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Report to the Chairman and Ranking Minority Member, Committee on Energy and Natural Resources, U.S. Senate

March 2007

LOW-LEVEL RADIOACTIVE WASTE MANAGEMENT

Approaches Used by Foreign Countries May Provide Useful Lessons for Managing U.S. Radioactive Waste

GAO-07-221

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Highlights

Highlights of GAO-07-221, a report to the Chairman and Ranking Minority Member, Committee on Energy and Natural Resources, U.S. Senate

Why GAO Did This Study

GAO has reported on limitations in the management of U.S. low-level radioactive waste (LLRW). LLRW ranges from very low-activity to higher-activity waste. To identify potential approaches to overcome these limitations, GAO was asked to examine the extent to which other countries have (1) LLRW inventory databases, (2) timely removal of higher-activity LLRW from waste generator sites, (3) disposition options for all LLRW, and (4) requirements that LLRW generators have financial reserves to cover waste disposition costs, as well as any other approaches that might improve U.S. LLRW management. GAO primarily relied on a survey of 18 countries representing leading LLRW generators to identify their management approaches and to compare them with U.S. survey results and with approaches suggested by LLRW generators, disposal operators, and regulators in the United States.

What GAO Recommends

GAO recommends that the Nuclear Regulatory Commission (NRC) and DOE evaluate and report on the usefulness of (1) adopting the identified management approaches, and the steps and any authorities necessary to implement them; and (2) developing a U.S. radioactive waste management plan, and the costs, steps, and any authorities necessary to do so. NRC and DOE generally agreed with these recommendations, but raised a number of issues regarding their implementation.

www.gao.gov/cgi-bin/getrpt?GAO-07-221.

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

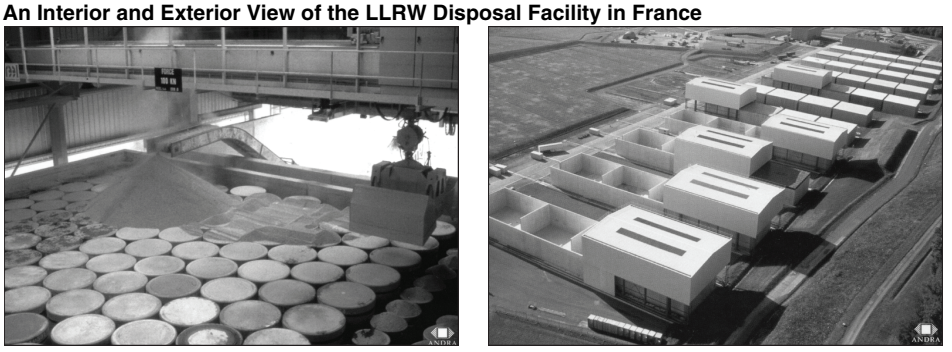
What GAO Found

Academic, industrial, medical, utility, and government entities in the United States, particularly the Department of Energy (DOE), disposed of at least 15 million cubic feet of LLRW in 2005. This waste includes debris, rubble, soils, paper, liquid, metals, and clothing that have been exposed to radioactivity or contaminated with radioactive material, and sealed radiological sources that are no longer useful for industrial or other applications (disused). Other countries that have nuclear reactor units and use radioactive materials in other ways manage the residual LLRW in some ways that are different than in the United States. Of the countries surveyed, GAO found that:

- Most countries indicated they have national radioactive waste inventory databases that include information on all waste generators, waste types, storage locations, and disused sealed radiological sources, and that they use them to forecast future disposal capacity needs.
- Most countries indicated they facilitate the timely removal of higher-activity LLRW, essentially disused sealed radiological sources, from generator sites to enhance safety and security, including requiring the return of a disused source to a source supplier.
- Most countries indicated they have disposal options for lower-activity LLRW, central storage options for higher-activity LLRW, and alternative disposal options for very low-level radioactive waste that in most cases does not require an exemption review by a nuclear regulatory authority.
- Half the countries indicated they impose financial assurance requirements on all waste generators to cover disposition costs, and most of these countries also use other approaches to reduce government costs to recover higher-activity LLRW, such as requiring a disposal fee at the time that a sealed radiological source is purchased.

GAO also found that most countries surveyed use national radioactive waste plans to guide the management of their radioactive wastes. Many representatives from LLRW generators, disposal operators, regulators, and others told GAO that the application of similar approaches to those used by other countries might improve the management of U.S. radioactive waste.

An Interior and Exterior View of the LLRW Disposal Facility in France



Source: French National Radioactive Waste Management Agency (Agence nationale pour la gestion des déchats radioactifs–Andra-FRL Productions).

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Abbreviations

DOE	Department of Energy
GTCC	greater-than-class C
IAEA	International Atomic Energy Agency
LLRW	low-level radioactive waste
NEA	Nuclear Energy Agency
NRC	Nuclear Regulatory Commission
WIPP	Waste Isolation Pilot Plant

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GAO
Accountability * Integrity * Reliability

United States Government Accountability Office
Washington, DC 20548

March 21, 2007

The Honorable Jeff Bingaman
Chairman
The Honorable Pete V. Domenici
Ranking Minority Member
Committee on Energy and Natural Resources
United States Senate

Academic, industrial, medical, utility, and government entities in the United States, particularly the Department of Energy (DOE)—commercially disposed of at least 15-million cubic feet of low-level radioactive waste (LLRW) in 2005.[1] LLRW substantially includes debris, rubble, and contaminated soils from facility decommissioning and site cleanup, as well as items such as rags, paper, liquid, glass, metal components, resins, filters, and protective clothing that have been exposed to radioactivity or contaminated with radioactive material. In addition, LLRW includes sealed radiological sources that are no longer used (disused) for their authorized use in agriculture, education, industry, medicine, and research applications. Sealed radiological sources contain radioactive material encapsulated, or sealed in metal to prevent its dispersal. At the present time, commercial disposal options are available for almost all LLRW in the United States. However, during the mid-1990s there was a period of time when a disposal facility was not available for some LLRW, and most waste generators are now facing the prospect of another disposal shortage in 2008 if the state of South Carolina restricts access as planned to a key LLRW disposal facility. The Nuclear Regulatory Commission (NRC) considers future disposal costs and availability to be uncertain. The uncertainties surrounding disposal costs and availability and other limitations in LLRW management are taking on even greater significance as the United States embarks on developing new nuclear power plants, which would eventually create even more LLRW. Moreover, according to NRC, many non-utility generators of LLRW do not have the physical or financial capability to effectively manage disposal shortages and may have to curtail beneficial uses of radioactive material.

[1]LLRW is defined by exclusion; that is, LLRW is defined in statute as radioactive waste that is not high-level radioactive waste, spent nuclear fuel, or certain byproduct materials, such as tailings or waste produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content 42 U.S.C. § 2021b(9).

The principal federal legislation governing the disposal of LLRW is the Low-Level Radioactive Waste Policy Act, as amended. The LLRW Policy Act, among other things, assigns to the states and the federal government responsibility for providing disposal availability for LLRW.[2] NRC has divided the radioactive waste covered by the act into categories of increasing levels of hazard, beginning with class A, followed by B, C, and greater-than-class C (GTCC) waste, although there is no statutory upper limit or lower limit for the level of radioactivity required to declare a material to be LLRW. In addition, the act required DOE to provide technical assistance to the states, establish a computerized database to assist the states and DOE in monitoring the management of LLRW, and to report annually to the Congress on the management of LLRW by the states. However, DOE no longer receives specific appropriations to provide technical assistance—except for some funding to maintain a database of LLRW disposed at commercial facilities—and its reporting requirements terminated effective May 2000. NRC—or when authorized an Agreement State—is responsible for licensing LLRW disposal facilities.[3] In addition, NRC is responsible for overseeing and regulating all nuclear power plants, and for promulgating rules governing the safe and secure use of nuclear materials. The Agreement States must adopt and implement requirements that are compatible with NRC's standards.

The LLRW Policy Act promotes greater LLRW disposal capacity on a regional basis and more equitably distributes responsibility for managing this waste among the 50 states. As an incentive for states to manage LLRW on a regional basis, the Congress consented to the formation of interstate agreements, known as compacts, and granted compact member states the authority to refuse to accept LLRW from other compacts or unaffiliated

[2]The states are responsible for providing near surface disposal of class A, B and C wastes as defined in 10 C.F.R. § 61.55, with the exception of three types of federal waste—DOE waste, Navy waste from decommissioning, and waste from nuclear weapons program research, development, testing, and production. DOE is responsible for providing disposal for a fourth category of LLRW, known as greater-than-class C waste, and the disposal of waste that it owns and generates.

[3]NRC provides assistance to states expressing interest in establishing programs to assume NRC regulatory authority under the Atomic Energy Act of 1954, as amended. Section 274 of the act provides a statutory basis under which NRC relinquishes to Agreement States portions of its regulatory authority to license and regulate byproduct materials (radioisotopes); source materials (uranium and thorium); and certain quantities of special nuclear materials. The mechanism for the transfer of NRC authority to a state is an agreement signed by the governor of the state and the NRC chairman, in accordance with section 274(b) of the act. There are presently 34 Agreement States.

states. There are currently three licensed commercial LLRW disposal facilities, each operating under different access and licensing restrictions, and none developed under the regional compact structure as authorized in the LLRW Policy Act. One of these disposal facilities is in Clive, Utah, and it accepts almost all the nation's class A waste. Another commercial LLRW disposal facility is in Barnwell, South Carolina, and it accepts almost all of the nation's class B and C waste. The third commercial disposal facility is in Richland, Washington, and it receives class A, B, and C waste from the 11 states of the Rocky Mountain and Northwest LLRW Compacts. DOE is currently studying the feasibility of disposal options for GTCC waste.

GAO has reported on limitations in the management of U.S. LLRW.[4] We have examined the contents of the LLRW commercial disposal inventory and national source tracking system databases; safety and security of stored class B, C, and GTCC waste; availability of LLRW disposition options; and issues facing DOE's ability to recoup costs for the recovery of disused sealed radiological sources. More specifically, we reported in 2004 on the scope and reliability of U.S. LLRW inventory information and found that DOE's commercial LLRW disposal database (1) did not contain data on all disposed LLRW, (2) did not capture information on LLRW that is produced and stored at waste generator sites, and (3) had data inaccuracies. We also found that the then proposed national source tracking system database would not have captured almost all the disused commercial sources that DOE had recovered from licensees. International authorities consider disused sealed radiological sources held in local storage at user premises waiting for disposal or return to manufacturer to be at greatest risk of becoming an orphan source.[5]

We also reported on the safety and security of storing class B, C, and GTCC waste at non-utility waste generator sites, such as industrials, medical and non-DOE governmental users of nuclear material. We found

[4]GAO, *Nuclear Security: Federal and State Action Needed to Improve Security of Sealed Radiological Sources*, GAO-03-804 (Washington, D.C.: Aug. 6, 2003); GAO, *Low-Level Radioactive Waste: Disposal Availability Adequate in the Short Term, but Oversight Needed to Identify Any Future Shortfalls*, GAO-04-604 (Washington, D.C.: June 9, 2004); GAO, *Nuclear Security: DOE Needs Better Information to Guide Its Expanded Recovery of Sealed Radiological Sources*, GAO-05-976 (Washington, D.C.: Sept. 22, 2005); and GAO, *Low-Level Radioactive Waste: Future Waste Volumes and Disposal Options Are Uncertain*, GAO-04-1097T (Washington, D.C.: Sept. 30, 2004).

[5]An orphan source is a source that is not under regulatory control, either because it has never been under regulatory control, or because it has been abandoned, lost, misplaced, stolen, or transferred without proper authorization.

that NRC does not place general time limits on local storage of any LLRW nor does it require waste generators to return their disused sealed radiological sources to a source supplier. However, NRC explained that its existing licensing and inspection programs are adequate to ensure the safety and security of stored LLRW. Nevertheless, we also found that adding additional information on the storage of disused sealed radiological sources to the then proposed national source tracking system would assist DOE's ongoing source recovery program to remove these sources from waste generator sites. We also reported on the adequacy of LLRW disposition options and found that greater federal oversight was needed to monitor LLRW storage and disposal conditions in light of uncertainties surrounding future disposal availability for class B and C waste. Finally, we commented on the lack of financial mechanisms for DOE to recoup the costs of recovering, storing, and disposing of thousands of disused sealed radiological sources from their holders who in some cases do not have capacity to store or dispose of them. We found that NRC did not require all non-utility waste generators, particularly those possessing sealed radiological sources, to ensure that funds are available to cover future LLRW disposition costs.

NRC and DOE accepted many of the recommendations made in these GAO reports and they have taken other actions to improve the management of LLRW. Other actions include a current strategic assessment of NRC's regulation of LLRW that is intended to identify and prioritize staff activities. According to NRC officials, this assessment will consider the recommendations made in GAO reports and other recent reports including those from an NRC chaired task force on radiation source protection and security, the NRC Advisory Committee on Nuclear Waste, and the National Research Council.[6] We were informed this assessment currently lacks a systematic review of approaches taken by other countries to manage their LLRW. DOE is also designing a complex-wide strategy to optimize the disposition of its low-level waste and mixed low-level waste. Appendix I contains a more detailed discussion of GAO findings and agency actions on LLRW management.

[6]Radiation Source Protection and Security Task Force, *The Radiation Source Protection and Security Task Force Report* (Washington, D.C.: Aug. 15, 2006); Advisory Committee on Nuclear Waste, *ACNW White Paper: History and Framework of Commercial Low-Level Radioactive Waste Management in the U.S.* (Washington, D.C.: Dec. 30, 2005); and National Research Council, *Improving the Regulation and Management of Low-Activity Radioactive Wastes* (Washington, D.C.: 2006). The current version of the advisory committee's report is on the NRC's Web sites under NUREG-1853.

Given our past reports on LLRW management and NRC and DOE responses to our recommendations, you asked us to identify approaches taken by other countries to manage their LLRW, and whether any of these approaches might be applicable in the United States. Specifically, you asked us to determine the extent to which other countries have: (1) comprehensive national LLRW inventory databases, (2) timely removal of higher-activity LLRW in storage at waste generator sites, (3) disposition options for all LLRW, and (4) requirements to assure that non-utility LLRW generators have adequate financial reserves to cover all waste disposition costs. We also agreed to report on any other approaches that we identified in the course of our work that might support improvement in the management of LLRW in the United States.

