed on October 18, 2002, DOE has estimated that of the two million sources in the United States, 20,000 to 250,000 might be considered GTCC waste once they reach the end of their useful life. The NRC has estimated this number to be around 27,000 GTCC sources. Without a national source database, it is unknown exactly how many sources will end up in the GTCC category. Of these, it is uncertain how many would be considered high-risk under the IAEA's new categorization. A large portion of the GTCC sources collected to date are around the one to two curie level. According to the IAEA's categorization system, these sources would fall under Category 3, but not under Category 2. The NRC considers category 1 and 2 sources to be "high-risk." However, the IAEA's Code of Conduct on the Safety and Security of Radioactive Sources discusses Categories 1, 2, and 3 when addressing sources that can pose safety or security concerns. Although Category 3 sources could cause some harm to human health if improperly handled, they are unlikely to lead to a fatal radiation dose.

Despite the success of the OSR project, however, the program had been subject to repeated funding cuts.[12] Positively, in late 2003, the project's prospects substantially improved. First, Congress restored cuts by adding supplemental funding to the fiscal year (FY) 2004 budget. Second, also in late 2003, the DOE's leadership moved the project from the Environmental Management division, which did not consider the project a high priority, to the National Nuclear Security Administration (NNSA), which considers the project an important national security endeavor. Because the project exceeded expectations in recovering disused sources, it ran out of money in early 2004. Wanting to keep the project moving forward, NNSA asked for and received permission to reprogram funds from other parts of DOE to the OSR project. Concerning the next fiscal year, the Bush administration has requested $5.6 million for the project, but according to interviews with NNSA officials, the project will need $13 million for FY 2005. These officials intend to obtain this money by asking Congress to insert language in DOE's authorization bill to allow use of money set aside for the international radioactive materials security program. In the past, money for that program had not been fully expended.

In the next few years, the OSR project will confront another hurdle. It will need to find a permanent repository for the disused sources now in interim storage. However, funds for developing a permanent disposal plan for these materials have yet to be provided. Moreover, additional funding will likely be required to pay for a needed expansion of the OSR project beyond the GTCC mandate. In particular, many other unwanted sources that do not fit the narrow GTCC definition could pose a high risk for use in a "dirty bomb." The OSR project has been recovering some of those sources on a case-by-case basis, but a more systematic approach could prove more effective at securing these radioactive materials.

A related issue affecting the viability of disposal options is the absence of a requirement that potential users of radioactive sources prepay or otherwise provide financial surety for disposal costs. As a result, licensees are usually uninformed of the costs and are unprepared to pay them when their sources reach the end of their service lives. Options such as return to the manufacturer are not necessarily cost-free and may not be available if the manufacturer discontinues business, as has already happened with some major manufacturers.

In the event of an emergency that threatens public health and safety—for example, abandonment of a source following bankruptcy of the licensee—the DOE, at the request of the NRC, will recover and secure such a disused source. The NRC has requested such assistance from the DOE over 20 times involving over 500 sources since the early 1990s.

Reuse of Disused Sources

Because of the difficulty and costs of disposing of a disused, or unwanted, source, selling it in a secondhand market place is a convenient way to off-load a headache. Although the disused source may no longer have enough radioactivity in it to perform its originally intended function, it may still contain sufficient radioactivity useful for other tasks—and may still be considered high-risk from a security standpoint. For example, disused teletherapy units and non-medical sources such as multi-curie americium-241 and cesium-137 sources have been listed on the Internet, some available for nothing more than the cost of packaging and shipping.

Without proper regulation, the disused source bazaar can be a major security weakness in the national regulatory system. When transferring sources within the United States, licensees are required to verify that the recipient is authorized to possess the source. Proof is normally provided in the form of a copy of the recipient's license. Licensing documents of the NRC and the agreement states are not uniform, however. Consequently, verifying authenticity of licenses is a challenge. Moreover, for sources sold over the Internet, website operators serve as middlemen only, never taking possession of the source and thus not needing a license, themselves.

Recycling and reusing used sources is a desirable practice, but only when consistent with safety and security considerations. Under present practices, the secondary market for disused sources is vulnerable to theft and diversion of sources and to the use of fraud to access them.

Orphan Sources

Disused sources that are not disposed of or transferred to another user promptly and properly risk becoming orphan sources—falling outside of regulatory control because of loss, theft, or abandonment. During a five-year period from October 1996 to September 2001, the NRC has estimated that this orphan rate was about 300 orphan sources per year.[13] While most of the sources so reported are not especially hazardous, some can be of concern. Based on the data from the above five-year period, only a small fraction of the orphan sources that were recovered would have posed high security concerns.[14] However, this data set is incomplete because less than half (44%) of the sources presumed to have been orphaned were ultimately recovered. Moreover, the NRC did not publish the exact amounts of radioactivity in the sources that were recovered. Furthermore, licensees tend to underreport orphan sources. Thus, the orphan source production rate could be much greater than reported above.

Orphan sources have caused major economic losses in the United States. For example, the U.S. steel industry accidentally melted such sources during steel production on 22 occasions between 1983 and 2004 resulting in a quarter billion dollar aggregate loss because the contaminated steel could not be sold and the mills required extensive decontamination in many instances. One of the first incidents took place in 1983 when an orphaned 25 curie Co-60 source became mixed with scrap metal that was melted in a steel mill.[15] Similar incidents spurred the steel industry into action. To try to prevent further financial harm, this industry has installed radiation detectors at its facilities and at scrap metal sites and has pressed the NRC to improve controls over sources. The problem is not yet fully solved: in May 2004, a 0.8 to 1.0 Ci cesium-137 source escaped detection at an Ohio steel mill and was accidentally melted. Although not considered "high-risk" based on the new IAEA and NRC standards, the economic damage to the mill meltings was significant. In other instances, from 1992-1999, unshielded sources were found uncontrolled in the public domain on 13 occasions, the largest of which was a 40 curie irridium-192 source.[16]

The Conference of Radiation Control Program Directors, Inc. (CRCPD), an organization of local, state and federal radiation control officials, is sponsoring a national orphan source recovery project, which began with discussions among these officials in October 1997.[17] Development of this program was funded by the U.S. Environmental Protection Agency (EPA) and the NRC, and the program is now sponsored by the NRC. DOE also works closely with the EPA and the NRC in this Orphan Source Initiative. The eventual goal is to turn this pilot program into a nationwide disposition program.

Wrongdoers: Licensing Fraud

The radioactive source licensing system is vulnerable to fraud. An outstanding case surfaced in 1996 when Stuart Lee Adelman, a.k.a. Stuart von Adelman, pleaded guilty to one federal felony count of fraudulently obtaining radioactive material and was sentenced to five years in prison. Adelman had posed as a visiting professor at the University of Rochester, NY, and, illicitly using university resources, obtained licensed radioactive material from suppliers. Earlier, in 1992, he was arrested in Toronto, Canada, on a U.S. fugitive warrant and was found to have illegally obtained radioactive material there and stashed it in a public storage locker. An assistant U.S. district attorney commented at the time of this arrest that the radioactive material may have been part of a scam to obtain money from terrorists. Possessing a graduate degree in nuclear physics, Adelman, had been employed as a radiation safety officer at two universities and had been a licensing reviewer in a state radiation control program. Adelman illustrates the very real potential of the insider threat.

There have been other cases in which criminal convictions of persons have been obtained following repeated findings of serious unsafe practices using radioactive material that adversely affected safety and security. These and the Adelman case point out the need to recognize the potential for insider and other crimes and to take appropriate steps to ensure that national and state licensing agencies, law enforcement officials, and intelligence agencies are informed of such cases.

Export and Import of Sources

The practice of importing and exporting sources also presents serious susceptibility to licensing fraud. Current U.S. export control regulations do not require a governmental check on the credentials of the recipient of a high-risk source exported from the United States, except for shipments intended for the embargoed countries of Cuba, Iran, Iraq, North Korea, and Sudan. An al Qaeda front company, for example, could attempt to pose as a legitimate entity in any other country in order to import sources and might be able to carry out such activity without being caught. Until March 2003 during Operation Liberty Shield when the NRC issued an advisory to licensees to report any transfers of high-risk sources into and out of the United States at least ten days prior to shipment, there was no government tracking of such sources. This advisory, however, did not change the underlying regulations.

Encouragingly, at the June 2004 Group of Eight (G-8) Summit, these leading industrialized nations, most of which are major exporters of commercial radioactive sources, issued a summit statement that they would enact rigorous end-user checks of exported high-risk radioactive sources by December 2005. Consequently, the NRC is considering new licensing regulations that would tighten controls over exports and imports. The proposed regulation changes were presented by NRC staff to the Commission for its consideration in early July 2004. In January 2004, the IAEA published its Code of Conduct on the Safety and Security of Radioactive Sources, which recommended that states strengthen export and import controls.[4] In June 2004, the Code was endorsed by the G-8.[18] Still to be agreed upon is the IAEA interim guidance to implement the code.[19] Presumably, the NRC will conform its export and import rules to the export and import provisions of the IAEA Code and implementation guidance.

Illicit Trafficking Detection and Response

On March 1, 2003, the new Bureau of Customs and Border Protection in the Department of Homeland Security began using radiation detection devices to screen every person who enters the United States at border security checkpoints. Every border security inspector is expected to be equipped with the pager-sized radiation detectors, which cost $2,500 a piece. Other radiation detection tools include hand-held "radiation isotope identifiers," which in essence can measure the radioactive "fingerprint" of a material and, therefore, determine the exact type of radioactive material that is being detected. Inspectors also can employ X-ray machines to determine if heavy shielding, such as lead, is being used to hide radioactive materials from detection by means of the hand-held detectors. However, reportedly not enough X-ray machines are currently available for all major border checkpoints.

This new Bureau brings together 9,000 former Customs Service inspectors, 6,000 former Immigration and Naturalization Service inspectors, 3,000 former Agriculture Department inspectors, and 10,000 officials from the former Border Patrol. At this level of personnel, the new Bureau takes a step forward in achieving an integrated and unified border security agency. At the level of radioactive materials detection at U.S. borders, the Bureau has acknowledged that the new hand-held radiation detectors are only one aspect of a defense-in-depth system. However, the U.S. government's comprehensive plans for a multi-layered and integrated border defense system to prevent the inflow of potentially dangerous radioactive and nuclear materials remain unclear. Indeed, as seen in the realms of illegal drugs and illegal immigration, preventing illicit transport across unofficial border crossings continues to pose a significant problem.

In addition, the Department of Homeland Security has been trying to work with its counterparts in other countries in order to detect nuclear and radioactive materials in ships in foreign ports before their embarkation to the United States. Even if this detection element were fully in place, there would still be the need to recheck ships and cargo before entering U.S. ports. For instance, a determined terrorist could shield the radioactive contents of the potentially deadly cargo or could transfer nuclear or radiological materials onto ships at sea that had received a "clean" detection sweep in a foreign port.

Justification: Consideration of Alternatives to Radioactive Sources

Justification of the use of a radiation source is one of the three cornerstones of international and national recommendations for radiation safety, the others being dose limitation and optimization. The justification principle calls for evaluating the risks and benefits of using a radiation source for a particular application. Users should consider opting for an alternative if there is one that provides comparable benefit and less risk. For radioactive sources, management of the source at the end-of-life is an additional consideration that should be included in the justification decision-making process. Potential users should consider the obligation to provide for safe disposal of a source at the end of its life-cycle and, equally important, plan for the cost of disposal, which, as noted, can sometimes exceed that of purchasing the source.

The U.S. steel industry, no stranger to the risks and costs of radioactive contamination, is rethinking some of the uses of nuclear gauges in its mills. Nuclear level gauges have been used to monitor the level of molten steel in continuous casters. On occasion, the molten steel breaks through the casting system and strikes the gauge, risking melting of the shield and the source itself. Mill operators are replacing these nuclear gauges with eddy current and thermal systems even though they are more expensive. The tradeoff—the cost of alternative technology versus the cost of decontamination—makes the use of alternative technology a smarter choice. Consideration of technological alternatives to radioactive sources in other settings has been recommended in reports and statements of the National Research Council, the

IAEA, the National Council on Radiation Protection and Measurements, and the Health Physics Society.[15,20,21,22,23] The NRC, however, does not believe it has the authority to implement the justification principle and is disinclined to promote it, believing that implementation is outside of its existing expertise.[24]

Recommendations for Action

- In the absence of universally available, inexpensive disposal options for unwanted sources, a national plan is needed that provides for prompt recovery and secure long-term storage of unwanted radioactive sources. The OSR project is ideally situated for this purpose. Long term commitments to fully fund it are needed.
- Re-sales and other transfers of used sources that are security risks should be subject to increased regulatory oversight to ensure that such transfers are made to legitimate recipients especially for those teemed to be high-risk sources.
- Information on convicted and known wrongdoers involved with radioactive sources should be exchanged between licensing, law enforcement, and intelligence agencies.
- NRC rulemaking to tighten import and export of radioactive sources should be accelerated and should conform to the IAEA Code of Conduct and its implementing guidance.

In the long term, consideration should be given to requiring potential users of radioactive sources to:

- justify their proposed use of the sources taking into account the availability of technological alternatives and the need to provide for disposition at end-of-life;
- pre-pay disposal costs before being allowed to take possession of sources.