To conduct our work, we primarily relied on the results of a survey of 20 foreign countries representing the leading generators of LLRW, reviews of reports from the International Atomic Energy Agency (IAEA) and the Nuclear Energy Agency (NEA),[7] and interviews with representatives from U.S. LLRW stakeholder groups. These countries, along with the United States, account for 85 percent of the world's installed nuclear power plant capacity. While countries generate similar radioactive waste, there is variation in the way they classify this waste. Our survey relied on the suggested IAEA waste classification scheme that defines two categories of LLRW, short-lived low- and intermediate-level radioactive waste (lower-activity LLRW) and long-lived low- and intermediate-level radioactive waste (higher-activity LLRW). The IAEA is also considering adding another class of radioactive waste—very low-level radioactive waste—which some countries already use in managing LLRW. Eighteen of the 20 foreign countries responded to our survey to identify their use of management approaches to address our four research objectives.[8] NRC collaborated with DOE and other LLRW stakeholder groups to complete a U.S. response to our survey. In addition, we visited LLRW facilities and interviewed officials in France, Japan, and Sweden. We chose these countries because of their extensive experience with nuclear power

[7]IAEA was established within the United Nations to promote safe, secure, and peaceful nuclear technologies. NEA is a specialized agency within the Organization of Economic Cooperation and Development, an intergovernmental organization of industrialized countries.

[8]The 18 countries that responded to the survey included Australia, Belgium, Canada, Denmark, Finland, France, Germany, Hungary, Italy, Japan, Mexico, Netherlands, Norway, Slovak Republic, Spain, Sweden, Switzerland, and United Kingdom. The two countries not responding to the survey were the Czech Republic and South Korea.

generation and with constructing and operating LLRW disposal facilities. We also interviewed representatives of U.S. LLRW stakeholder groups regarding their knowledge of approaches used in other countries and their opinions on new approaches that might help improve LLRW management in this country. For the most part, these representatives provided little awareness of approaches used in other countries. Those interviewed represented federal and state nuclear regulatory authorities, commercial LLRW disposal operators, state LLRW compact commissions, and other groups. As not all representatives provided a response to questions about each LLRW management issue, our content analysis of the interviews captures opinions from only those representatives that responded to each issue. We also reviewed a variety of documents provided to us by these representatives. We identified and assessed the reliability of various waste inventory databases in an attempt to describe the volume and location of LLRW in the United States. We determined that these data were sufficiently reliable for the purposes of our report. We conducted our review between September 2005 and February 2007 in accordance with generally accepted government auditing standards. A more detailed description of our scope and methodology is provided in appendix II. Appendix III provides the response of the United States to the survey of LLRW management approaches.

Results in Brief

Most countries we surveyed use comprehensive national radioactive waste inventory databases to assist in the management of LLRW. Thirteen countries indicated that their inventory databases typically contained information on all waste types—10 of which specifically inventoried very low-level radioactive waste—the storage of waste at generator sites, including disused sealed radiological sources, and all waste generator types in their countries. In addition, 15 countries indicated that they take steps to increase the reliability of the information collected by ensuring its completeness, accuracy, and timeliness. Almost all countries use these databases to track the location and quantities of radioactive waste to forecast future disposal capacity needs. Most of the U.S. LLRW stakeholder group representatives who responded to this issue generally supported the usefulness of developing comprehensive national LLRW inventory databases. The NRC chaired task force also commented on the need to evaluate including more source categories in the national source tracking system.

Fourteen of the 18 countries we surveyed use methods to promptly remove higher-activity LLRW from generating sites in order to reduce safety and security risks. These countries both encourage and enforce the

timely removal of disused sealed radiological sources to prevent the uncontrolled exposure of workers and the public to radiation. Some of these countries also place general time limits on the storage of these sources at generator sites. To facilitate the removal of this higher-activity LLRW, almost all countries surveyed require that sealed radiological sources be returned to their suppliers or to central waste storage when they are no longer in use. Most of these countries also have established orphan source recovery programs to collect sealed radiological sources that have been abandoned or lost. Some U.S. stakeholder group representatives who responded to this issue and the recent report from the NRC chaired task force generally supported the need to evaluate methods that could be used to facilitate the removal of higher-activity LLRW, essentially disused sealed radiological sources, from non-utility waste generator sites.

Ten of the 18 countries we surveyed have disposal options for lower-activity LLRW and 6 other countries have plans to build such facilities. While only 3 countries indicated that they have a disposal option for higher-activity LLRW, 14 countries reported that they have central storage facilities for this waste. Moreover, 13 countries indicated that they have clearance or unrestricted removal of very low-level radioactive waste from regulatory control as LLRW, and 8 countries indicated that they have disposal options for this waste. The U.S. LLRW stakeholder group representatives who responded to this issue were split on the need for central storage options for higher-activity LLRW when a disposal option is not available, but most of them supported exempting very low-level radioactive waste from regulatory control as LLRW. The NRC chaired task force and other reports have commented on, among other related issues, the need to reexamine disposal options for LLRW.

Half the countries we surveyed indicated that their nuclear regulatory authorities require all non-utility LLRW generators to have sufficient financial assurances to cover the removal of radioactive waste from their sites. In addition, seven of the countries use other financial assurance approaches to ensure that the government is reimbursed for any sealed radiological sources that it may need to recover from non-utility LLRW generators. More than half of the U.S. LLRW stakeholder group representatives who responded to this issue and the recent report from the NRC chaired task force commented on the need to improve the financial assurance structure for some LLRW generators in the United States. The task force report suggested that NRC evaluate some approaches that are similar to those used in some other countries to ensure that radioactive material users have financial reserves to cover waste disposition costs.

We also found that 12 of the 18 countries surveyed rely on national radioactive waste management plans to guide the management of their radioactive wastes and that the United States lacks such a plan. Several of these plans required the management of radioactive waste from a national perspective and specified one administrative entity as responsible for coordinating their development. In addition, there was often a requirement in the plans for periodic public reporting of LLRW conditions. While the usefulness of such a plan was not sought through a question in the survey or specifically raised in interviews with U.S. LLRW stakeholder group representatives, most of the representatives and recent reports on LLRW management mentioned the need to evaluate alternative ways to manage LLRW.

To improve the management of LLRW in the United States and address a potential disposal shortage for higher-activity LLRW in 2008 and other management concerns, we are recommending that the Chairman of NRC and the Secretary of Energy evaluate and report back to the Congress within 1 year on the usefulness to the United States of (1) adopting the LLRW management approaches used in the countries that are discussed in this report, and the steps and any authorities necessary for their implementation, if deemed appropriate; and (2) developing a U.S. radioactive waste management plan, and the potential costs, steps, and any authorities necessary to develop such a plan, if deemed appropriate.

NRC and DOE generally agreed with the recommendations in a draft of our report, but raised a number of issues regarding their implementation. Specifically, they suggested other means through which they could report the results of their evaluations to Congress and they questioned the benefits of developing a national radioactive waste management plan. We do not take issue with how NRC and DOE may choose to report to the Congress; as long as the Congress gets the information it needs, the reporting format is a secondary consideration. In addition, in response to NRC and DOE suggestions, we revised our recommendation regarding the development of a national radioactive waste management plan to clarify that the agencies first evaluate and report on the usefulness of such a plan, and then conduct other analysis if deemed appropriate. However, based on the experience of other nations, we continue to believe that a national radioactive waste management plan has merit. We responded to specific comments from NRC and DOE in appendix VI and VII, respectively, and incorporated technical changes in this report where appropriate based on detailed comments provided by the agencies. The State Department did not comment on our draft report.

Background

The 30 countries in the world that generate electricity from 435 nuclear power reactor units face the need to manage the radioactive wastes that are generated from these units as well as the waste generated by non-utility users of nuclear materials. The United States is a large generator of radioactive waste with its 104 nuclear power reactors and thousands of radioactive material licensees. These countries, including the United States, contribute to and are guided by advice from international organizations on approaches to manage radioactive materials. The principal international organizations are IAEA and NEA. For example, countries may voluntarily use IAEA standards to demonstrate implementation of the obligations set forth in the *Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management*, which the United States has signed. According to IAEA, the Joint Convention recognizes and reinforces the internationally held view that radioactive waste management is an issue of national concern, but that the development, implementation, and maintenance of national programs for radioactive waste management must be carried out with due regard to internationally-endorsed criteria and standards.[9] Moreover, for contracting parties to various international safety conventions, IAEA standards provide a consistent, reliable means of ensuring the effective fulfillment of their obligations. One example of these criteria and standards is the *IAEA Code of Conduct for the Safety and Security of Radioactive Sources*.[10] This code, which the United States has agreed to work toward implementing, is intended to guide countries in developing and harmonizing policies, laws, and regulations pertaining to sealed radiological sources. The code states, among other things, that the nuclear regulatory authority in each country should establish a national registry of radioactive sources to track the possession of these sources. At a minimum, the code recommends that the nuclear regulatory authority in each country include sources in categories 1 and 2 of the five source categories defined by IAEA. These two categories contain sources with the highest level of radioactivity. However, the code suggests that the nuclear regulatory authorities also give appropriate attention to sources in the other three categories, as they would pose health and security risks when aggregated in harmful quantities.

[9]IAEA, *Radioactive Waste Management: Status and Trends-Issue#2* (Vienna, Austria: Sept. 2002) 11.

[10]IAEA, *Code of Conduct on the Safety and Security of Radioactive Sources* (Vienna, Austria: Jan. 2004).

IAEA has also put forth suggested guidance on a general system for classifying radioactive waste to facilitate communication and information exchange among countries. In general, U.S. class A, B, and most of class C waste would fall into IAEA's category of short-lived low- and intermediate-level radioactive waste (lower-activity waste), and the remaining 25 percent of class C waste and all of GTCC waste would be within IAEA's long-lived low- and intermediate-level radioactive waste category (higher-activity waste). IAEA acknowledges that spent or disused sealed radiological sources are not considered waste in certain countries, such as the United States, but considers that the safe management of such sources is achieved by compliance with the requirements for managing radioactive waste. Table 1 provides a description of the suggested IAEA radioactive waste classification scheme.

Table 1: IAEA Suggested Radioactive Waste Classification System

Waste class	Typical characteristics	Disposal options
1. Exempt waste	Activity levels at or below clearance levels, which are based on annual dose less than 0.01 mSv[a]	No radiological restrictions
2. Low- and intermediate-level waste	Activity levels above clearance levels and thermal power below about 2 kW/m^3[b]	
2.1 Short-lived waste	Restricted long-lived radionuclide concentrations	Near-surface or geological disposal facility
2.2 Long-lived waste	Long-lived radionuclide concentrations exceeding restricted short-lived waste	Geological disposal facility
3. High-level waste	Thermal power above about 2 kW/m^3 and long-lived radionuclide concentrations exceeding limitations for short-lived waste	Geological disposal facility

Source: IAEA, Radioactive Waste Management: Status and Trends-Issue #2 (Vienna, Austria: Sept. 2002) 24.

[a]mSv (millisivert) is a unit of radiation dose measurement. Two and a half millisieverts is the national average dose of background radiation from all sources.

[b]kW/m^3 is kilowatts per cubic meter of thermal power.

IAEA presently does not define a category for very low-level radioactive waste, but such a category is under consideration. IAEA has drafted for consideration by its member states a new waste classification system that would add more waste categories, particularly categories for low-activity radioactive waste. This proposed system would have six categories: (1)

exempt waste, (2) very short-lived waste, (3) very low-level waste, (4) low-level waste, (5) intermediate-level waste, and (6) high-level waste. The very low-level waste category might be considered the lower spectrum of class A waste, and include materials with very limited radioactivity, such as contaminated soil and rubble from decommissioned power plants.

Finally, IAEA issued a Safety Standard guide in 2005 regarding the management of waste from the use of radioactive material in medicine, industry, agriculture, research and education.[11] IAEA stated that a national strategy for the management of radioactive waste should be developed in accordance with the safety objectives and principles. A strategy is necessary in order to define the infrastructure and the means to be adopted for the management of radioactive waste. IAEA stated that a key element in the strategy is the extent to which national and regional waste management facilities are developed rather than managing the waste at a number of locations where it arises.

Comprehensive National LLRW Inventory Databases Are Widely Used to Track and Manage LLRW

Most countries we surveyed use comprehensive national radioactive waste inventory databases to assist in the management of LLRW. Thirteen countries indicated that their inventory databases typically contained information on all waste types—10 of which specifically inventoried very low-level radioactive waste—the storage of waste at generator sites, including disused sealed radiological sources, and all waste generator types in their countries. In addition, 15 countries indicated that they take steps to increase the reliability of the information collected by ensuring its completeness, accuracy, and timeliness. Almost all countries use these databases to track the location and quantities of radioactive waste to forecast future disposal capacity needs. Most of the U.S. LLRW stakeholder group representatives who responded to this issue generally supported the usefulness of developing comprehensive national LLRW inventory databases. The NRC chaired task force also commented on the need to evaluate including more source categories in the national source tracking system.

[11]IAEA, *Management of Waste from the Use of Radioactive Material in Medicine, Industry, Agriculture, Research and Education*, Safety Guide No. WS-G-2.7 (Vienna, Austria: 2005).

Most Countries Have Comprehensive National Radioactive Waste Inventory Databases

Thirteen of the 18 countries are considered to have comprehensive national radioactive waste inventory databases that typically contain information on a wide range of waste types, locations of stored waste, waste generators, and the possession of sealed radiological sources. Almost all countries (17/18) indicated that their inventory databases include short-lived low- and intermediate-level waste as well as long-lived intermediate-level waste. In addition, 10 countries indicated that their inventories also include very low-level radioactive waste, 13 include long-lived low-level waste, and 14 include high-level waste. All 17 countries that have national radioactive waste inventory databases indicated that they capture waste data from all generators in their countries, which could include academic, government, industrial, medical, and nuclear reactor sources of LLRW. In regard to tracking the location of waste, 14 countries indicated that their radioactive waste inventory databases capture waste in storage at generator sites. For example, France indicated that its national radioactive waste inventory database records the types of radioactive waste located at all waste generator sites, central storage, and disposal sites.

The countries in our survey also maintain national registries of sealed radiological sources, including those in use, storage or disuse. Most countries indicated in their survey responses that their national radiological source registries go beyond the minimum of category 1 and 2 suggested in the *IAEA Code of Conduct on the Safety and Security of Radioactive Sources*. Fourteen of 18 countries indicated that their national source registries include all category 1, 2, and 3 sources, and nine of these countries also include category 4 and 5 sources. The nine countries with comprehensive source registries were Denmark, Finland, France, Hungary, Italy, Japan, Mexico, Slovak Republic, and Switzerland. While the survey did not seek information on the number of sources in a country, the countries with comprehensive source registries include those that may have a relatively small number of sources to track, such as Denmark, to those countries that have much larger numbers to track, such as France and Japan. Figure 1 summarizes the comprehensiveness of the national radioactive waste inventory databases in the countries we surveyed.