Sources: [1] Atomic Energy Act of 1954, as amended, NRC website, <http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr0980/ml022200075-vol1.pdf>. [2] The Code of Federal Regulations for radioactive and nuclear material licensing issues, NRC website, <http://www.nrc.gov/reading-rm/doc-collections/cfr/>. [3] J. O. Lubenau and J. G. Yusko, "Radioactive materials in recycled metals—an update," *Health Physics*, Volume 74, No. 3, March 1998, pp. 293-299. [4] "Code of Conduct on the Safety and Security of Radioactive Sources," IAEA/CODEOC/2001 (Vienna: IAEA, 2001). [5] "Categorization of Radiation Sources," IAEA-TECDOC-1344 (Vienna: IAEA, 2001). [6] J. O. Lubenau and J. G. Yusko, "Spent/disused/orphan sources: Action is Needed," *Health Physics Society Newsletter*, Volume 28, No. 7, July 2000, pp. 2-6. [7] A. J. González, "Strengthening the Safety of Radiation Sources and the Security of Radioactive Materials: Timely Action," *IAEA Bulletin*, Volume 41, No. 3, 1999, pp. 2-17, IAEA website, <http://www.iaea.org/Publications/Magazines/Bulletin/Bull413/article1.pdf>. [8] Title 10, CFR, Part 61, "Licensing Requirements for Land Disposal of Radioactive Waste," NRC website, <http://www.nrc.gov/reading-rm/doc-collections/cfr/part061/>. [9] Title 10, CFR, Part 61, Subpart D, Paragraph 55, "Waste Classification," NRC website, <http://www.nrc.gov/reading-rm/doc-collections/cfr/part061/part061-0055.html>. [10] U.S. Department of Energy, "DOE Surpasses Congressional Target of Recovering Radioactive Sources," May 18, 2004, National Nuclear Security Administration website, <http://www.nnsa.doe.gov/docs/PR_R-04-103_orphaned_sources release(5-04).pdf>. [11] Off-Site Source Recovery Project, "Off-Site Source Recovery," Los Alamos National Laboratory, LALP 02-26, February 2002. [12] U.S. General Accounting Office, "Nuclear Nonproliferation—DOE Action Needed to Ensure Continued Recovery of Unwanted Sealed Radioactive Sources," GAO-03-483, April 2003. [13] R. A. Meserve, "Effective Regulatory Control of Radioactive Sources," Speech at the IAEA International Conference of National Regulatory Authorities with Competence in the Safety of Radiation Sources and the Security of Radioactive Materials, Buenos Aires, Argentina, December 11-15, 2001, NRC website, <http://www.nrc.gov/reading-rm/doc-collections/commission/speeches/2000/s00-32.html>. [14] C. D. Ferguson, T. Kazi, and J. Perera, "Commercial Radioactive Sources: Surveying the Security Risks," CNS Occasional Paper No. 11, January 2003, CNS website, <http://www.cns.miis.edu/pubs/opapers/op11/index.htm>. [15] F. J. Bradley, L. Cabasino, R. Kelley, A. Awai, G. Kasyk, "The Auburn Steel Company Radioactive Contamination Accident," NUREG-1188 (Washington, DC: NRC, 1986). [16] G. J. Dicus, "USA Perspectives. Safety and security of radioactive sources in the United States," *IAEA Bulletin*, Volume 41, No. 3, 1999, pp. 22-27, IAEA website, <http://www.iaea.org/Publications/Magazines/Bulletin/Bull413/article3.pdf>. [17] CRCPD Orphan Source Program, <http://www.crcpd.org/orphans.asp>. [18] G8 Action Plan on Nonproliferation, G8 2004 Sea Island Summit website, <http://www.g8usa.gov/d_060904d.htm>. [19] IAEA, "Security of Radioactive Sources—Interim Guidance for Comment," IAEA-TECDOC-1355 (Vienna: IAEA, June 2003). [20] Committee on Science and Technology for Countering Terrorism, National Research Council, "Nuclear and Radiological Threats," Chapter 2 in *Making the Nation Safer: The Role of Science and Technology in Countering Terrorism*, National Academy Press, 2002, p. 61, National Academies Press website, <http://www.nap.edu/html/stct/39-64.pdf>. [21] "Findings of the President of the Conference," IAEA International Conference on Security of Radioactive Sources, Vienna, March 2003, <http://www.iaea.org/NewsCenter/Features/RadSources/PDF/findings.pdf>. [22] National Council on Radiological Protection, "Managing Potentially Radioactive Scrap Metal," Report 141, January 2003. [23] Health Physics Society, "State and Federal Action is Needed for Better Control of Orphan Sources," HPS Position Statement, April 2002, HPS website, <http://hps.org/documents/orphansourcesposition.pdf>. [24] N. J. Diaz, "Radiological Terrorism," *Issues in Science and Technology*, Winter 2004, pp. 13-14.

Status of Radioactive Materials in Tajikistan

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Introduction

Radioactive sources in Tajikistan are used in various sectors of industry and science, but their use remains largely unregulated. In spite of the support received from the IAEA to locate orphan sources and develop the regulatory framework to ensure the radiation safety of Tajikistan, the implementation of these new rules is still far from what is needed. This article highlights the weaknesses of the existing laws and makes recommendations of ways to improve the implementation of safety regulations and prevent the proliferation and health hazards associated with the unregulated use of radioactive sources.

Use of Radioactive Sources in Tajikistan

During the Soviet era, radioisotope technologies in Tajikistan were either developed by the All-Soviet Scientific Research Institute of Radiation Equipment (VNIIRT) itself or with its mandatory participation, while equipment containing radioisotope sources was supplied, as a rule, by the All-Soviet Enterprise Isotop. There has never been any independent production of radioisotope sources in Tajikistan. Below are several examples of the application of such technologies in Tajikistan.

Geological Surveying and Mining

Radioisotope technologies were used especially intensively in geological surveying and the mining industry. The sampling of rocks during geological exploration was conducted in-situ. X-ray fluorescent methods of trench sampling (adit sampling) used radioactive isotopes of americium-241 and tin-120. In oil prospecting, various neutron logging techniques were widely applied directly in wells to identify the content of adjacent rocks using such radioisotope neutron sources as californium-252 or composite plutonium-, polonium-, or radium-beryllium sources. Radioisotopes of cesium-137 and cobalt-60 were used for purposes of sampling via density logging. In addition to their use on-site, radioactive isotopes of americium-241 and tin-120 were used to examine the elemental content of rocks using X-ray fluorescence analysis in laboratories.

Mining and processing enterprises used radioisotope techniques as early as during the first grading of rocks from adits to determine the average concentration level of minerals in them. This was necessary because significant concentration deviations inevitably cause losses of expensive flotation reagents or of the material being concentrated itself, unless there is quick intervention in the technological process. X-ray fluorescence analyses using radioactive isotopes of americium-241 and tin-120 were applied in laboratory examination of product content both on production lines and during final quality control.

Public Health and Biological Sciences

To date, Tajikistan only uses radiation therapy at the country's main hospital—Republican Hospital No. 1 in Dushanbe. The equipment, which uses highly radioactive isotopes of cobalt-60, is used for both external and intracavitary irradiation. A large quantity of isotopes, most of which are short-lived, was used for early disease detection. The possibility of resuming research efforts at the Republican Diagnostic Center and at the Academy of Sciences biology-related scientific-research institutes is currently under discussion.

Industry

Practically every enterprise that needs to measure large quantities of different materials has nucleonic gauges that use highly radioactive cesium-137 or cobalt-60 sources. Similar equipment is used to monitor smokestacks at facilities, such as thermal power plant boilers, cement factories, and other enterprises, where smokestacks may accumulate soot or other waste that block them and reduce their effectiveness. To detect embedded/internal defects in foundry products, easy-to-operate and effective radioisotope defectoscopes were used. There are foundry shops at Tajiktekstilmash, Tajikgidroagregat, and almost all other major plants. A type of non-destructive testing, defectoscopes are "flaw detectors" that can detect defects in materials, and they use sets of radioisotope sources that possess various types of gamma radiation, which are applied depending on the material of foundry goods, their size, and other parameters.

Academic Science

Various radioisotope items are used in academic science. The range of isotopes used here varies from the lightest radioisotopes, such as deuterium and tritium, to the heaviest, such as uranium, thorium, and plutonium. While the above-mentioned industries used mostly sealed sources in ampoules, in science, various open-type chemical compounds of radioactive substances were used most often.

The range of scientific studies using such substances is similarly broad. These include problems of photosynthesis in middle- and high-mountain conditions, development of chemical technologies, new methods to study the chemical and elemental content of various substances, and many other issues.

The most stringent requirements were imposed on the use of such radioactive substances due to difficulties in their accounting and storage, and the ease of ingestion of these materials. Nonetheless, such sources would not be considered high-risk from the perspective of fueling potent radiological dispersal devices.

Regulatory Framework: Law On Radiation Safety

The first government attempts to improve controls over radioactive materials in Tajikistan faced practically insurmountable difficulties due to the results of the civil war and a large outflow of specialists. Under these circumstances, in December 1999, the Tajik government decided to join the IAEA and request its assistance both in obtaining technical capabilities and in dealing with organizational and legal issues. To the IAEA's credit, such assistance began immediately. The first technical assistance was rendered even before the official recognition of Tajikistan as an IAEA member on September 20, 2000, at the IAEA General Conference. Despite serious financial difficulties, the Academy of Sciences assumed coordination functions in the regulation of activities related to the use of radioactive substances. The Agency for Nuclear and Radiation Safety, which was established under the Presidium of the Academy of Sciences, works in close contact with IAEA specialists.

On the whole, there has been clear progress in ensuring the radiation safety of Tajikistan. In July 2003, the ninth session of the Madzhlisi Milli (upper house of the parliament of the Republic of Tajikistan) adopted a law *On Radiation Safety*, which was signed by the president of Tajikistan on August 1, 2003. However, Tajik legislation fails to create a system that fully defines the responsibilities of government agencies for ensuring the safe and secure use of radioactive materials.

The following agencies were given powers as regulatory authorities in the Republic of Tajikistan:

- Ministry of Internal Affairs—responsible for issuing permits to possess radioactive substances and control of their safety;
- Ministry of Public Health—responsible for licensing activities of facilities that use radioactive substances and control of their radiation hygiene conditions and degree of pollution;
- Ministry of Environmental Protection—responsible for control of environmental contamination;
- Ministry of Emergency and Civil Defense—responsible for taking adequate response measures against the consequences of possible accidents.

However, due to the lack of regulatory legislation, the agencies listed above perform their assigned functions without mutual coordination, often duplicating each other's functions, and do not meet international standards, such as *Organization and Implementation of a National Regulatory Infrastructure Governing Protection against Ionizing Radiation and the Safety of Radiation Sources*, IAEA-TECDOC-1067 (IAEA: Vienna, 1999). Thus, at present it is unlikely to find an organization in Tajikistan that can precisely determine the total amount of radioactive material in the country and describe their locations.

A major gap in the radiation safety law is that it appears to place all responsibility for implementing the law with the Agency for Nuclear and Radiation Safety under the Academy of Sciences. That agency is designated as the state regulatory authority that ensures radiation safety, conducts unified state policy, and coordinates the work of other authorized agencies. Other elements of the government, however, such as the Ministries of Heath and Interior also have important responsibilities for protecting the public from radiation but how these various authorities are to be harmonized is not specified in the Radiation Safety law.

In particular, the law does not specify controlling and licensing authorities, though it is evident that only the Ministry of Public Health can handle issues of radiation sanitation and hygiene, that the Ministry of Internal Affairs is responsible for ensuring physical safety, that the Ministry of Environmental Protection protects the environment against adverse effects, that the State Disposal Site for Radioactive Waste is designed to dispose of wastes, and that the Ministry of Emergency is best suited to respond to emergencies. The legislative consolidation of these responsibilities along with coordination and licensing by the Agency for Nuclear and Radiation Safety might become the basis for the creation of a comprehensive system to ensure radiation safety, but for now, the confusion of responsibilities continues.

Another weakness in the law is that the 24 basic concepts defined in Article 2 may confuse even experts. Although the *International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources*, developed under the IAEA, contains a glossary that provides definitions of a number of notions that are recommended for use in IAEA member countries, the authors of the law did not use that publicly available document in their lawmaking activities.

Perhaps the law's most serious flaw is in Article 3, *Principles of Ensuring Radiation Safety.* This provision was added to the text of the law from an alternative draft developed by the Academy of Sciences. But the editing of the text without the assistance of experts led to the change of one word, which resulted in incomprehensible phrasing that appears to imply that larger doses of radiation are better than lower ones. Below are the extracts from the adopted law and the draft, developed by experts:

- In the law: "prohibition of all kinds of activities involving the use of ionizing radiation sources when the *dose* received by humans and the public does not exceed the damage that could result from exposure to radiation exceeding natural radiation levels;"
- In the draft: "prohibition of all kinds of activities involving the use of ionizing radiation sources when the *benefit* received by humans and the public does not exceed the damage that could result from exposure to radiation exceeding natural radiation levels."

This law needs revision to eliminate such errors, as well as to introduce additional mechanisms for its implementation. Such revision would also make it possible to bring it into compliance with international standards. Meanwhile, it would be prudent were the government to decide to enact the above mentioned *International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources* for use on the territory of Tajikistan. As the country is an IAEA member, this would appear to imply that the international standards should indeed be recognized within Tajikistan.

The Current Safety Situation and Future Steps

Unfortunately, very little is being done at present to ensure the country's radiation safety, despite the fact that the sanitary and epidemiological service of the Ministry of Public Health, chemical and radiation surveillance units of the Ministry of Emergency and the Academy of Sciences are seriously concerned with the problem. The first two agencies conduct very important work on the accounting of radioactive substances at enterprises. But due to a lack of personnel and technical capabilities, they have not been able to undertake physical inventories and have been limited to working with the documents enterprises provide.

However, it is impossible to solve the problem of radiation safety solely by addressing the issue of the accounting of radioactive substances. Export controls, for example, are another critical element in controlling radioactive materials. Tajikistan was one of the first of the post-Soviet Central Asian states to adopt a law *On State Control over Export of Arms, Military Equipment, and Dual-Use Items*, under which all radioactive items are subject to export controls. However, apparently, the law remained only in the form of the declaration, since no authorized body was established to implement its provisions. The inactivity in addressing export control issues in Tajikistan does not help to effectively solve the problem of radiation safety.

Urgent collection of all radioactive sources that have exceeded their service lives and have therefore become radioactive waste, and their disposal at the State Disposal Site for Radioactive Waste, should be considered another extremely important activity.

Under current economic conditions, the government is unlikely to resolve all these problems. It is precisely in this sort of case that government agencies turn to non-governmental organizations for help. These organizations can independently solve a number of problems and focus the attention of government agencies and international organizations on the most urgent problems. Such organizations do exist in Tajikistan, and they have made a number of proposals. For instance, in order to prevent possible accidents and normalize the radiation situation, the Academician Adkhamov Foundation suggested an urgent physical inventory of radioactive sources together with the registration of enterprise activities involving their use. The inventory was to include the compulsory registration of orphan radioactive sources describing reasons for losses in inventory lists. Such an inventory could be conducted jointly by representatives of the Ministries of Internal Affairs, Emergency and Public Health, along with experts of the Academy of Sciences and the Ministry of Education. If an announcement were made that during the inventory and for three months after its conclusion the disposal of radioactive sources would be done at state expense, and after that period, at the prices set by the State Disposal Site for Radioactive Waste, there would be an additional incentive for users to report and bring in disused radioactive sources. In addition, the Foundation's proposal suggested that urgent measures be taken to equip relevant services of the Ministries of Emergency and Public Health with additional radiometric, radiation-measuring, and search equipment with IAEA technical assistance and funding, and that parallel searches for orphaned and abandoned sources be organized with the help of IAEA experts, who managed to find a large number of such sources at former military bases in Georgia.