Figure 1: Contents of National Radioactive Waste Inventory Databases

LLRW management approach	1 France	2 Japan	3 Germany	4 Canada	5 United Kingdom	6 Sweden	7 Spain	8 Belgium	9 Finland	10 Switzerland	11 Slovak Republic	12 Hungary	13 Mexico	14 Netherlands	15 Italy	16 Australia	17 Denmark	18 Norway	**Total Yes Count**
Maintains a national radioactive waste inventory database	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	○	●	●	17
Very low-level radioactive waste is included in the national radioactive waste inventory database	●	●	○	●	○	○	●	○	NR	●	●	●	●	○	●	NA	●	NR	10
Short-lived low- and intermediate-level waste, and long-lived intermediate-level waste are included in the national radioactive waste inventory database	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	NA	●	●	17
Long-lived low-level waste (including naturally occurring radioactive material) is included in the national radioactive waste inventory database	●	●	●	●	●	○	●	●	●	●	●	●	○	●	●	NA	●	○	14
High-level radioactive waste are included in the national radioactive waste inventory database	●	●	●	●	●	○	●	●	●	●	●	●	●	●	●	NA	NA	○	14
All types of radioactive waste generators in the country are included in the national radioactive waste inventory database	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	NA	●	●	17
National radioactive waste inventory database captures waste stored at generator sites	●	●	●	●	●	○	●	●	●	●	●	●	●	●	●	NA	○	○	14
Maintains a national source registry containing IAEA categories 1, 2, and 3 radiological sources	●	●	●	●	○	○	NR	○	●	●	●	●	●	●	●	●	●	●	14
Maintains a national source registry containing IAEA categories 1-5 radiological sources	●	●	○	○	○	○	NR	○	●	●	●	●	●	○	●	○	●	○	9

Source: GAO survey of foreign countries, 2006.

Legend: ● – Yes, o – No; NR – No response; NA – Not applicable

Note: Denmark responded to questions about the contents of its national radioactive waste inventory database, although it will not be established until 2007. Countries are ordered according to their nuclear electricity generation at the beginning of 2006, as reported by NEA. The last four countries in the table currently do not have nuclear electricity generation, but Italy did in the past, and the other countries have nuclear research reactors. The United States would be the largest nuclear electricity generator if listed.

Countries Take Steps to Ensure Reliability of Information in Their Inventory Databases

The countries in our survey try to increase the reliability of their radioactive waste inventory databases by taking steps to ensure that the information collected is complete, accurate, and timely. Almost all countries (15/18) indicated that they have at least one control in place to verify the completeness and accuracy of information in their national radioactive waste inventories. These controls include periodic inspections of the waste at generator sites, checking generator waste inventory data

submissions against past and projected waste from the generator, and periodic audits of the waste inventory records maintained by the generator. For example, in the United Kingdom, the information provided by LLRW waste generators is reviewed and checked for consistency with previous inventory information and against similar types of waste. Moreover, independent assessments are undertaken to provide upper-bound estimates of total radioactivity of the waste at generator sites. The waste generators are also required to obtain a letter of compliance to package their waste before final waste processing. At the time the letter of compliance is issued, the waste data is reviewed, and if found insufficient, the waste generator may be subject to a further audit.

Although almost all countries (17/18) have a national authority or waste management organization responsible for maintaining their national radioactive waste inventory databases, countries varied in how information is transmitted to the entity managing the inventory and the frequency of information submission. Currently, only 2 of the 18 countries require the submission of waste data through a secure website. The most common methods for data submission were use of e-mail, standard mail, fax, and by phone. Most of the countries (12/18) indicated that their national radioactive waste inventory databases receive data from waste generators annually or more frequently. Survey results indicated that inventory updates every 6 months or less are obtained from waste generators in Denmark, Mexico, Norway, Slovak Republic, Spain, and Switzerland. Figure 2 summarizes the approaches used in the countries surveyed to manage their national radioactive waste inventory databases.

Figure 2: Management Approaches for National Radioactive Waste Inventory Databases

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
LLRW management approach	France	Japan	Germany	Canada	United Kingdom	Sweden	Spain	Belgium	Finland	Switzerland	Slovak Republic	Hungary	Mexico	Netherlands	Italy	Australia	Denmark	Norway	**Total Yes Count**
National nuclear regulatory authority or national waste management organization is responsible for managing the national radioactive waste inventory database	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	NR	●	●	17
Manager of national radioactive waste inventory database uses at least one control to verify the completeness and accuracy of information submitted by waste generators	●	●	●	●	●	●	●	●	●	●	●	●	●	NR	●	NR	NR	●	15
Waste generators submit data to manager of national radioactive waste inventory database through a secure website	NR	○	○	NR	●	●	○	○	NR	○	NR	○	○	○	○	NR	NR	○	2
Waste generators submit data to manager of national radioactive waste inventory database through e-mail, mail, fax, or by phone	●	●	●	●	●	○	●	●	●	●	●	●	●	○	●	NR	●	●	15
Waste generators are required to submit data to manager of national radioactive waste inventory database once a year or more frequently	○	●	●	○	○	●	●	○	●	●	●	●	●	○	●	NA	●	●	12
Member of the European Union and has implemented Council Directive 2003/122EURATOM regarding the control of high-activity sealed radioactive sources and orphan sources	●	NA	●	NA	●	●	●	●	●	NA	●	●	NA	●	○	NA	○	NA	10

Source: GAO survey of foreign countries, 2006.

Legend: ● – Yes, o – No; NR – No response; NA – Not applicable

Note: Denmark responded to questions about the management of its national radioactive waste inventory database, although it will not be established until 2007. Countries are ordered according to their nuclear electricity generation at the beginning of 2006, as reported by NEA. The last four countries in the table currently do not have nuclear electricity generation, but Italy did in the past, and the other countries have nuclear research reactors. The United States would be the largest nuclear electricity generator if listed.

Countries Use Inventory Databases to Track and Manage LLRW

Sixteen of the 18 countries in our survey indicated that they use their national radioactive waste inventory databases to forecast waste volumes, plan for disposal capacity, and track the location of disused sealed radiological sources. Thirteen countries indicated that they publicize information from their national radioactive waste inventory databases on what is stored and disposed of to gain community acceptance for siting these facilities. Sixteen of the countries indicated that they keep records of the location and status and use of sources in their national source registries. Figure 3 shows the responses for each country.

Figure 3: Management Approaches for Tracking and Managing LLRW

LLRW management approach	1 France	2 Japan	3 Germany	4 Canada	5 United Kingdom	6 Sweden	7 Spain	8 Belgium	9 Finland	10 Switzerland	11 Slovak Republic	12 Hungary	13 Mexico	14 Netherlands	15 Italy	16 Australia	17 Denmark	18 Norway	**Total Yes Count**
Regulator keeps a record of the locations and status of use of sources, including disused sources	●	○	●	●	●	●	●	●	●	●	●	●	●	●	●	NR	●	●	16
National radioactive waste inventory database is used to make projections of future waste volumes for capacity planning of central waste storage and disposal facilities	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	○	●	○	16
Radioactive waste inventory information is publicized to help obtain community acceptance of LLRW central storage and disposal facilities	●	●	●	●	NR	●	●	●	●	●	●	●	○	NR	○	●	NR	●	13

Source: GAO survey of foreign countries, 2006.

Legend: ● – Yes, o – No; NR – No response

Note: Denmark responded to questions about the management of its national radioactive waste inventory database, although it will not be established until 2007. Countries are ordered according to their nuclear electricity generation at the beginning of 2006, as reported by NEA. The last four countries in the table currently do not have nuclear electricity generation, but Italy did in the past, and the other countries have nuclear research reactors. The United States would be the largest nuclear electricity generator if listed.

Domestic Experts Support Need for More Comprehensive LLRW Inventory Databases

Most representatives of domestic LLRW stakeholder groups who responded in interviews to this issue (19/25) supported the need to establish a more comprehensive national radioactive waste inventory database in the United States. Over half of these representatives commented that such an inventory would allow LLRW stakeholders to forecast waste volumes and to plan for future disposal capacity requirements. However, some representatives felt that a more comprehensive national radioactive waste inventory database would not be necessary. For example, one representative argued that the cost-effectiveness of adding more reporting requirements to include the storage of class B and C waste might not be justified given the small quantities of this waste that are generated each year.

A recent report of the interagency Radiation Source Protection and Security Task Force, chaired by NRC, addressed the scope of the current national source tracking system, which currently tracks the possession of category 1 and 2 sources. The task force suggested that NRC conduct a comprehensive analysis of category 3 sources for possible inclusion in the National Source Tracking System. The task force found that category 3

and lower-activity sources comprise a major portion of those sources voluntarily identified as surplus, excess, or unwanted in the commercial sector. Moreover, the task force found that the U.S. metal recycle industry claims that category 3 sources are those more commonly misplaced or abandoned by industry, resulting in potential contamination of the metal recycling process with operational and financial impacts.

Methods for Promptly Removing Higher-Activity LLRW from Waste Generator Sites Are Widely Used to Reduce Safety and Security Risks

Fourteen of the 18 countries we surveyed use methods to promptly remove higher-activity LLRW from generating sites in order to reduce safety and security risks. These countries both encourage and enforce the timely removal of disused sealed radiological sources to prevent the uncontrolled exposure of workers and the public to radiation. Some of these countries also place general time limits on the storage of these sources at generator sites. To facilitate the removal of higher-activity LLRW, almost all countries surveyed require that sealed radiological sources be returned to their suppliers when they are no longer in use. Most of these countries also have established orphan source recovery programs to collect sealed radiological sources that have been abandoned or lost. Some U.S. stakeholder group representatives who responded to this issue and the recent report from the NRC chaired task force generally supported the need to evaluate methods that could be used to facilitate the removal of higher-activity LLRW, essentially disused sealed radiological sources, from non-utility waste generator sites.

Most Countries Encourage and Enforce the Prompt Removal of Higher-Activity LLRW from Generator Sites

Most countries we surveyed (14/18) indicated that their nuclear regulatory authority encourages the removal of higher-activity LLRW, essentially disused sealed radiological sources, from generator sites, and half of the countries enforce the prompt removal of these sources. Some of the countries that require the prompt removal of these sources also place time limits on how long LLRW can remain in storage at waste generator sites. Seven countries indicated that they limit the amount of time that LLRW can remain in storage at non-utility waste generator sites, and four other countries impose time limits only when waste generators have a disposal option for the waste. For example, in Sweden, depending on the facility, waste generators can only hold disused sealed radiological sources for 6 months to a year and a half, and any other LLRW intended for storage at a waste generator site for more than 2 years must be registered with the national regulatory authority.

Most Countries Use a Variety of Approaches to Facilitate the Removal of Higher-Activity LLRW from Generator Sites

Almost all countries we surveyed (15/18) indicated that they require that sealed radiological sources be returned to their source supplier or to a central storage facility when they are no longer in use. The general support for this LLRW management approach might be attributable to international guidance on managing sources. All countries in our survey have agreed to follow the *IAEA Code of Conduct on the Safety and Security of Radioactive Sources*, which recommends that nuclear regulatory authorities attach clear and unambiguous conditions on the use of sources, including, where applicable, agreements regarding the return of disused sources to a supplier. In addition, the Council of the European Union Directive 2003/122 states that all member countries must establish requirements that a holder of a sealed radiological source return the source to the supplier, place it in a recognized installation, or transfer it to another authorized holder without undue delay after termination of the use, unless otherwise agreed by the nuclear regulatory authority. For example, in France, the supplier of sealed radiological sources is responsible for the sources it sells. Once the purchaser of a source ceases to use it, the holder must immediately return it to the supplier who is responsible for accepting it unconditionally. Until the source user can prove that the source has been returned to a supplier, the user retains responsibility for it. Only three countries, two of which are non-European Union member countries, indicated that they do not currently impose this regulation on source holders.

Most countries we surveyed (11/18) indicated that they have government programs to recover higher-activity sources that are not under regulatory control (orphan sources). Once again, there is international guidance in this area. The *IAEA Code of Conduct on the Safety and Security of Radioactive Sources* recommends that nuclear regulatory authorities establish provisions to recover and restore appropriate control over orphan sources. Moreover, the Council of the European Union also recognized that despite the existence of an appropriate regulatory framework to control these higher-activity sources, they still may be abandoned or lost. Council Directive 2003/122 states that all member countries shall ensure that their nuclear regulatory authorities are prepared to or have assigned responsibilities for recovering orphan sources. This directive also states that the nuclear regulatory authorities in these countries shall be notified of any changes in the situation of a higher-activity source, such as its location and use, and to register these changes. Nine countries, including three non-European Union countries, indicated that holders of sealed radiological sources are required to notify the nuclear regulatory authority when a source has become disused, and most countries (14/18) indicated that their authority verifies this information by

periodically inspecting the storage of disused sources at user sites. Eleven countries indicated that a government entity is given responsibility for managing an orphan source recovery program; 3 countries give this responsibility to a non-governmental entity. For example in Japan, the Japan Radioisotope Association is responsible for recovering and storing sealed radiological sources and other radioisotopes from users of these radioactive materials. The association, regulated by the Ministry of Education, Culture, Sports, Science and Technology—the Japanese ministry responsible for regulating medical uses of radioisotopes—is funded through fees collected by users of these materials. Figure 4 provides a summary of the methods used by countries in our survey to facilitate the prompt removal LLRW, particularly disused sealed radiological sources from waste generator sites.

Figure 4: Methods to Facilitate Prompt Removal of LLRW from Generator Sites

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
LLRW management approach	France	Japan	Germany	Canada	United Kingdom	Sweden	Spain	Belgium	Finland	Switzerland	Slovak Republic	Hungary	Mexico	Netherlands	Italy	Australia	Denmark	Norway	**Total Yes Count**
On-site storage time limits for LLRW are set for non-nuclear power plant entities	●	○	○	NR	●	●	○	●	○	○	●	○	○	●	●	○	○	○	7
On-site storage time limits for LLRW are set only when a disposal option is available	●	NR	NR	NR	●	NA	NR	NA	NR	NR	NA	NR	●	NA	●	NR	NR	NR	4
Regulator encourages removal of disused radiological sources from user sites	NR	○	●	●	●	●	●	●	●	●	●	●	●	●	●	NR	NR	●	14
Regulator enforces prompt removal of disused radiological sources from user sites	●	○	○	●	○	○	●	○	●	○	●	○	●	NR	●	NR	●	●	9
Time limits are placed on length of time a radiological source can be used	●	○	○	●	○	○	○	○	○	○	○	●	●	○	○	○	○	○	4
Requirement that disused radiological sources be returned to a supplier or central waste storage	●	○	●	●	●	●	●	●	●	●	●	●	●	●	○	○	●	●	15
Maintains an orphan radiological source recovery program	●	●	○	○	●	○	●	○	●	○	●	○	●	●	○	○	●	●	10
Government entity is made responsible for orphan radiological source recovery program	●	○	NR	●	●	NR	●	NR	●	NR	○	NR	●	●	●	●	●	●	11
An organization other than the government is responsible for recovering orphan radiological sources	○	●	NR	○	○	NR	○	NR	○	NR	●	NR	○	○	○	○	○	●	3
Users must inform regulators if holding disused sources	○	●	●	●	●	○	●	○	NR	●	●	●	○	NR	●	NR	○	○	9
Regulator periodically inspects the operational storage of disused radiological sources	●	○	●	●	●	○	●	●	●	●	●	●	○	●	●	NR	●	●	14

Source: GAO survey of foreign countries, 2006.