These suggestions met with some success. With the help of IAEA experts and their technical support, not only were the services mentioned above successfully equipped with radiometric, radiation-measuring, and search equipment, but also several radioactive sources were found. For instance, two sources from helicopters that crashed in separate incidents were found in the mountains after the IAEA sent an expert team in August 2002.

Unfortunately, due to a lack of funds, the physical inventory of radioactive sources and inspection of storage conditions were not fully implemented. The situation remains disturbing. For example, in 2003, an empty container from a defectoscope, which usually contains highly active sources, was found at a dump near Akademgorodok. The container shielding was made of depleted uranium, which itself is very weakly radioactive.

Available estimates indicate that the cost of collecting unused radioactive sources from enterprises would not exceed $7,500-$10,000 in total. However, the search for every orphan source would require more significant funds, although this would be offset by the reduction in the danger of injury to the public.

In addition, there are several old Soviet-made americium-241 sources in Tajikistan. These sources have an essential weakness: helium accumulating in hermetically sealed sources can break the source casing, leading to the radioactive contamination of storage sites, and potentially to the ingestion of radioactive substances by plant workers. (The radioactive decay of an americium-241 atom produces an alpha particle, a helium nucleus, which can combine with electrons to form helium gas.)

It is most likely that the decontamination of storage sites and the search for other possible contaminated sites will have to be conducted after the collection of sources containing americium-241. Therefore only specially instructed personnel should be involved in the collection of such radioactive sources.

Another Adkhamov Foundation proposal was related to the prevention of the illegal possession of radioactive substances. An analysis of criminal cases involving the illegal possession of radioactive substances demonstrates that, as a rule, arrests of perpetrators occur accidentally, for instance, while inspecting vehicles. At present, such inspections are conducted in the Central Asian states on a regular basis due to a sharp increase in drug trafficking. In Tajikistan, inspection posts are located on practically all inter-district borders. Apparently, perpetrators are forced to use vehicles because of the need to pack radioactive substances into fairly heavy containers. Equipping the transport police with the simplest radiation detectors would sharply increase the probability of detecting cargoes containing radioactive materials.

Editor's Note: In the coming years, international cooperation will continue to remain an important component of developing more effective controls over radioactive sources. Several initiatives are already in place. A trilateral program launched in May 2002 by the United States, Russia, and the IAEA initially focused on developing cooperative projects in Azerbaijan, Georgia, Kazakhstan, Moldova, Tajikistan, Ukraine, and Uzbekistan. The U.S. Department of Energy's RDD program has three main options for helping to secure dangerous radioactive sources. "The first is facilitating disposition. The second is to pursue consolidation in order to minimize the number of buildings housing dangerous sources. The third option is to secure the source in place."[1]

Sources: [1] Katherine Garner, Craig Johnson, Anne Kohnen, and Brian Waud, "Cooperative RDD Work in States of the Former Soviet Union," Presentation at the 44th INMM Annual Meeting, Phoenix, Arizona, July 2003. [2] For a critique of this initial U.S. effort, see U.S. General Accounting Office, "U.S. and International Assistance Efforts to Control Sealed Radioactive Sources Need Strengthening," May 2003, <www.gao.gov/cgi-bin/getrpt?GAO-03-638>.

Review of Nuclear and Radiation Safety in Georgia

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Inventory of Radioactive Sources and Regulatory System in Georgia

Georgia is stepping up its efforts to improve the regulatory process in the area of nuclear and radiation safety. Since February 1997, when Georgia joined the IAEA, it has been actively working together with this international organization. The cornerstone of all activities related to nuclear and radiation safety in the country is the framework law *On Nuclear and Radiation Safety* (No. 1674-1c), which was adopted by the national parliament on October 30, 1998, and entered into force when signed by the president on January 1, 1999. According to the law (Article 8, Paragraph 1) the task of regulating nuclear and radiation safety is delegated to the Ministry of Environmental Protection and Natural Resources (MEPNR) of Georgia, and a Nuclear and Radiation Safety Service (NRSS) is set up for this purpose within the Ministry (Article 8, Paragraph 2). In addition, the law lists the following state agencies as authorized to regulate nuclear and radiation safety:

- The State Inspectorate for Technical Supervision oversees technical safety aspects of nuclear and radiation activities and issues permits;
- The Inspectorate of Labor under the Ministry of Social Security, Labor, and Public Health ensures worker safety at nuclear and radiation facilities, and issues permits;
- The Ministry of Social Security, Labor, and Public Health exercises state sanitary control in order to prevent public exposure to the adverse effects of ionizing radiation resulting from violations of sanitary and hygienic rules and norms and issues permits;
- The Ministry of Internal Affairs conducts fire prevention and control operations; provides emergency response training to civilians; plans and supervises preventive measures; ensures physical protection of nuclear and radiation facilities and issues permits;
- The Ministry of State Security ensures the physical protection of nuclear and radiation facilities, carries out decontamination in case of nuclear accidents and issues permits;
- The State Department of Standardization, Metrology, and Certification provides government supervision over nuclear and radiation safety, monitors compliance with state standards, and issues permits;
- The Ministry of Urban Planning and Construction reviews projects involving the construction of nuclear and radiation facilities and issues permits.

MEPNR coordinates the activities of all of the above state agencies. Through NRSS, it implements procedures to regulate and monitor this sensitive area. Updating the database on radiation sources in Georgia is the most important prerequisite of this work. According to this registry, Georgia currently has 1,300 radioactive sources (the list does not include the so-called "orphan sources" because by definition these are outside of regulatory and accounting control). The following groups of radioactive items are the most critical:

- Radioactive sources used in radioisotope devices (level switches, density meters, level gauges, gamma defectoscopes) at 28 industrial and geological facilities. Most of these are gamma radioactive sources (Cs-137, Co-60, Ir-192), 48 in total;
- Neutron sources used for borehole logging (Am-241-Be, Po-201-Be, Pu-239-Be, Cf-252) as well as two neutron generators (NG-200 type, energy = 18.6 keV, radioactivity content = 9.2 x 10^{11}Bq, or 24.9 curies) for activation analysis;
- A special group of gamma irradiators that includes the GUBE-400 type (Cs-137 with 28 x 10^{13}Bq, or 7,568 curies, activity) and KOLOS type (Cs-137 with 13 x 10^{13}Bq, or 3,513 curies, activity) irradiators; plus three PXM-γ-20 units with Co-60 isotope (8 x 10^{13}Bq, or 2,162 curies); this group of sources, in particular, pose a high-security risk due to their high activity levels.
- Unsealed radioactive sources used at 13 scientific research institutes and medical institutions. By their annual activity these sources belong to Category 3 applications, and thus are not in the highest risk as Categories 1 and 2 sources;
- A radioactive waste burial site (not in operation);
- A separate group of radioisotope devices with source activity up to five microcuries, including smoke detectors, static electricity neutralizers and other devices that use various types of sources.