Legend: ● – Yes, o – No; NR – No response; NA – Not applicable

Note: Countries are ordered according to their nuclear electricity generation at the beginning of 2006, as reported by NEA. The last four countries in the table currently do not have nuclear electricity generation, but Italy did in the past, and the other countries have nuclear research reactors. The United States would be the largest nuclear electricity generator if listed.

Domestic Experts Support Need to Evaluate Methods for Facilitating the Removal of Higher-Activity LLRW from Waste Generator Sites

The representatives from domestic LLRW stakeholder groups who responded in interviews to this issue generally agreed that the United States should consider exploring methods for promptly removing higher-activity LLRW from waste generator sites. Eleven of 27 representatives supported imposing time limits on storing higher-activity LLRW at non-utility waste generator sites, but not for radioactive wastes that are allowed to decay in storage within a reasonable amount of time. For example, several representatives suggested that LLRW generators should be treated the same as generators of hazardous waste. The generators of large quantities of hazardous waste are required to remove waste from their sites within 90 days, unless they receive authorization for long-term storage of this waste. However, other representatives were not in favor of establishing time limits for waste storage, for the most part because of uncertainties surrounding disposal availability in the United States. Some of the representatives noted that placing time limits on the storage of higher-activity LLRW could only be justified if it posed a safety and security risk. In this respect, almost all representatives (25/26) suggested that having a requirement that disused sealed radiological sources be returned to their source supplier would be an effective way to promote more timely removal of these sources from waste generator sites.

The NRC chaired task force reported that while existing measures to ensure the safety and security of higher-activity sealed radiological sources are adequate, the current disposal system is prompting some users into long-term storage of their disused sources and otherwise creating significant disincentives for properly disposing of these sources. The report noted that the lack of a legal disposal pathway or the high costs of disposal due to the lack of alternative disposal options will perpetuate this situation until the disposal system changes. The task force report suggested that the U.S. government should encourage suppliers to provide arrangements for the return of disused sources. The task force noted that holding a source in storage longer than 24 months usually indicates the lack of a strategy to use or dispose of the source. As a result, the task force suggested that NRC consider a new requirement for licensees to review and document the reasons for storing higher-activity sources for longer than 24 months. Moreover, the task force suggested that once disposal options are available for GTCC waste (equivalent to long-lived intermediate-level waste), NRC should also consider requiring a maximum time limit on long-term storage of disused sealed radiological sources that would be considered GTCC waste when packaged for disposal.

Central Storage and Alternative Disposal Options Are Widely Used to Facilitate Management of LLRW

Ten of the 18 countries we surveyed have disposal options for lower-activity LLRW and 6 have plans to build such facilities. While only 3 countries indicated that they have a disposal option for higher-activity LLRW, 14 reported that they have central storage facilities for this waste. Moreover, 13 countries indicated that they have clearance or unrestricted removal of very low-level radioactive waste from regulatory control as LLRW and eight countries indicated that they have disposal options for this waste. The U.S. LLRW stakeholder group representatives who responded to this issue were split on the need for central storage options for higher-activity LLRW when a disposal option is not available, but most of them supported exempting very low-level radioactive waste from regulatory control as LLRW. The NRC chaired task force and other reports have commented on the need to reexamine the disposal options for LLRW.

About Half the Countries Make Disposal Options Available for Most Lower-Activity LLRW

About half of the countries in our survey indicated that they currently have a disposal option for lower-activity LLRW, but few have a disposal option for higher-activity LLRW. Ten of 18 countries indicated that they have disposal options available for lower-activity LLRW, and 10 have reported plans to build new or additional disposal facilities for lower-activity LLRW. While only 3 countries indicated that they currently have a disposal option for higher-activity LLRW, 14 have reported plans to develop a disposal facility for such waste.

Other countries have made a variety of organizations responsible for providing and operating the existing or planned disposal facilities, including national regulatory authorities, nuclear utility organizations, and commercial waste management companies. In the 10 countries that have disposal facilities for lower-activity LLRW, only 2 indicated that a national organization is responsible for both providing and operating this disposal facility. The other eight countries indicated that these responsibilities were given to other combinations that sometimes included nuclear utilities and commercial waste management companies. In the 14 countries that are planning to build disposal facilities for higher-activity LLRW, 6 indicated that a national organization would be responsible for providing and operating the future disposal facility and 3 indicated that it would be another organization. The other countries indicated either a mix of responsibilities or they did not respond to the question. For example, the Netherlands has reported that it has decided to delay a final decision on developing a disposal facility and instead construct an engineered surface storage facility with sufficient capacity for all radioactive waste generated in a period of at least 100 years. However, if a disposal facility is ever constructed, this country indicated in its survey that its nuclear regulatory

authority would be responsible for providing the facility and a national waste management organization would be responsible for operating it. In regard to the cost of disposal, half of the countries indicated that disposal fees are currently or anticipated to be set nationally, based on waste type. Two countries indicated that such fees are currently based on negotiations with disposal operators according to waste type. Mexico indicated use of both a national fee schedule and negotiated fees. Figure 5 provides a summary of LLRW disposal availability and management responsibilities across the countries in our survey.

Figure 5: LLRW Disposal Options and Management Responsibilities

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
LLRW management approach	France	Japan	Germany	Canada	United Kingdom	Sweden	Spain	Belgium	Finland	Switzerland	Slovak Republic	Hungary	Mexico	Netherlands	Italy	Australia	Denmark	Norway	**Total Yes Count**
Disposal options are available for all LLRW	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	0
Disposal options are available for short-lived low- and intermediate-level radioactive waste	●	●	○	○	●	●	●	○	●	○	●	●	○	○	○	●	○	●	10
There are plans to build a LLRW disposal facility for short-lived low- and intermediate-level radioactive waste	○	○	●	●	●	○	●	●	○	●	○	●	○	○	●	●	●	○	10
Disposal options are available for long-lived low-level radioactive waste	○	NR	○	○	●	○	○	○	NR	○	○	●	○	○	○	○	○	○	2
Disposal options are available for long-lived intermediate-level radioactive waste	○	NR	○	○	○	○	○	○	NR	○	○	○	○	○	○	NR	○	●	1
There are plans to build a disposal facility for long-lived low- and intermediate-level radioactive waste	●	●	●	●	●	●	●	●	○	●	●	●	○	○	●	●	●	○	14
A central organization (national nuclear regulatory authority or national waste management organization) is responsible for providing a waste disposal facility	●	○	●	○	●	○	●	●	○	○	●	○	○	●	○	NR	NR	●	9
A central organization (national nuclear regulatory authority or national waste management organization) is responsible for operating a waste disposal facility	●	○	●	●	○	○	●	●	○	●	○	●	○	●	○	NR	NR	○	8
A nuclear utility organization is responsible for providing a waste disposal facility	NR	●	○	●	○	●	○	○	●	●	●	○	○	○	○	NR	NR	○	6
A nuclear utility organization is responsible for operating a waste disposal facility	○	NR	○	●	○	●	○	○	●	●	●	○	○	○	○	NR	NR	●	6
A commercial waste management company is responsible for operating a waste disposal facility	○	●	○	○	●	●	NR	○	NR	●	NR	○	○	○	○	NR	NR	○	4
Disposal fees are or planned to be determined by a national fee schedule based on type of radioactive waste	○	○	●	NA	●	○	●	●	○	●	●	○	●	●	NA	NA	NA	●	9
Waste generators negotiate disposal fees based on type of radioactive waste	●	●	○	NR	○	○	NR	○	○	○	NR	○	●	○	NA	NR	NA	○	3

Source: GAO survey of foreign countries, 2006, and reported information on planned LLRW disposal facilities in IAEA and NEA country reports.

Legend: ● – Yes, o – No; NR – No response; NA – Not applicable

Note: Countries are ordered according to their nuclear electricity generation at the beginning of 2006, as reported by NEA. The last four countries in the table currently do not have nuclear electricity generation, but Italy did in the past, and the other countries have nuclear research reactors. The United States would be the largest nuclear electricity generator if listed.

Most Countries Have Central Storage for LLRW Lacking a Disposal Option

Most countries we surveyed currently have interim or long-term central storage options for some LLRW. Thirteen countries reported that they have central storage options available for lower-activity LLRW. Six countries reported that they have both disposal and some central storage options for this waste. Fourteen countries reported that they have central storage options for higher-activity LLRW, sometimes at large waste production sites as in France. For the most part, these countries do not have a disposal option for higher-activity LLRW, although Norway indicated that it had disposal and interim storage options for the long-lived, intermediate-level waste. Figure 6 provides a summary of the central storage options available in the countries we surveyed.

Figure 6: Central Storage Options for LLRW

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
LLRW management approach	France	Japan	Germany	Canada	United Kingdom	Sweden	Spain	Belgium	Finland	Switzerland	Slovak Republic	Hungary	Mexico	Netherlands	Italy	Australia	Denmark	Norway	**Total Yes Count**
Disposal options are available for short-lived low- and intermediate-level waste	●	●	○	○	●	●	●	○	●	○	●	●	○	○	○	●	○	●	10
Central storage options are availabe for short-lived low- and intermediate-level waste	●	●	●	●	●	○	●	●	○	●	○	●	●	●	○	○	●	●	13
Disposal options are available for long-lived low-level waste	○	NR	○	○	●	○	○	○	NR	○	○	●	○	○	○	○	○	○	2
Disposal options are available for long-lived intermediate-level waste	○	NR	○	○	○	○	○	○	NR	○	○	○	○	○	○	○	○	●	1
Central storage options are available for long-lived low-level waste and long-lived intermediate-level waste	●	●	●	●	●	●	●	●	○	●	●	○	●	●	○	○	●	●	14

Source: GAO survey of foreign countries, 2006, and reported information on central storage options for LLRW in IAEA and NEA country reports.

Legend: ● – Yes, o – No; NR – No response

Note: Countries are ordered according to their nuclear electricity generation at the beginning of 2006, as reported by NEA. The last four countries in the table currently do not have nuclear electricity generation, but Italy did in the past, and the other countries have nuclear research reactors. The United States would be the largest nuclear electricity generator if listed.

Most Countries Make Alternative Disposal Options Available for Very Low-Level Radioactive Waste

Most countries provide alternative disposal options for very low-level radioactive waste either by removing such waste from regulatory control as LLRW or providing special disposal arrangements. Almost all countries (15/18) indicated that their nuclear regulatory authorities exempt this waste from regulatory control as nuclear material, thus allowing alternative disposal options for the waste. The countries use various approaches to remove very low-level radioactive waste from regulatory control as LLRW, including general exemption, case-by-case exemption, and clearance. The most frequently cited approach used by the countries was exemption (15/18), followed by clearance (13/18), and then case-by-case exemption (11/18). For example, according to a May 2005 updated nuclear development report submitted by Japan to the NEA, Japan followed IAEA guidance to amend its "Law for the Regulations of Nuclear Source Material, Nuclear Fuel Material and Rectors" to introduce a clearance system for materials, such as scrap metals and concrete used in nuclear installations. Half the countries in our survey indicated that they use all three management approaches.

Some countries in our survey indicated that they have alternative disposal options for very low-level radioactive waste. These options included disposal at municipal landfills, nuclear power plants, and in special facilities for such waste. Eight countries indicated that they have disposal options for very low-level radioactive waste. For example, in Sweden, this radioactive material is cleared for unrestricted use or disposal as conventional non-radioactive waste. Sweden reported that, in 2004, approximately 660 tons of very low-level radioactive waste was cleared for disposal at municipal landfills and approximately 550 tons of melted scrap metal was cleared for recycling. In contrast, France does not have a clearance threshold below which radioactive waste is no longer considered a radioactive hazard. Instead, France uses a case-by-case exemption process to allow for the disposal of very low-level radioactive waste in a special repository that was commissioned in 2003. The French government reported that this facility represents another essential component of France's overall system for radioactive waste management and that it will accommodate most of the waste resulting from the decommissioning and dismantling of facilities in which radioactive substances have been used. Figure 7 provides a summary of the disposal options and exemption methods used by countries in our survey for managing very low-level radioactive waste.

Figure 7: Disposal Options and Exemption Methods for Managing Very Low-Level Radioactive Waste

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
LLRW management approach	France	Japan	Germany	Canada	United Kingdom	Sweden	Spain	Belgium	Finland	Switzerland	Slovak Republic	Hungary	Mexico	Netherlands	Italy	Australia	Denmark	Norway	**Total Yes Count**
Disposal options are available for very low-level radioactive waste	●	●	○	○	●	●	○	○	●	○	○	●	○	○	○	●	○	●	8
Exemption by the nuclear regulatory authority of a source or practice that need not be subject to some or all aspects of regulatory control on the basis that exposure is too small given the moderate quantities of radioactive material	NR	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	NR	○	15
Case-by-case exemption by the nuclear regulatory authority of large quantities of radioactive material the still requires some regulatory control	●	○	●	○	○	●	●	○	●	●	●	●	●	○	●	NR	NR	●	11
Clearance or unrestricted removal of radioactive materials or radioactive objects with authorized practices from any further regulatory control by the nuclear regulatory authority	○	●	●	○	●	●	●	●	●	●	●	●	●	●	●	NR	NR	○	13

Source: GAO survey of foreign countries, 2006.

Legend: ● – Yes, ○ – No; NR – No response

Note: Countries are ordered according to their nuclear electricity generation at the beginning of 2006, as reported by NEA. The last four countries in the table currently do not have nuclear electricity generation, but Italy did in the past, and the other countries have nuclear research reactors. The United States would be the largest nuclear electricity generator if listed.

Domestic Experts Support Need to Examine Alternative Disposition Options for Some LLRW

The representatives of domestic LLRW stakeholder groups who responded in interviews to this issue as well as findings reported by some groups generally supported the need to evaluate alternative disposition options for some LLRW. In regard to developing central storage options for higher-activity LLRW when a disposal option is not available, the representatives were split in their support. Those in favor (13/27) noted that having a central storage option would encourage the efficient and timely removal of higher-activity LLRW from waste generator sites. For example, one representative commented that facilities such as hospitals, academic institutions, and some industries may have limited on-site storage space, restrictions placed on waste storage time in their license, or possession limits for radioactive material, which would need to account for the radioactivity in the stored waste. Those opposed (14/27) to developing central storage options for LLRW generally rejected this approach as an unnecessary step prior to disposing of the waste—a step they also saw as potentially increasing safety and security risks. For example, one representative commented that developing central storage for LLRW that

does to have a disposal option would only detract from finding an ultimate disposal solution.

The representatives from LLRW stakeholder groups were more supportive of the need for NRC to adopt a clearance rule in lieu of the current case-by-case exemption process for allowing very low-level radioactive waste to be removed from regulation as LLRW. Most representatives (19/25) who responded in interviews to this issue commented that a clearance rule would promote more rapid removal of very low-level radioactive waste from waste-generating sites or in some cases negate the need for the on-site removal of this type of radioactive waste. They also suggested that this action would expedite the cost-effective disposal of this waste by reducing administrative burdens, lowering disposal costs, and saving space in licensed LLRW disposal facilities for higher-activity LLRW. For example, one representative commented that knowing up front what type of radioactive waste would not require nuclear regulatory authority review prior to disposition could reduce the need to plan for storage space, shipment, and disposal of such waste as LLRW. Another representative commented that a clearance rule would provide a clear and consistent exemption for very low-level radioactive waste across the Agreement States and non-Agreement States. Several representatives supported the adoption of a clearance rule, but cautioned that public resistance and other factors have impeded previous NRC attempts to adopt this approach. Some representatives contended that exempting very low-level radioactive waste from disposal as LLRW might prompt LLRW disposal operators to increase the cost of disposing of the other LLRW to compensate for the lost revenue from no longer receiving large quantities of very low-level radioactive waste.

The NRC chaired task force report concluded that a number of challenges are associated with disposing of all categories of commercial sealed radiological sources because of the limited number of available disposal facilities, the lack of options to dispose of all types of radioactive waste, and the high cost of disposal. The task force found that commercial LLRW disposal has evolved from an essentially free-market system to a much more constrained and costly system today. However, the task force did not identify any immediate security concerns related to the higher-activity sources under review because licensees are required to safely and securely store these sources, and DOE has a program to recover sealed radiological sources that represent a threat to public heath, safety, and security. Nevertheless, the task force noted that because of uneven implementation of the LLRW Policy Act, several issues affect the disposal of higher-activity sources, such as the possible closure of the South Carolina LLRW disposal

facility to non-compact member states. The task force recommended that the U.S. government evaluate the waste disposal options as outlined in the 2004 and 2005 GAO reports addressing this issue.[12]

The recent National Research Council report on *Improving the Regulation and Management of Low-Activity Radioactive Wastes* also commented on disposal options for low-activity waste (very low-level radioactive waste). The report noted that the United States could benefit from greater consideration of standards and practices developed internationally to institute risk-based management of very low-level radioactive waste. The report noted that European Commission and IAEA standards already provide guidelines for wastes that pose insignificant risks to be cleared or exempted from control as radioactive material. The report recommended that the United States give greater consideration to the international consensus standards surrounding alternative disposition options for very low-level radioactive, including disposal with other non-hazardous wastes, or disposal in special facilities suitable for such waste. The report did not conclude, however, that exemption or clearance should necessarily imply the free release of this waste into general commerce.

Finally, NRC's Advisory Committee on Nuclear Waste similarly commented on the need to examine alternative options for the disposition of some LLRW. The committee's December 2005 white paper referred to previous recommendations the committee made to NRC with respect to concerns about the interim storage of LLRW at waste generator sites. The committee found that no evidence exists that on-site storage of waste can be safe and secure over the expected life of the waste and that the proliferation of on-site storage at waste generator sites across the country will only increase the probability of an adverse event. The white paper also discusses past initiatives by NRC to examine regulations governing future development of assured isolation facilities (central storage facilities) for LLRW. The committee found that only one Agreement State, Ohio, had such regulations as of the end of 2005. The committee report noted that in January 2004, the Commissioners directed NRC staff to defer action on the development of an assured isolation rule, but to annually review the need for further action in this area.

[12]GAO, *Low-Level Radioactive Waste: Disposal Availability Adequate in the Short Term, but Oversight Needed to Identify Any Future Shortfalls*, GAO-04-604 (Washington, D.C.: June 9, 2004); and GAO, *Nuclear Security: DOE Needs Better Information to Guide Its Expanded Recovery of Sealed Radiological Sources*, GAO-05-967 (Washington, D.C.: Sept. 22, 2005).

Financial Assurance Requirements and Other Approaches Are Used by Most Countries to Reduce Government LLRW Recovery Costs

Nine of the 18 countries we surveyed indicated that their nuclear regulatory authorities require all non-utility LLRW generators to have sufficient financial assurances to cover the removal of radioactive waste from their sites. In addition, seven countries use other financial assurance approaches to ensure that the government is reimbursed for any sealed radiological sources that it may need to recover from non-utility LLRW generators. More than half of the representatives from U.S. LLRW stakeholder groups who responded to this issue and statements in the recent report from the NRC chaired task force indicated some need to improve the financial assurance structure for some LLRW generators. The task force report suggested that NRC evaluate some approaches that are similar to those used in some other countries to ensure that radioactive material users have financial reserves to cover waste disposition costs.

Half of the Countries Require All Non-Utility LLRW Generators to Meet Financial Assurance Requirements

Half of the countries we surveyed indicated that they require all non-utility LLRW generators to set aside sufficient financial reserves to cover waste disposition costs. These countries more often provide disposal options for lower-activity LLRW and generally provide central storage for higher-activity LLRW. In addition, three countries indicated that they have plans to impose financial assurance requirements on all non-utility LLRW generators. For example, Japan indicated that it planned to develop these requirements, but could not predict when they would be implemented.

Some Countries Use Other Financial Approaches to Reduce Government Orphan Source Recovery Costs

Some countries have taken approaches to reduce the potential government costs of recovering orphan sealed radiological sources that are no longer under regulatory control. The Council of the European Union Directive 2003/122 states that all member countries must organize campaigns to recover orphan sources left behind by past activities, and suggests campaigns include financial participation by member countries in the costs of recovering, managing, and disposing of these sources, as well as in the review of records on the sealed radiological sources being used at research institutes, material testing institutes, and hospitals. This directive also requires that member countries ensure establishment of a system of financial assurance requirements or other equivalent means of reimbursing the government for its costs in recovering orphan sources. As a means to reimburse the government for orphan source recovery costs, 5 countries in our survey indicated that users of sealed radiological sources have established common funds to pay the LLRW disposition costs by source users. Moreover, 2 countries indicated that sealed radiological source recovery funds have been established by source suppliers to cover similar disposition costs for these companies. For example, in France, the

association of source suppliers and manufacturers contribute to a common fund to reimburse the government for recovering sealed radiological sources from any supplier or manufacturer that is unable to disposition them. In cases where the supplier cannot be identified, the government is reimbursed by an insurance system implemented by the source manufacturers. In addition, France indicated on its survey that under the new radiation protection regulations consideration is being given to examining the benefits of adding financial guarantees to this system. Nine countries indicated that they either require a disposal fee at the time that a source is purchased or are planning to impose such a fee to ensure that funds are available to reimburse government for the costs of recovering orphan sources. Figure 8 provides a summary of the financial approaches used by the countries in our survey to reduce government costs of recovering LLRW.

Figure 8: Financial Approaches to Reduce Government Costs to Recover LLRW

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
LLRW management approach	France	Japan	Germany	Canada	United Kingdom	Sweden	Spain	Belgium	Finland	Switzerland	Slovak Republic	Hungary	Mexico	Netherlands	Italy	Australia	Denmark	Norway	**Total Yes Count**
Requirement that sufficient funds be set aside by non-nuclear power plant entities to pay the cost of the central storage and/or disposal of their LLRW	○	○	○	●	NR	○	●	●	●	○	●	●	○	●	○	○	●	●	9
Plan to implement a requirement that sufficient funds be set aside by non-nuclear power plant entities to pay the cost of the central storage and/or disposal of their LLRW	○	●	○	NA	NR	NR	NA	NA	NA	○	NA	NA	●	NA	●	○	NA	NA	3
Orphan source recovery costs paid by a national organization	●	○	NA	NA	●	NA	●	○	●	NA	●	NA	●	●	NA	NA	●	●	9
Orphan source recovery costs paid by disposition fund established by source users	○	○	NR	NR	NR	○	○	●	NR	NR	●	○	○	●	●	NR	NR	●	5
Orphan source recovery costs paid by disposition fund established by source suppliers	●	○	NR	NR	NR	○	○	○	NR	NR	NR	●	○	NR	○	NR	NR	○	2
Requirement that a disposal fee be assessed when a sealed radiological source is purchased to pay the cost of future central storage and/or disposal costs	●	○	○	○	●	○	●	○	●	○	●	○	○	●	○	○	NR	○	6
Plan to establish a requirement that a disposal fee be assessed when a sealed radiological source is purchased to pay the cost of future central storage and/or disposal costs	NR	○	○	NR	NR	●	NR	○	NR	○	NR	○	●	NR	●	○	NR	○	3

Source: GAO survey of foreign countries, 2006.

Legend: ● – Yes, o – No; NR – No response; NA – Not applicable

Note: Countries are ordered according to their nuclear electricity generation at the beginning of 2006, as reported by NEA. The last four countries in the table currently do not have nuclear electricity generation, but Italy did in the past, and the other countries have nuclear research reactors. The United States would be the largest nuclear electricity generator if listed.

Domestic Experts Support the Need to Evaluate Financial Assurance Approaches

The potential usefulness of financial assurance approaches that were identified through our survey was reflected in interviews with domestic LLRW stakeholder group representatives. More than half of the representatives (8/14) who responded to this issue in interviews commented on the need to improve the financial assurance structure for LLRW generators in the United States. These representatives suggested approaches to improve financial assurances, such as new rulemaking by NRC, periodic updating of the level of financial assurance requirements for LLRW generators, and providing a mechanism for small businesses that cannot self-guarantee financial assurance to otherwise provide this assurance. In addition, some of the representatives (5/16) supported the imposition of a disposal fee at the time of source purchase to help promote a more cost-effective disposal system and more predictable disposal costs for source users. For example, one representative noted that imposing such a fee has merit, but obtaining a commitment or obligation to pay the disposal fee would be an important first step.

The NRC chaired task force found that sealed radiological source users are moving disused sources into prolonged storage because they are not required to have financial assurance to cover the disposal costs or otherwise appropriately dispositioning their disused sources. The report reiterated the concern that prolonged storage of disused sources can lead to possible misuse, abandonment, loss, or theft. Further, the task force found that the cost of source disposal can often be high, prompting the holders of disused sources to delay disposal either by choice or economic necessity. The task force identified three options to improve financial assurance coverage that were in many ways similar to approaches used to varying extents in other countries. The first option is to broaden NRC financial assurance requirements to include those entities that have lower thresholds of radioactive materials. This option would ensure that adequate funds are set aside by these entities to cover their waste disposition costs. However, the task force found that this action alone would not cover government costs of recovering orphan sources or sources for which there is no responsible or financially capable party. Thus, two other options were proposed that include (1) assessing a source-specific surcharge at the time of source acquisition or throughout a source's service life to pay the costs of disposal, and (2) assessing a universal disposal surcharge on all licensees of radioactive material (not limited to sealed radiological source holders) to cover waste disposition costs. The task force recommended that NRC evaluate these alternative financial assurance options and include the impacts on the regulated community, implementation approaches, and the involvement of stakeholders.

National Radioactive Waste Management Plans Are Considered Important for Managing LLRW

We also found that 12 of the 18 countries surveyed rely on national radioactive waste management plans to guide the management of their radioactive wastes. Several of these plans required the management of radioactive waste from a national perspective and specified one administrative entity as responsible for coordinating their development. In addition, there was often a requirement in the plans for periodic public reporting of LLRW conditions. While the usefulness of such a plan was not sought through a question in the survey or specifically raised in interviews with U.S. LLRW stakeholder group representatives, most of the representatives and recent reports on LLRW management mentioned the need to evaluate alternative ways to manage LLRW in the United States.

Many Countries Have Developed Radioactive Waste Management Plans That Are National in Scope and Formulated by One Administrative Entity

At least 12 of the 18 countries in our survey have national radioactive waste management plans or draft plans to guide the management of this material. The 12 countries included Belgium, Canada, France, Germany, Italy, Japan, the Netherlands, Slovakia, Spain, Sweden, Switzerland, and the United Kingdom. While the other countries may also have such plans, we did not ask whether they had one in our survey. We identified the 12 countries with management plans through a review of recent IAEA and NEA country reports. The management plans from France, Germany, and Spain contain strategies to address all radioactive waste types. They are formulated by either a national level ministry or national waste management organization, often through consultation with other stakeholder groups. The management plans are approved by the parliament, with in some cases requirements for periodic reporting of waste management conditions back to the governing body.

France

In 2003, the national nuclear regulatory authority of France formulated a national plan for the management of radioactive waste and reusable material. The development of this plan involved many stakeholders, including the national waste management organization, waste producers, elected representatives, and professional associations. According to the 2006 Program Act on the Sustainable Management of Radioactive Materials and Wastes, the national management plan will evaluate existing management approaches for radioactive materials and waste, identify foreseeable needs for storage or disposal facilities and the time frame for storage as well as assess the management approaches for radioactive wastes that do not yet have a path to disposal. The Program Act also states that the national plan for managing radioactive materials and wastes will be updated and reported to the parliament by the nuclear regulatory authority every 3 years.

Germany

According to a 2006 update report to NEA on the status of German radioactive waste management, in late 2001 Germany amended its Atomic Energy Act to request that the Federal Ministry for the Environment prepare and submit a national waste management plan. At the same time it amended this act, the parliament decided to phase out the use of nuclear energy for commercial electricity generation. According to the report, the draft plan, which is expected to be approved by parliament in 2007, addresses the strategic management of all radioactive waste, provides an inventory of existing radioactive waste, forecasts further waste production, delineates waste management planning for the next few years, and contains recommendations and required actions. The national radioactive waste inventory, for the first time, captures all types of radioactive waste, including high-level waste, waste from research, medicine, and industry; decommissioning waste from nuclear power plants; and uranium mine and mill tailing waste. Until a final disposal site in a deep geologic formation is available for all radioactive waste, the plan calls for the German federal states to construct and operate regional interim storage facilities for all non-utility waste generators, and requires nuclear power plants to provide interim on-site waste storage.