Since many enterprises were shut down or converted to new uses after the collapse of the Soviet Union, the register of radioactive sources needs to be revised. Preparation for this work is underway. Cs-137 gamma level switches pose a particular challenge. Inspections at various enterprises have revealed that in many cases the switches are no longer in operation and are being stored in ordinary facility storerooms that do not provide conditions necessary for storing radioactive sources.[2] Georgia used Soviet-made gamma sources of various types (models GR-6, GR-7, and GR-8) that contained Cs-137 with radioactivity of approximately one Curie, housed in a special shielding container. Another device using Cs-137 that deserves particular attention because of its relatively high radioactivity content is the KOLOS device, which was used to irradiate seeds. Georgia has six such devices (all made in 1974). Each unit contains approximately 60 Cs-137 sources with a total initial activity of 1.3 x 10^{14} Bq (3,513 Curies). Another device—the STEBEL device, officially designated GUPOS-N-04-800-3M, with 16 Cs-137 sources with a total initial activity of 7.77 x 10^{13} Bq (2,100 Curies)—was also used in agriculture. In addition, there are Cs-137 sources used in defectoscopes and other devices.

Co-60 is mainly used in PXM-γ-Co irradiators (source activity around 10^{13} Bq or 270 Curies), which are used by research institutes, and in medical equipment, such as AGAT and ROKUS irradiation units used to treat cancer patients. This second group of equipment is used more widely and therefore requires special attention. Recently the IAEA sponsored the re-equipment of Georgian cancer centers. The old Co-60 source at the National Cancer Center in Tbilisi was replaced with a new one (activity approximately 22 x 10^{13} Bq, or 6,000 Curies), and new equipment with appropriate Co-60 sources (same activity) was provided for the Kutaisi and Ajaria cancer centers. These replacements will increase the effectiveness of the cancer centers and simultaneously reduce overexposure to patients. The center upgrades were closely monitored by the NRSS.

Ir-192 is mainly used in defectoscopes. The activity of Ir-192 sources varies from 1 to 10 curies (8.5 x 10^{11} Bq – 1.47 x 10^{13} Bq). Since the half-life of Ir-192 is 74 days, many old iridium sources have ceased to emit ionizing radiation. For instance, Poti Shipyards had 12 Ir-192 sources in storage which had been used in defectoscopes. There is no need for them any longer. The sources were manufactured over ten years ago, and their activity is so low that they are no longer considered radioactive by current standards.[2] However, it was decided that these sources should be stored in concrete boxes (with radiation levels at the surface not exceeding natural background radiation) even though the sources were no longer subject to special control as ionizing radiation sources.

The most powerful of the Sr-90 sources in Georgia are the sources that have been found in Svaneti region (see the description below). This radionuclide was widely used by various research institutions. There is an insignificant number (45 pieces) of BIS-MI-2 Sr-90 sources and other low power Sr-90 sources stored in Georgia. Today Sr-90 sources find increasingly more applications in industry. Two devices with low activity Sr-90 sources (9.25 x 10^{8} Bq, or 0.025 Curies, each) were purchased recently by a tobacco company in Georgia to test the quality of cigarettes.

Another source of significance is Am-241. Most of the Am-241 devices in Georgia are IGIA models (21 units), although there are also other models that are not currently in use. Am-241 sources are widely used in geological logging, such as for oil well prospecting, alongside with the neutron sources Pu-Be, Po-Be, and Am-Be. Cf-252 neutron sources can be used for the same purpose but are less commonly employed. Am-241 sources are also found in smoke detectors. Smoke detectors sometimes use Pu-239 sources. However, as the quantity of radioactive material is very small, they do not fall into the category of potentially hazardous ionizing radiation sources and are not subject to special regulation.

Medical devices are known to be the main sources of public exposure to radiation. Therefore medical devices containing ionizing radiation sources receive particular attention. The overwhelming majority of these devices are X-ray machines. Most X-ray machines in Georgia are worn out and outdated and need to be replaced. Only 2.2% of the machines are less than five years old, 3% have been used for 10 years, while the rest are more than 10 years old.

Licensing Requirements

As mentioned above, the law *On Nuclear and Radiation Safety* provides the regulatory basis for nuclear and radiation safety in Georgia. However, the provisions of the law cannot be put into effect successfully without a body of supporting laws and regulations. An essential new regulation is one that establishes a system of licensing of nuclear and radiation activities in the country. To that end, following the law *On Nuclear and Radiation Safety* (Article 48, Paragraph A) Georgia's Minister of Environmental Protection and Natural Resources approved the regulation *On Licensing Nuclear and Radiation Activities* (Order No. 3 of 14 January 2002). The new document establishes a licensing system as required by the framework law (Chapter 3.4). It makes a reference to Article 7 of the law and clearly specifies the functions of the various ministries and agencies within the new licensing system. More importantly, the regulation spells out the distribution of powers and responsibilities between the regulating agency and the Ministry of Labor, Health, and Social Protection, insofar as, before the establishment of the regulating agency, the Ministry had carried some of its functions. According to Article 9 Paragraph 3 of the new regulation, prior to seeking a license for nuclear and radiation activities the applicant must obtain a set of permits from each of the agencies listed in Article 7 of the framework law. (See the list of eight agencies above.). The most important of these permits is the "sanitary and hygienic passport" issued by the Ministry of Labor, Health, and Social Protection to certify that the applicant has prepared all the necessary quality assurance documentation. Another important requirement under the new licensing system is that the applicant must have a staff member responsible for radiation protection. In addition, the applicant must receive special approval from various authorized organizations, according to Article 7 of *On Nuclear and Radiation Safety*.

License applications are reviewed by a licensing council,[3] which is expected to reach a positive or negative verdict within 30 days from the date an application is filed. The procedure, however cumbersome, ensures maximum safety while handling sources of radiation.

Regular inspection of the facility involved in activities using nuclear or radiation sources is a major condition that the applicant must commit to during the licensing process. Georgia practices almost all known types of inspections: commissioning, decommissioning, announced, unannounced, and others.

Licenses are granted for a limited period of time, depending on the risks associated with specific nuclear and radiation operations. However, the new law *On Licensing of Industrial Activities* will render ineffective all previous documents regulating the licensing process; their still-relevant provisions will be incorporated into the framework law. The law will provide for licenses of unlimited duration. Appropriate amendments to the framework law (*On Nuclear and Radiation Safety*) have been already prepared and will be brought to the parliament for consideration after they are approved by the ministries.

According to Georgian legislation, notification and registration are not enough to handle sources of ionizing radiation. The use of all radiation sources is subject to licensing, with the exception of certain sources that are exempt from regulation. The level of exemption for a source is defined in the *National Standards of Radiation Safety*[2] adopted in 2000. The Georgian national standards closely follow the

IAEA International Basic Safety Standards,[4] although there are some differences. For instance, the national standards distinguish two categories of technical personnel: those involved in the direct handling of ionizing radiation sources, and those who come into indirect contact with such sources. For the first category the average annual threshold dose is 20mSv, for the second category it is 12.5mSv.