Spain

In 2006, Spain adopted its sixth general radioactive waste plan. This plan replaces the previous plan enacted 7 years ago. As stated in the plan, this document contemplates the strategies, the necessary actions, and the technical solutions to be developed in the short-, medium-, and long-term to ensure the adequate management of radioactive waste, the dismantling and decommissioning of nuclear and radioactive facilities, and related activities, including the economic and financial measures required to carry them out. Further, this document states that this plan is the basic reference document that clearly and concisely addresses all the strategies and actions to be undertaken in Spain with regard to the different fields of radioactive waste management and the dismantling of facilities, along with a corresponding study of economic and financial conditions. The plan, among other components, presents the data related to radioactive waste generation, programs for removal, the capacity of disposal facilities as well as costs and revenues. Every 4 years or whenever requested by the cognizant ministry, the national waste management organization develops a new radioactive waste management plan, which is submitted to government and then reported to the parliament. The national waste management organization, a state-owned company established in 1984, has been given the responsibility for radioactive waste management and decommissioning of nuclear facilities. In addition to this action, the national waste management organization must draw up an annual report describing the actions taken during the previous financial year and any

incremental revisions that need to be made to the general radioactive waste plan.

Domestic Experts Support Need to Evaluate the U.S. LLRW Management System

There was general agreement among the representatives from the LLRW stakeholder groups that the management of LLRW in the United States needs improvement. Most of the representatives who responded to questions associated with this issue (22/29) suggested that the time is right to explore alternative approaches to make the LLRW disposal system more predictable (reliable) and stable (cost-effective). Many of the representatives cited the proposed closure of the South Carolina disposal facility to non-compact waste generators as the reason to explore these alternatives approaches. However, one representative cautioned that while the present disposal system in the United States is not what was envisioned in the LLRW Policy Act, it is an alternative that has generally provided disposal availability to most waste generators. As we did not directly ask the representatives about the need for a national radioactive waste management plan at the time of the interviews, we have no basis to tabulate their reaction to this specific LLRW management approach.

The National Research Council of the National Academies recently reported on improving the regulation and management of low-activity waste in the context of the U.S. LLRW management system. The report recommended that regulatory agencies develop integrated strategies to implement risk-informed regulation for very low-level radioactive waste. According to the report, such a strategy would require continued integration and coordination among the regulatory agencies, including NRC, DOE, the Environmental Protection Agency, Department of Defense, and other federal and state agencies. Moreover, the report recommended that government agencies continue to explore ways to improve their efforts to gather knowledge and opinions of stakeholders, particularly public stakeholders. While the report did not go so far as to recommend the establishment of a national radioactive waste management plan, it did find that the current patchwork of regulations is complex and inconsistent—leading in some instances to inefficient management practices and possibly to increased overall risk in the system.

Finally, in May 2006, the NRC Advisory Committee on Nuclear Waste agreed to examine issues surrounding the shortcomings in the national LLRW management system. The committee solicited industry and stakeholder views regarding the future role of NRC in the area of commercial LLRW management, noting that NRC staff is updating its LLRW strategic plan following NRC-directed program reductions. In an

August 2006 letter to the NRC Commissioners, the committee recommended that an examination be undertaken of how NRC and the Agreement States are preparing to regulate potential increases in the storage of class B and C waste if and when the LLRW disposal facility in South Carolina closes to waste generators in non-compact states and no alternative options become available. While the committee did not call for developing a national radioactive waste management plan, it seemed to suggest the need for contingency planning in the context of a strategic approach to NRC's involvement in LLRW management.

Conclusions

The 18 countries surveyed rely on a wide variety of approaches to manage their LLRW. However, the extent to which each country uses these LLRW management approaches varied across the surveyed countries. Based on previous GAO reports, other pertinent reports, and responses to GAO's survey, it appears that the United States relies on these approaches to a lesser degree or not at all. In some cases, NRC has already evaluated the merits of implementing some of these approaches and rejected them or is in the process of evaluating the usefulness of a few other approaches. Comments from representatives of U.S. LLRW stakeholders groups as well as statements and recommendations in recent reports related to LLRW management indicate that the application of approaches similar to those used in other countries may improve the management of U.S. radioactive waste. The management approaches identified in this report include methods to improve the:

1. Comprehensiveness and usefulness of national radioactive waste inventory databases

    - inventory all types of radioactive waste by volume, location and generator type;
    - inventory the possession and status of use of sealed radiological sources in more than category 1 and 2;
    - designate a national authority to manage the radioactive waste inventory databases;
    - take steps to verify the completeness and accuracy of these databases;
    - require waste generators to submit waste inventory information to the national authority at least once a year; and

- use the radioactive waste inventory databases to forecast future waste volumes, and to inform the public on volumes of waste at central storage and disposal facilities.

2. Prompt removal of higher-activity LLRW, primarily disused sealed radiological sources from waste generator sites

   - establish on-site storage time limits for non-utility waste generators, at least when disposal options are available; and

   - implement other methods to facilitate the removal disused sealed radiological sources, such as requiring time limits on the use of sources, return of disused sources to a supplier, and users to notify the nuclear regulatory authority when the source becomes disused.

3. Disposition options for all LLRW

   - provide disposal options for all LLRW or central storage options for higher-activity LLRW produced by non-utility waste generators if a disposal option is not available; and

   - provide alternative disposal options for very low-level radioactive waste by either removing this waste from review by the nuclear regulatory authority as LLRW, or providing special disposal options for this waste.

4. Financial assurance requirements on all waste generators to reduce government disposition costs

   - require that all non-utility LLRW generators have sufficient financial reserves to disposition their radioactive waste; and

   - implement methods to ensure that funds are available to reimburse government for any costs to recover and disposition radioactive materials, including requiring the establishment of insurance funds for entities that receive disused sources back from their users, and a disposal fee upon purchase of any sealed radiological sources.

In addition to the survey results, we also identified another management approach used in most countries—national radioactive waste management plans—that also might provide lessons for managing U.S. radioactive waste. IAEA guidance supports the development of a national strategy to define the infrastructure and the means to be adopted for the management

of radioactive waste. Currently, the United States does not have a national radioactive waste management plan and does not have a single federal agency or other organization responsible for coordinating LLRW stakeholder groups to develop such a plan. Such a plan for the United State could integrate the various radioactive waste management programs that reside at the federal and state levels into a single source document. A national plan could assist those interested in radioactive waste management to identify waste quantities and locations, plan for future storage and disposal development, uncover research and development opportunities, and assess the need for regulatory or legislative actions. For example, there are no national contingency plan, other than allowing LLRW storage at waste generator sites, to address the impending closure of a key LLRW disposal facility. The availability of a national plan and periodic reporting on waste conditions might also provide the Congress and the public with a more accessible means to monitor the management of radioactive waste and provide a mechanism to build greater public trust in the management of these wastes in the United States.

Recommendations

In order to improve the management of LLRW in the United States and address a potential shortfall of disposal availability for higher-activity LLRW in 2008 and other management concerns, we recommend that the Chairman of NRC and the Secretary of Energy evaluate and report back to the Congress within 1 year on the usefulness to the United States of:

- Adopting the LLRW management approaches used in the countries discussed in this report, and the steps and any authorities necessary for their implementation, if deemed appropriate.
- Developing a U.S. radioactive waste management plan, and the potential costs, steps, and any authorities necessary to develop such a plan, if deemed appropriate.

Agency Comments and Our Evaluation

We provided a draft of our report to NRC, DOE, and the State Department for their review and comment. The State Department did not comment on the draft report. NRC and DOE generally agreed with the recommendations in our draft report, but raised a number of issues regarding their implementation. Specifically, they suggested other means through which they could report the results of their evaluations to Congress and they questioned the benefits of developing a national radioactive waste management plan. While we recognize the long-standing experience and international leadership of NRC and DOE in the

field of radioactive materials, the intent of our report is to discuss the approaches used in other countries. Based on our findings, we are recommending that NRC and DOE collaborate in reviewing, and in some cases perhaps reconsidering, the management approaches identified on pages 36-37 of this report for their potential usefulness in the United States. We believe the Congress would benefit from a collaborative evaluation or reevaluation of these approaches to ensure that the best management approaches are used in the United States.

NRC stated that it has already evaluated many of the LLRW management approaches and is in the process of evaluating some others as part of a strategic assessment of its LLRW program to ensure that NRC's regulatory framework will continue to ensure the safe management of LLRW. Further, NRC stated that it prefers to evaluate LLRW management approaches through ongoing efforts and to report on these evaluations in its annual letter to the Congress that addresses progress in completing actions in response to recommendations in multiple GAO reports. NRC also raised some concerns about our recommendation to evaluate and report on the development of a national radioactive waste management plan in specific comments accompanying its letter. While NRC did not disagree with this recommendation, it pointed out that the costs to develop a U.S. radioactive waste management plan would be significant and the benefits unclear, particularly given the complex composition of the current U.S. system. NRC noted that legislative changes would likely be needed before the development of a plan could substantially improve the U.S. system.

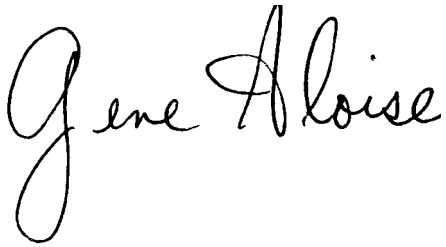
DOE stated that it regards the report as a useful comparison of U.S. LLRW programs with comparable international programs. DOE accepted the recommendation to evaluate the international approaches summarized in our report, but did not agree that a report to the Congress is necessary at this time. DOE offered to brief the Congress on the status of its radioactive waste management efforts if asked to do so. Regarding the development of a national radioactive waste management plan, DOE stated that a single document synthesizing the activities of numerous agencies and entities involved in radioactive waste management would facilitate understanding of these complex programs. However, DOE commented that it is concerned that development of such a document would provide limited utility to the actual implementation of these strategies yet would require diversion of significant resources from actual waste management efforts. Moreover, DOE suggested that the U.S. Second National Report for the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management provides a summary of the existing national waste management strategies, issues, and progress.

We recognized in our report that NRC has evaluated some of the LLRW management approaches in the past and is currently evaluating some others. We also found that many of the U.S. LLRW stakeholder representatives that we interviewed and some recent U.S. LLRW management reports generally supported the reevaluation, if not use of many of the management approaches identified in our report. We believe that the Congress would benefit from a consolidated report that contains the evaluations of these LLRW management approaches as they apply to the U.S. situation. In regard to reporting, we do not take issue with how the agencies might collaborate together and with other LLRW stakeholder groups on reporting back to the Congress on these management approaches as long as the evaluations are comprehensive.

We acknowledge the concerns of NRC and DOE regarding our draft recommendation to evaluate and report on the development of a national radioactive waste management plan. We have revised this recommendation to clarify that the agencies need to evaluate and report on the usefulness of such a plan and conduct further analysis if deemed appropriate. We still conclude that the use of a national radioactive waste management plan in most other countries in our survey and our own assessment of its potential benefits, as reflected on pages 37-38 of this report, indicates to us that there is value in further evaluating this management approach. In addition, in our view, the U.S. national report to the Joint Convention provides useful information on radioactive waste management, but the waste inventory information in this report is not comprehensive and the document does not contain strategies to guide the management of radioactive waste. The letters from NRC and DOE, along with our responses to their specific comments are contained in appendix VI and VII, respectively.

We will send copies of this report to the appropriate congressional committees as well as to the Chairman of NRC and the Secretary of Energy. We will make copies available to others upon request. In addition, the report will be available at no charge on the GAO Web site at http://www.gao.gov.

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



Gene Aloise
Director, Natural Resources
and Environment

Appendix I: Recent GAO Findings and Agency Actions on LLRW Management

GAO reports have addressed various aspects of low-level radioactive waste (LLRW) management in the United States.[1] We reported in 2004 on the scope and reliability of national LLRW inventory information and found that the Department of Energy (DOE)'s commercial LLRW disposal database did not contain data on all disposed LLRW, did not capture information on LLRW that is produced and stored at waste generator sites, and had data inaccuracies. We recommended that DOE take steps to correct internal control weaknesses and shortcomings in the usefulness and reliability of this database, which DOE claims it has for the most part accomplished. More recently, we reviewed the U.S. report to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, which commits the United States to, among other things, report on its national inventory of radioactive waste, but does not prescribe how this should be done or the level of reporting detail regarding the location and quantities of LLRW. The U.S. report includes the location and quantities of DOE's radioactive waste in storage and disposal as well as the commercially-generated LLRW that has been disposed of, but less comprehensive coverage of the location and quantities of non-DOE LLRW in storage around the country. The response of the United States to the GAO survey highlighted some gaps in the U.S. radioactive waste inventory. The United States is also committed through its signing of the Joint Convention to take steps to ensure the safe possession, remanufacture, or disposal of disused sealed radiological sources. One step in this direction is the establishment of a national radioactive source registry in support of the *IAEA Code of Conduct for the Safety and Security of Radioactive Sources*. We recommended in our 2005 report that the Nuclear Regulatory Commission (NRC) and DOE, in collaboration with the Radiation Source Protection and Security Task Force, evaluate and report on how its source registry (National Source Tracking System) could be designed and implemented to improve DOE's ability to identify and track sources that may need DOE recovery and

[1]GAO, *Nuclear Security: Federal and State Action Needed to Improve Security of Sealed Radiological Sources*, GAO-03-804 (Washington, D.C.: Aug. 6, 2003); GAO, *Low-Level Radioactive Waste: Disposal Availability Adequate in the Short Term, but Oversight Needed to Identify Any Future Shortfalls*, GAO-04-604 (Washington, D.C.: June 9, 2004); GAO, *Nuclear Security: DOE Needs Better Information to Guide Its Expanded Recovery of Sealed Radiological Sources*, GAO-05-976 (Washington, D.C.: Sept. 22, 2005); and GAO, *Low-Level Radioactive Waste: Future Waste Volumes and Disposal Options Are Uncertain*, GAO-04-1097T (Washington, D.C.: Sept. 30, 2004).

disposal.[2] We found that 98.5 percent of the disused sealed radiological sources that DOE had recovered as of June 2005 would not have been included in the National Source Tracking System. NRC's final rule on this source tracking system stipulates the tracking of only category 1 and 2 sources, although NRC indicated that additional sources could be added through subsequent rulemaking.[3] NRC has no plans to monitor the status of sealed radiological source use in this tracking system. However, according to NRC officials, the online version of the tracking system will allow licensees to voluntarily provide information on whether a source has been put in storage and will no longer be used. Appendix IV contains an assessment of what is known about the volume and location of LLRW in the United States.

In regard to the safety and security of stored class B, C, and GTCC waste, we reported in 2004 about the possible increase in the storage of this higher-activity LLRW at generator sites because, among other reasons, generators may decide to store their waste on-site because of high disposal costs. While NRC does not place time limits on the storage of LLRW, NRC claims that its licensing and inspection programs for waste generators provide assurance that stored LLRW will remain safe and secure. Moreover, NRC contends that with the exception of disused sealed radiological sources, LLRW does not present an attractive target for adversaries. In regard to the safety and security of sealed radiological sources, NRC reported that it has conducted vulnerability assessments, imposed new security measures on those licensees that possess category 1 and 2 sources, and it is reviewing the adequacy of its guidance for long-term LLRW storage as well as possible updates to this guidance. NRC officials informed us that the new security measures also apply to licensees who possess aggregations of category 3 or lesser-activity source categories that would meet or exceed the category 2 radioactivity threshold. In addition, they told us that NRC requires the timely removal of radioactive material as part of the decommissioning process. Nevertheless, the response of the United States to the GAO survey indicated that NRC does not enforce the removal of disused sealed radiological sources from licensees that generate this waste or require them to return their disused

[2]The Energy Policy Act of 2005 established an interagency task force under the leadership of NRC to evaluate and provide recommendations to the President and Congress relating to the security of radiation sources in the United States from terrorist threats, including acts of sabotage, theft, or use of a radiation sources in a radiological dispersal device.

[3]National Source Tracking of Sealed Sources: Final Rule, 71 Fed. Reg. 65,686 (Nov. 8, 2006).

sources to the source supplier. As we reported in 2005, NRC works with DOE to identify disused sealed radiological sources at user sites that should be recovered because they pose a safety and security risk. The Conference on Radiation Control Program Directors also provides a clearinghouse service for users to disposition their disused sources. We noted, however, that the lack of information to track the number and status of sealed radiological sources that may require recovery and disposal in the future limits DOE's ability to effectively plan and budget for its recovery and disposal efforts and to monitor the performance of its source recovery program.

We also reported on LLRW disposal options in the United States, which are affected by federal and state nuclear regulatory authorities, commercial LLRW disposal operators, and LLRW compact commissions. We found in our 2004 report that there appears to be sufficient disposal capacity for class A, B, C waste, but uncertain future access to a disposal facility for class B and C waste. In our 2005 report, we found that there was some central storage for GTCC waste, essentially for disused sealed radiological sources recovered by DOE, but no disposal availability. These reports and others have commented on the many factors affecting the predictability of disposal availability and disposal costs. For example, NRC and the Agreement State regulators are involved in granting the approval of LLRW disposal facilities and the classes of waste that can be accepted. They also have discretion, on a case-by-case basis, to exempt very low-level radioactive waste from regulation as LLRW, thus providing waste generators with more disposal options for this waste.[4] According to NRC officials, approvals for waste generators in states under its jurisdiction have been granted for small quantities of waste—averaging about 2 per year over the past 6 years—however, no comparable information is available on the 34 Agreement States. NRC officials also told us that the agency has attempted to improve the transparency of this process for a number of stated reasons, including the anticipation that there will be large amounts of this waste from nuclear power plant decommissioning. NRC has evaluated and decided to defer action on a rule that would exempt very low-level radioactive waste from having to go through regulatory review as LLRW. The LLRW compact commissions can also affect the predictability of the disposal system because they have

[4]NRC notes that other measures for controlling the hazard from these materials could be implemented at the disposal facilities, for example at disposal sites under the regulatory control of the Environmental Protection Agency that can accept hazardous materials.

discretion to restrict access to disposal facilities as well as to charge variable disposal fees based not only on waste type but the type of generator. Likewise, commercial disposal facility operators can affect the predictability of the disposal system. For example, the operator of the disposal facility that accepts almost all of the class A waste charges variable disposal fees based on the generator of the waste. Waste generators, such as DOE and nuclear power plants, which dispose of large volumes of class A waste, can negotiate lower disposal fees per volume of waste than generators that dispose of much smaller quantities of this waste. Appendix V contains a discussion of the type of waste and waste generators that would be affected by reduced access to the South Carolina disposal facility. For example, of the 671 waste generators that sent disused sealed radiological sources to the South Carolina disposal facility between 2001 and 2005, only 70 would be allowed to do so after mid-2008.

In our 2005 report we commented on the limitations on DOE's ability to recoup its costs for recovering disused sealed radiological sources from non-utility waste generators. The response of the United States to the GAO survey indicated that not all non-utility waste generators, particularly those possessing sealed radiological sources, are currently required to ensure that funds are available to cover future LLRW disposition costs. NRC officials told us that they are revising the financial assurance regulations aimed at addressing sites that permanently cease radiological operations without adequate funds to complete decommissioning. The revised regulations are intended to address problems with funding large, complex sites that may include extensive soil and groundwater contamination. The disposal of disused sealed radiological sources is not part of this rulemaking. For non-Agreement States, NRC officials indicated that about 5 to 10 small businesses possessing sealed radiological sources go bankrupt each year. However, NRC officials informed us that they have no information on the annual number of bankruptcies in the 34 Agreement States. In cases where waste generators do not have the funds to cover the cost of removing, centrally storing, or disposing of their higher-activity disused sealed radiological sources, the U.S. government has covered these costs. One of NRC's performance goals is to reduce the potential for unnecessary federal government funding to clean up sites if licensees go bankrupt and have insufficient financial reserve to cover these costs. According to NRC officials, the potential expansion of the financial assurance requirements for its licensees will ensure that they can meet their responsibilities to cover the cost to disposition a broad range of radioactive materials, including sealed radiological sources. NRC officials note that this initiative may also help reduce the cost of DOE's program to recover disused sealed radiological sources. Nevertheless, DOE officials

told us that the department has no basis to charge waste generators to recover and store disused sealed radiological sources that would generally constitute GTCC waste when disposed of because there is presently no disposal option for this waste and thus no basis to determine a service fee schedule. In our 2005 report, we recommended that NRC and DOE evaluate mechanisms to reduce government costs of recovering, storing and disposing of higher-activity LLRW. The response of the United States to the GAO survey indicated that NRC does not require a disposal fee at the time of purchase or require that source users and suppliers contribute to a recovery fund.

Finally, in reviewing the U.S. report to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, prepared by DOE in cooperation with other federal agencies, we noted that while the report describes existing national policies and practices for managing radioactive waste, it does not constitute a national radioactive waste management plan. However, the Joint Convention does not mention the need for such a plan and there is no requirement in U.S. legislation for a federal agency to prepare a plan. While the LLRW Policy Act required DOE to report to the Congress annually on national LLRW conditions, the provision, which terminated effective May 2000, it did not require a national radioactive waste management plan. DOE officials have, however, provided us with a draft copy of the department's strategy to optimize the disposition of DOE low-level and mixed low-level radioactive waste. Similarly, NRC officials told us that their responsibilities to oversee the use, storage and disposal of radioactive materials do not include development of a national radioactive waste management plan. However, NRC officials informed us that in light of new challenges, influences, and issues facing LLRW management today, they are currently conducting a strategic assessment that will identify and prioritize staff activities to ensure a stable, reliable, and adaptable regulatory framework for effective LLRW management.

Appendix II: Scope and Methodology

In our review, we examined the extent to which foreign countries have (1) comprehensive national LLRW inventory databases, (2) timely removal of higher-activity LLRW in storage at waste generator sites, (3) disposition options for all LLRW, and (4) requirements to assure that LLRW generators have adequate financial reserves to cover all waste disposition costs. We also examined another management area that surfaced during our review pertaining to the use of national radioactive waste management plans. Our examination primarily relied on a survey of radioactive waste management officials in countries, along with the United States that account for 85 percent of the world's installed nuclear power plant capacity. To better understand the context of managing LLRW in other countries, we also spoke with radioactive waste management officials and visited disposal facilities in France, Japan, and Sweden. To describe the status of LLRW management in the United States, we obtained responses from NRC to the same questionnaire sent to other countries, interviewed NRC and DOE officials as well as representatives from a wide range of domestic LLRW stakeholder groups, and reviewed past GAO reports and other pertinent documents.

Specifically, we developed, pretested, and sent out questionnaires to 20 countries to identify foreign experiences in managing LLRW. The countries included Australia, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Hungary, Italy, Japan, Mexico, the Netherlands, Norway, Slovak Republic, South Korea, Spain, Sweden, Switzerland, and United Kingdom. These countries, along with the United States, are represented on the NEA Radioactive Waste Management Committee.[1] The questionnaire contained 32 questions and potential answers that were distributed across the four areas of LLRW management under review. Respondents were also given an opportunity to specify other responses not listed and to provide additional comments on most of the questions. Appendix II provides the questionnaire and the responses from the United States. To increase the potential response rate to the survey, we attended a March 2006 meeting of the NEA Radioactive Waste Management Committee in Paris, France, to discuss our interests in surveying the representatives of foreign countries who attended the meeting. While at this meeting, we also reviewed a draft questionnaire with representatives

[1]The Radioactive Waste Management Committee is an international committee made up of senior representatives from regulatory authorities, radioactive waste management agencies policy-making bodies, and research and development institutions. The committee is under the NEA, which is a specialized agency within the Organization for Economic Cooperation and Development, an intergovernmental organization of industrialized countries.

from the NEA and IAEA. We further reviewed the draft questionnaire with radioactive waste management officials that we met with in France and Sweden. Several e-mail messages were sent to all 20 countries prior to administering the survey in order to confirm the appropriate country official to receive the questionnaire and to encourage each of them to participate in the survey. All but two countries, the Czech Republic and South Korea, responded to our survey (a 90-percent survey response rate). For the most part, we accepted the responses provided by each country; however, in a few cases we contacted country officials to clarify their responses to some questions, and we took other steps to ensure more complete responses to all questions. We then tabulated frequencies for each question across the countries.

We made site visits to France, Japan, and Sweden to speak directly with representatives from the nuclear regulatory authority, waste management organization, and waste generators about LLRW management in their country. These countries were selected because they are large generators of radioactive waste and they represent both European Union and non-European Union member countries on the NEA Radioactive Waste Management Committee. We sent out questions in advance of our meetings with these representatives and we used our time with them to obtain a better understanding of why different management approaches were taken and the experiences of stakeholder groups with them.

We identified and examined foreign country and international documents addressing the management of radioactive waste to supplement the information we obtained from our survey. These documents included radioactive waste management reports that countries are required to submit to IAEA under international agreements, national radioactive waste management reports and updates prepared for the NEA Radioactive Waste Management Committee, and information that we obtained during our visits to the three countries. For example, we used these documents to describe the extent to which countries use central storage facilities for LLRW, formulate radioactive waste management plans, and apply specific management approaches. In some instances, we used these documents to check the responses provided by countries on their questionnaire.

We interviewed NRC and DOE officials and representatives from a diverse group of domestic LLRW stakeholders to describe the current LLRW management situation in the United States and to identify approaches that might be applied to improve the management of LLRW corresponding to our four research objectives. The interviewees represented nuclear regulators at the federal and state levels; LLRW disposal operators;

advisory groups including the Conference on Radiation Control Program Directors, Department of Defense's Low-Level Radioactive Waste Executive Agent, National Research Council of the National Academies, and NRC Advisory Committee on Nuclear Waste; pertinent associations, including the Council on Radionuclides and Radiopharmaceuticals, the Health Physics Society, the Low-Level Radioactive Waste Forum, and the Nuclear Energy Institute; and private consultancies. The Health Physics Society is a scientific and professional organization whose 6,000 members specialize in occupational and environmental radiation safety, and the Nuclear Energy Institute represents all nuclear power plant operators. We conducted a content analysis of 33 domestic interviews; coding responses as either agreeing, not agreeing, or not responding to a common set of questions addressed in each interview (respondents are shown in table 2). These responses were then quantified for statistical analysis. In addition to interviews based on a standard list of questions, in the course of our review we also conducted informational interviews with the Energy Policy Research Institute, Army Corps of Engineers, Exelon Nuclear, and program officials at DOE. Moreover, we reviewed several pertinent reports, including a report of the NRC chaired Radioactive Source Protection and Security Task Force, a report from National Research Council, and a report of the NRC Advisory Committee on Nuclear Waste.[2] The formation of the interagency NRC chaired task force and periodic reporting requirements were mandated in the Energy Policy Act of 2005.

Finally, we examined LLRW inventory data from several sources to estimate the volumes, types, locations, and generators of LLRW in the United States and what is now received at the LLRW disposal facility in South Carolina from non-compact member states. For the most part, we relied on data from DOE's Manifest Information Management System and from the U.S. report to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. We determined that these data were sufficiently reliable for the purposes of this report. Our assessment of what is known about the location and volume of LLRW in the United States is covered in appendix III. The status of class B and C waste disposal in the United States, as well as the impact

[2]Radiation Source Protection and Security Task Force, *The Radiation Source Protection and Security Task Force Report* (Washington, D.C.: Aug. 15, 2006); National Research Council, *Improving the Regulation and Management of Low-Activity Radioactive Wastes* (Washington, D.C.: 2006); and Advisory Committee on Nuclear Waste, *ACNW White Paper: History and Framework of Commercial Low-Level Radioactive Waste Management in the U.S.* (Washington, D.C.: Dec. 30, 2005).

of closing the South Carolina disposal facility to non-compact member states, slated for 2008, is contained in appendix V.

We conducted our review between September 2005 and February 2007 in accordance with generally accepted government auditing standards.

Table 2: Listing of Domestic LLRW Stakeholder Group Respondents

Number	Domestic LLRW Stakeholder Group Respondent
1	Nuclear Regulatory Commission
2	Organization of Agreement State-Alabama
3	Organization of Agreement State-Arkansas
4	Organization of Agreement State-Louisiana
5	Organization of Agreement State-New York
6	Organization of Agreement State-North Carolina
7	Organization of Agreement State-Texas
8	Organization of Agreement State-Washington
9	Organization of Agreement State-Wisconsin
10	State of South Carolina, Bureau of Land and Waste Management
11	State of South Carolina, Bureau of Radiological Health
12	State of South Carolina, South Carolina Energy Office
13	State of Texas, Department of State Health Services
14	State of Utah, Division of Radiation Control
15	American Ecology
16	Duratek (now Energy Solutions)
17	Envirocare (now Energy Solutions)
18	Waste Control Specialists
19	Conference of Radiation Control Program Directors
20	Department of Defense's Low-Level Radioactive Waste Executive Agent
21	National Research Council of the National Academies
22	NRC Advisory Committee on Nuclear Waste
23	Council on Radionuclides and Radiopharmaceuticals
24	Health Physics Society
25	Low-Level Radioactive Waste Forum-Director
26	Michigan Low-Level Radioactive Waste Authority
27	Midwest Low-Level Radioactive Waste Compact Commission
28	Northwest Low-Level Radioactive Waste Compact Commission
29	Southeast Low-Level Radioactive Waste Compact Commission
30	Southwest Low-Level Radioactive Waste Compact Commission

Number	Domestic LLRW Stakeholder Group Respondent
31	Nuclear Energy Institute
32	JTG Consulting, Inc.
33	MRT, Inc.

Source: GAO interviews with representatives from LLRW stakeholder groups.

Appendix III: Survey of LLRW Management Approaches: Response from United States

United States Government Accountability Office
Foreign Experiences in Managing Low- and Intermediate-Level Radioactive Waste

Background

The U.S. Government Accountability Office (GAO) is a professional, nonpartisan legislative branch agency that supports the Congress by reviewing the performance of federal agencies, assessing federal policies and programs, analyzing the financing of government activities, and anticipating emerging issues. One such issue is the management of low- and intermediate-level radioactive waste.