To ensure the effective regulation of nuclear and radiation activities Georgia has adopted the *Basic Sanitary Rules for the Use of Sources of Ionizing Radiation*. Following Article 48, Paragraphs A and B of the framework law, draft laws *On Transportation of Radioactive Substances* and *On Radioactive Waste* and *Radioactive Waste Storage Facilities* have been developed and after consultations with various ministries submitted to the Georgian Parliament. These bills take into consideration relevant international documents.[5]

Georgia is a transit country, with a large volume of shipments crossing its territory. Therefore, it is of primary importance to adopt a law *On Transportation of Radioactive Substances*, which will regulate issues related to the transportation of radioactive materials both through and within the country. Article 41 of the law prohibits the transit, export, and re-export of all radioactive wastes through the territory of Georgia. This means that legal import or transit transportation is only permitted for radioactive sources that are used for practical purposes.

The current procedure for the import of radioactive sources is as follows. Every user of a radioactive source must obtain an appropriate license from the regulating agency. An official statement must be issued by the Georgian Ministry of Economy, Trade, and Production characterizing the dual-use properties of the source. The Ministry also issues an end-user certificate confirming that the source will only be used for the stated purpose. As mentioned above, acceptance of inspections, including unannounced inspections, to verify the use of the radiation source constitute a mandatory precondition for licensing. The user must obtain a certificate of origin of the source from the Chamber of Commerce, notify the Georgian State Department of Border Protection of the radioactive shipment, and have the transportation route approved by the regulating agency (NRSS of the Ministry of Environmental Protection and Natural Resources of Georgia). At the border crossing, representatives of the regulating agency and the Main Directorate for Emergency Situations and Civil Defense check the shipment against the declaration and escort the source to its destination on Georgian territory.

When transportation after importation occurs by road, the source is escorted by specialists from NRSS, the Department of Civil Defense and Emergency Situations of the Ministry of Internal Affairs, and road police to ensure unobstructed travel. The same procedure is applied for transit and export of radiation sources. For example, the IAEA is currently sponsoring the establishment of a calibration laboratory for ionizing radiation instruments at the State Standards Committee (Gosstandart) in Tbilisi. The above-described procedure is used to supply radioactive reference standards to the laboratory. Overall, the procedure helps to prevent the illegal import or export of radiation sources. However, the border check points still require stationary equipment that would enable them to detect every radioactive shipment. Although the existing equipment is far from perfect, Georgia is working to resolve this issue in cooperation with the IAEA and other international organizations. Meanwhile, border radiation control details are being introduced at some major border crossing points, such as Poti and Batumi sea ports. They consist of officers who have been trained by the regulating agency to use mobile radiation meters. This approach has rendered visible results already. In May 2000, a radioactive shipment, en route through Georgia, was detained at the sea port of Poti. It had entered the country without appropriate documents. The cargo was placed in temporary storage in a fenced-off area, labeled with a radiation caution sign and put under heavy guard. After the cargo was examined by a regulating agency expert, the State Security Council of Georgia decided to have it returned to the shipper under escort, as described above.

Illicit Trafficking

As mentioned above, Georgia is a major transit center. The Great Silk Road that crossed the country in ancient times is once again becoming an important thoroughfare connecting Europe and Asia. There are concerns, however, that it may become a major corridor for illicit trafficking of nuclear and radioactive materials. There have been several seizures of contraband uranium at the Georgian border. For example, on September 20, 1999, State Security Ministry officers apprehended several persons in possession of 219 cylinder-shaped capsules with a total of 1,000.7 grams of 33% U-235. [*Editor's Note: Although this is highly enriched uranium, the enrichment is still far from weapons-grade and the amount of material seized was much less than what is required to build a nuclear weapon.*]

On April 21, 2000, in Batumi, State Security Ministry officers apprehended several persons, seizing the total of 920 grams of 3% U-235. On July 18, 2001 Ministry officers detained a group of people possessing 1,581 grams of 5% U-235 [*Editor's Note: In both cases, the enrichment level is too low to be useful for nuclear weapons*].

On December 19, 2001 operatives of the Anti-Terrorist Center of the same ministry arrested an individual who was attempting to sell U-235 in Akhaltsikh city. A lead container with three metal plates containing nine grams of U-235 was found during the search. All seized material was inspected at the Institute of Physics of the Georgian Academy of Sciences and placed in a high-security guarded location.

Orphan Sources

Radioactive sources outside of institutional control because they have been lost, abandoned, or stolen (known as orphan sources) are of particular concern. Regulatory agency experts and other specialists have identified 233 such sources (see appendix). Most of them are Cs-137 sources. Cs-137 is a radionuclide which was used by the former Soviet Army to calibrate radiation meters. After Russian troops pulled out of Georgia, many sources were abandoned at military bases, and some of them became scattered around Georgian territory. Unfortunately, some of these sources are known to have caused serious health damage. On one occasion, 11 young cadets of the State Department of Border Protection who were stationed at a former Soviet military base in Lilo received radioactive burns of varying severity from orphan Cs-137 sources. All of them were sent to Moscow and Paris for skin transplantation.

Among other orphan sources found at former military bases are spots of Ra-226 (radioactive soil). They pose a particular health hazard, as radioactive particles may enter the human body through the respiratory tract and result in internal exposure. The list in the appendix does not include minor orphan radiation sources, such as the hundreds of the Ra-226-containing Kalashnikov assault rifles discovered at former military bases.

Thermoelectric generators using Sr-90 form another critical group of orphan sources. Only six units (three pairs) of such generators have been found. The initial activity of each source in the generators was enormous—35,000 Ci, resulting in radiation exposure of 1Sv/h at 1 m from the source. The generators were used in pairs as power batteries for electric antennas located in gorges along the Inguri river in Svaneti, a highland area in Western Georgia. Power batteries with sources were buried in the ground and covered with concrete. Later they were discovered and disassembled by local residents.

Three operations were carried out by specialists from NRSS and the Department of Civil Defense and Emergency Situations of the Ministry of Internal Affairs to deactivate these sources, two around the village of Haishi, and one in Tsalendzhikh district. Radioactive sources were placed in special containers and transported to a safe location for storage. The third operation took place in Tsalendzhikh district in early 2002. The generator was discovered in a mountain forest by three residents of the village of Lia who attempted to relocate it but had to abandon their find under a cliff at a roadside because they unexpectedly felt ill. In response, the Registering Agency of the Main Directorate for Emergency Situations and Civil Defense of the Georgian Ministry of Internal Affairs and other authorities sent a team to the location. The team conducted a survey of the area, measured radiation levels, made a photographic and video record, fenced off the location and posted appropriate signs. Fortunately, the sources were located 25 km away from the nearest settlement. Despite the fact that local residents demanded immediate removal of the sources, poor weather and thick snow in the mountains precluded an urgent recovery operation.

As a first step of these three recovery operations, the Department of Civil Defense and Emergency Situations of the Ministry of Internal Affairs created a special response team that went through multiple training sessions led by the regulating agency and IAEA representatives. Special-purpose equipment was assembled. Safety rules were developed for handling the source, taking into account high potential exposure. Handling operations were to be conducted at two meters away from the source, for a maximum time of 20 seconds. A lead container weighing 5.5 metric tons was designed and constructed to ensure adequate safety during transportation of the sources. These precautions made it possible to conduct a smooth deactivation operation despite extreme weather conditions and the high level of radiation. The greatest individual exposure was 1.16mSv (every team member carried a personal electronic dosimeter and a thermoluminescent dosimeter). The minister for environmental protection and natural resources and his deputies were actively involved in preparing and carrying out the operation.

The NRSS is continuing the search for and deactivation of orphan radioactive sources. A number of orphan sources have already been deactivated in the past. These clean-up operations are supported by the IAEA. In 2000, the IAEA spearheaded and funded a large-scale aerial gamma radiation survey in some districts of Georgia. Gamma emission levels were taken from a helicopter in several focal districts of Georgia by a team of French experts and Georgian and IAEA representatives using the newest equipment. Valuable nuclide distributions were obtained, and an orphan Cs-137 source was discovered and deactivated near the city of Poti.

A similar but larger scale operation was undertaken in 2002. Two vehicles were used to carry the measuring equipment instead of aircraft. This survey method is more effective in the mountains. The operation used specially trained officers of the Main Directorate for Emergency Situations and Civil Defense, who were using survey dosimeters. Along with the IAEA the survey was supported by several friendly nations: the United States, Turkey, France, and India. These nations and the IAEA provided the necessary equipment. The survey covered areas in Svaneti, Ajaria, Samtskhe-Javakheti, and Kakheti. Several Ra-226 sources were found.

The above suggests that Georgia has accumulated a significant number of previously orphaned, now deactivated, sources. All of them require secure storage. Currently the sources are stored in a government facility which was equipped with the help of U.S. DOE experts. Georgia, however, lacks a centralized storage facility that would accommodate all radioactive waste. The presence of decommissioned industrial sources in storage at enterprises makes the demand for such a facility even more critical. Once these sources are placed in central storage, the overall radiation safety will certainly be improved. At the same time, a regulatory mechanism is needed for the handling of radioactive wastes. Georgia has no plant to reprocess such wastes, and other waste operations are carried out by the Registering Agency. A new draft law *On Radioactive Waste and Radioactive Waste Storage Facilities* envisions that all radioactive waste operations will be the function of a newly created body, the Agency for Radioactive Waste Management.

Sources: [1] “On Site Disposal as a Decommissioning Strategy,” IAEA-TECDOC-11224 (Vienna: IAEA, 1999), p. 42. [2] “Normy radiatsionnoy bezopasnosti, RUN-2000” [Radiation safety limits, RSL-2000] (Tbilisi: 2000). (in Georgian). [3] “O litsenzirovanii yadernoy i radiatsionnoy deyatelnosti” [On Licensing Nuclear and Radiation Activities], Order of the Minister of Environmental Protection and Natural Resources of January 14, 2002 (No. 3). [4] IAEA Safety Standards Series (Vienna: IAEA, 1997). [5] “Organization and Implementation of Natural Regulatory Infrastructure Governing Protection Against Ionizing Radiation and the Safety of Radiation Sources” (Vienna: IAEA, 1999). [6] “The Radiological Accident in Lilo” (Vienna: IAEA, September 2000), IAEA website, <http://www-pub.iaea.org/MTCD/publications/PDF/Pub1097_web.pdf>.

Recovered Orphaned Radiation Sources in Georgia

No.	Source	Number of Sources	Source Surface Radiating Power (Gy/h) or Activity (Ci)	Location	Date
1	Cs- 137	43 containers 61 sources		Zestafoni	January 1995
2	Cs- 137	6 containers 11 sources	1.6-6 Gy/h	Lilo	September 1997
3	Cs- 137	2 containers 11 sources	0.3 Gy/h 0.17 Gy/h	Makhata	October 1997
4	Cs- 137	4 containers 6 sources	6 Gy/h 0.3 Gy/h 0.17 Gr/h	Akhaltsikh	October 1997
5	Cs- 137	2 sources	750 μGy/h 200 μGy/h	Kutaisi	January 1998
6	Sr-90 Ra-226	40 sources	Total-0.06 Gy/h	Godogani, near Kutaisi	July 1998
7	Cs-137	2 containers 2 sources	6 Gy/h 0.17 Gy/h	Matkhoji (Honi district)	July 1998
8	Cs-137	11 sources	1-6 Gy/h 100 μGy/h each	Vaziani	August 1998
9	Cs-137	2 containers 3 sources	6 Gy/h 0.3 Gy/h 0.17 Gy/h	Poti	September 1998
10	Cs-137	2 containers 2 sources	6 Gy/h 0.3 Gy/h	Senaki	September 1998
11	Cs-137	2 containers 3 sources	6 Gy/h 0.3 Gy/h 0.17 Gy/h	Tbilisi	February 1999
12	Cs-137	1 containers 1 sources	6 Gy/h	Gori	April 1999
13	Cs-137	2 containers 3 sources	6 Gy/h 0.3 Gy/h 0.17 Gy/h	Tbilisi	April 1999
14	Am-241	1 source	0.6 м Gy/h	Anakliya	May 1999
15	Sr-90	4 sources	35000 Ci each	Khaishi (Svaneti)	May 1999
16	Co-60	1 source	80 Gy/h	Tbilisi	June 1999
17	Cs-137	2 containers 3 sources	6 Gy/h 0.3 Gy/h 0.17 Gy/h	Rustavi	July 1999
18	Cs-137	3 ground spots	5-6 Ci only	Poti	August 1999
19	Cs-137	2 containers 3 sources	6 Gy/h 0.3 Gy/h 0.17 Gy/h	Zemo Keda (Dedoflistkaro district)	April 2000
20	Cs-137	1 container 2 sources	0.3 Gy/h	Meriya (Ozurgeti district)	June 2000
21	Am-241	1 source	0.6 м Gy/h	Tbilisi	September 2000

No.	Source	Number of Sources	Source Surface Radiating Power (Gy/h) or Activity (Ci)	Location	Date
22	Sr-90	1 container 1 source	90 mCi	Tbilisi	October 2000
23	Cs-137	5 containers 7 sources	3 – 6 Gy/h 2 - 0.3 Gy/h 2 - 0.17 Gy/h	Vaziani	July 2001
24	Sr-90	4 containers 14 sources	90 mCi only	Vaziani	August 2001
25	Cs-137	4 containers 6 sources	2- 6 Gy/h 2- 0.3 Gy/h 2-0.17 Gy/h	Vaziani	August 2001
26	Cs-137	1 source	0.3 Gy/h	Surami	September 2001
27	Sr-90	2 source	3500 Ci	Tsalenjikha	December 2001
28	Cs-137	16 sources	4 Gy/h each	Rustavi	December 2001
29	Sr-90	1 source	30 μGy/h	Zestafoni	February 2002
30	Cs-137	2 sources	0.3 Gy/h 0.17 Gy/h	Khashuri	February 2002
31	Cs-137	4 sources	4 Gy/h each	Ozurgeti	January 2002
32	Cs-137	1 source	8 Gy/h	Vaziani	March 2002
33	Ra-226	300 m^2	3 mGy/h	Vaziani	March 2002
34	Cs-137	2 sources	0.3 Gy/h 0.17 Gy/h	Saakadze	March 2002
35	Sr-90	2 sources	35000 Ci	Tsalenjikha	February 2002

Total: 223 sources

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