While the United States embarks on new nuclear power development, it also confronts the need to dismantle and dispose of older reactors. Both activities will result in increased generation of low- and intermediate-level radioactive waste. The current lack of a reliable and cost-effective radioactive waste disposal system in the United States may prompt the need to revise federal legislation and the policies of the nuclear regulatory authorities. The Congress is particularly interested in identifying approaches to improve the management of these wastes, particularly in four key areas. GAO has been asked to determine the extent to which the United States and other countries have established: (1) national waste inventory and source tracking systems; (2) requirements for the timely removal of waste from user sites; (3) reliable and cost-effective waste disposal options; and (4) funding mechanisms to ensure that users can cover waste storage and disposal costs.

In order to obtain information about management approaches used in other countries, GAO is seeking the cooperation of countries represented on the OECD Nuclear Energy Agency Radioactive Waste Management Committee. These countries generate relative large volumes of low- and intermediate-level radioactive waste. We have worked with representatives of the Nuclear Energy Agency, International Atomic Energy Agency, and the U.S. Nuclear Regulatory Commission to prepare a questionnaire that will collect information useful to all countries. While these organizations support the GAO survey, they are not sponsors or in other ways associated with the results of this survey.

Directions for Completing the Questionnaire

Most of the 32 questions in this survey can be answered easily by checking boxes ☐ or filling in blanks, which are highlighted in yellow. Unless otherwise noted, please mark *only one response* for each question.

You will notice that many questions are followed by boxes that allow you to provide additional comments. You should only use these boxes if you feel that you have additional information that you need to convey to clarify your response. The box will expand to accept your entire response. If the check mark answers provided are sufficient, you do not need to provide any additional comments in the boxes.

- Please use your mouse to navigate throughout the survey by clicking on the field or check box you wish to answer.
- To select a check box, simply click on the center of the box.
- To change or deselect a response, simply click on the check box and the "X" will disappear.

You will also notice that we ask about both low- and intermediate-radioactive waste in the survey. The United States does not have a low- and intermediate radioactive waste classification system, but rather it relies on four classes of low-level radioactive waste–class A, B, C, and greater-than-class C waste. The International Atomic Energy Agency (IAEA) has estimated that all of U.S. class A and B waste, and 75 percent of the class C waste would fall into the international short-lived low- and intermediate-level waste category, and the remaining 25 percent, as well as all of the greater-than-class C waste would fall into the long-lived low and intermediate-level waste category. The U.S. class A waste includes radioactive wastes that some other countries classify as very low-level radioactive waste (<10Bq/g, with a half-life on the order of decades).

Please complete this questionnaire and return it via e-mail within 3 weeks of receipt. If you have any questions, please contact:

Stated GAO Official

If you prefer to return the survey via post, the return address is:

U.S. Government Accountability Office
Denver Field Office
1244 Speer Boulevard, Suite 800
Denver, Colorado 80204
USA

Although this questionnaire may require input from various individuals, GAO asks that one person assume responsibility for coordinating its completion. Please list the person's name below in case we have questions or need follow-up. Thank you.

Name: NRC Official
Title: .
Telephone Number: _____
E-mail: _____
Country: USA
Agency or Organization: NRC

Definition of Radioactive Waste Generators: The U.S. radioactive waste disposal inventory database for low-level radioactive waste captures six waste generator categories–academic, government (including defense, but excluding the Department of Energy), industry, medical, utility (nuclear power plant), and other. Data is not collected on the generation of radioactive waste on the front and back end of the fuel cycle, as well as operators that treat and condition the waste.

Radioactive Waste Inventory Database

1. Does your country currently have a national radioactive waste inventory database?

   Yes ..... ☒ ***Skip to question 3.***

   No ..... ☐

2. Do you plan to develop a national radioactive waste inventory database?

   Yes ..... ☐
   [Please specify the date the database is scheduled to be operational.] ➔

   No ..... ☐

   Skip to question 13.

3. What types of radioactive wastes are in the national radioactive waste inventory database?

	Yes	No
Very low-level radioactive waste	☐	☒
Short-lived low- and intermediate-level waste	☒	☐
Long-lived low-level waste (including naturally occurring radioactive material)	☐	☒
Long-lived intermediate-level waste	☐	☒
High-level radioactive waste	☐	☒
Other	☐	☐

please specify:

Additional comments

National waste inventory "database" is defined here as the U.S. National Report for the Joint Convention, which contains quantities and types of most of the nuclear fuel cycle wastes in the U.S. The U.S. also has a computerized database for non-DOE waste that's been disposed of (the Manifest Information Management System (MIMS)). MIMS covers only LLW disposed of in commercial LLW facilities.
For Long-Lived LLW in the above list, there is an inventory of fuel cycle wastes, but none for naturally occurring material.

4. What categories of radioactive waste generator are included in the national radioactive waste inventory database?

	Yes	No
Academic	☒	☐
Government (including defense)	☒	☐
Industrial	☒	☐
Medical	☒	☐
Nuclear power plants	☒	☐
Front end of fuel cycle	☐	☒
Back end of fuel cycle	☒	☐
Waste Treatment	☐	☒
Other	☐	☐

please specify:

Additional comments

See U.S. National Report and MIMS for details.

5. What locations of radioactive waste does the national radioactive waste inventory database capture?

	Yes	No
Disposed at national facilities	☒	☐
Disposed at regional facilities	☒	☐
Disposed at waste generator sites	☐	☒
Stored at national facilities	☒	☐
Stored at regional facilities	☐	☒
Stored at the waste generator sites	☐	☒
Other	☐	☒

please specify:

Additional comments

Note--National facilities are defined as the DOE LLW disposal sites. Inventory in MIMS includes waste disposed at commercial (non-DOE) facilities.
The locations of the above facilities are in the National Report. See, for example, Annexes D-1 and D-2.
At least partial inventory information is also included and may be available from other sources (e.g., WIPP disposal inventory is readily available).
Data on waste stored at DOE sites is contained in the National Report. Similar data on waste in storage at commercial sites not reported.

6. Who is responsible for maintaining the national radioactive waste inventory database?

	Yes	No
National nuclear regulatory authority	☒	☐
National waste management organization	☐	☐
Regional nuclear regulatory authority	☐	☐
Nuclear utility organization	☐	☐
Commercial waste management company	☐	☐
Other	☒	☐

please specify:

Additional comments

DOE maintains the MIMS. DOE also is the lead Federal agency for the preparation of the U.S. National Report for the Joint Convention and receives assistance from NRC and EPA. DOE is a national organization and has regulatory authority for its own internal activities, so we have checked that block. This may not be the sense that GAO uses the term "national nuclear regulatory authority," however.

7. How does the national radioactive waste inventory database receive data from the waste generators?

	Yes	No
Secure website reporting form	☒	☐
E-mail attachments	☒	☐
Mail or faxed paper documents	☒	☐
Phone	☐	☐
Other	☒	☐

please specify: ——

ional comments

e MIMS, DOE receives e-mail attachments of disposal data from al facility operators. Generators furnish waste manifests either nically or in paper to disposal facility operators.

8. How frequently does the national radioactive waste inventory database receive data from waste generators?

Once a month	☐
Twice a year	☐
Once a year	☐
Other	☒

please specify: Updates are typically received quarterly.

Additional comments

DOE maintains the MIMS. DOE also is the lead Federal agency for the preparation of the U.S. National Report for the Joint Convention and receives assistance from NRC and EPA. DOE is a national organization and has regulatory authority for its own internal activities, so we have checked that block. This may not be the sense that GAO uses the term "national nuclear regulatory authority," however.

7. How does the national radioactive waste inventory database receive data from the waste generators?

	Yes	No
Secure website reporting form	☒	☐
E-mail attachments	☒	☐
Mail or faxed paper documents	☒	☐
Phone	☐	☐
Other	☒	☐

please specify: ——

ional comments

e MIMS, DOE receives e-mail attachments of disposal data from al facility operators. Generators furnish waste manifests either nically or in paper to disposal facility operators.

8. How frequently does the national radioactive waste inventory database receive data from waste generators?

Once a month	☐
Twice a year	☐
Once a year	☐
Other	☒

please specify: Updates are typically received quarterly.

Additional comments

9. Which of the following activities, if any, are used by the organization responsible for maintaining the national radioactive waste inventory database to verify the completeness and accuracy of the data?

	Yes	No
Periodic inspections of waste generators to verify the accuracy of the reported waste data	☐	☐
Check generator submissions against past and projected waste from the generator	☐	☐
Periodic audits of waste generator records	☐	☐
Other	☒	☐

please specify: DOE, who manages MIMS, has some data routines that verify format and consistency of the data.

None of the above ☒

Additional comments ——

10. Is the national radioactive waste inventory database used to make projections of future waste volumes that are used for capacity planning of central waste storage and waste disposal facilities?

Yes ☐
No ☒

11. If your country is a member of the European Union, has it implemented Council Directive 2003/122/EURATOM, regarding the control of high-activity sealed radioactive sources and orphan sources?

Yes ☐
No ☐
Not a European Union country ☒

12. As a country that has made a political commitment to the IAEA Code of Conduct on the Safety and Security of Radiological Sources, which of the following source categories, if any, are or will be included in the national source registry?

	Yes	No
IAEA category 1 sources	☒	☐
IAEA category 2 sources	☒	☐
IAEA category 3 sources	☐	☒
IAEA category 4 sources	☐	☒
IAEA category 5 sources	☐	☒

Additional comments: The Commission has directed NRC staff to conduct a survey of Category 3.5 sources (0.1 of Cat 3) and to prepare a proposed rule that would include Category 3 data in the tracking system. See http://www.nrc.gov/reading-rm/doc-collections/commission/srm/2006/2006-0094srm.html for details.

Removal of Radioactive Waste from User Sites

13. What limits, if any, are placed on the time that radioactive waste can be stored at the waste generator's site?

Radioactive waste generator	Time Limit	
Nuclear power plants	_____	☒ No limits
Non-nuclear power plant entities	_____	☒ No limits

please specify: ____

14. Does your country place any limit on the time that a sealed radioactive source can be used?

Yes ..... ☐

[Please specify the time limits.] ➔

No ..... ☒

15. Has your country implemented requirements that a disused radioactive source be returned either to the manufacturer of the source or to central waste storage?

Yes ..... ☐
No ..... ☒

Additional comments ——

16. Does your country have an orphan source recovery program to collect disused radioactive sources from entities that cannot afford to send them to an off-site central waste storage or a waste disposal facility?

Yes ..... ☒
No ..... ☐ ***Skip to question 18.***

Additional comments The US has two programs (DOE's Offsite Source Recovery Program, and a Conference of Radiation Control Program Directors (CRCPD) program) that may collect disused sources from entities that cannot afford to get rid of them, under certain specific circumstances (e.g., a lack of disposal alternative for GTCC waste, or a case involving a safety/security concern).

17. Which organization is responsible for recovering orphan radioactive sources?

	Yes	No
National nuclear regulatory authority	☐	☐
National waste management organization	☐	☐
Regional nuclear regulatory authority	☐	☐
Nuclear utility organization	☐	☐
Commercial waste management company	☐	☐
Other	☒	☐

please specify: ——

Additional comments: DOE, CRCPD. The U.S. Army also has a source recovery program for its sources, and EPA could recover sources in certain emergency situations.

18. What additional actions, if any, has the national nuclear regulatory authority taken to reduce the potential number of orphan radioactive sources?

	Yes	No
Users must inform regulators if holding disused sources	☐	☒
Regulators keep records of the location and status of use of sources, including disused sources	☒	☐
Regulators periodically inspect the operational storage of disused sources at user sites	☒	☐
Regulators encourage users to send disused sources to central storage or disposal, if available	☒	☐
Regulators enforce the prompt removal of disused sources from user sites	☐	☒
Other	☒	☐

please specify: Multiple US agencies fund CRCPD's Orphan Radiological Material Disposition Program (a non-profit program to facilitate information exchange and provide limited assistance in source disposition, including disused and orphan sources).

Additional comments: For item 2, records are kept for certain subsets of sources (i.e., high risk sources). There are increased controls on certain subsets of sources to reduce the likelihood of loss or theft. DOE funds OSRP

Reliable and Cost Effective Storage and Disposal Options

19. Which approaches does your country have to clear low- and intermediate-level radioactive waste from regulatory control or to reduce the level of control for very low-activity radioactive waste?

	Yes	No
Exemption, defined as the determination by a regulatory body that a source or practice need not be subject to some or all aspects of regulatory control on the basis that exposure is too small given the moderate quantities of radioactive material	☐	☒
Case by Case Exemption for larger quantities of radioactive material that still require some regulatory control	☒	☐
Clearance defined as the unrestricted removal of radioactive materials or radioactive objects within authorized practices from any further regulatory control by a regulatory body	☐	☒
Do not clear bulk radioactive materials from regulatory control but establish a new regulated disposal facility for very low-activity radioactive waste	☐	☒
Other	☒	☐

please specify: —

Additional comments: US has a number of exemptions, such as smoke detectors, in regulations but they are not for "waste" specifically. These materials often become waste when their use has ended. US has no rule for clearance, but NRC has issued guidance for releasing materials that is used by licensees. DOE also has its own clearance process

20. Are disposal options available for the following low- and intermediate-level radioactive waste?

	Yes	No
Very low-level radioactive waste	☐	☐
Short-lived low- and intermediate-level waste	☒	☐
Long-lived low-level waste (including naturally occurring radioactive material)	☒	☐
Long-lived intermediate-level waste	☒	☒

Other..... ☐

please specify: Some long-lived commercial LLW (GTCC) does not have a disposal option at this time.

Additional comments: On July 1, 2008, LLW generators in 34 States are expected to lose access to their Class B/C disposal option at the Barnwell facility. The facility is scheduled to close to out-of-compact waste on that date.

21. Which entity in your country is primarily responsible for **providing** disposal facilities for low- and intermediate-level radioactive waste? *If more than one entity is responsible for different types of waste, please clarify each entity's responsibility in the Additional Comments box.*

	Yes	No
National nuclear regulatory authority	☐	☒
National waste management organization	☐	☒
Regional nuclear regulatory authority	☒	☐
Nuclear utility organization	☐	☒
Commercial waste management company	☐	☒
Other	☐	☐

please specify: States and LLW Compacts are responsible under law for providing for disposal capacity for commercial (non-DOE) LLW. DOE is responsible for providing for disposal of GTCC waste (which is also commercial waste). In one case, a private company, EnergySolutions, has developed a facility on its own initiative for commercial waste. DOE diposes of its own LLW and TRU waste.

Additional comments ____

22. Which entity in your country is primarily responsible for **operating** disposal facilities for low- and intermediate-level radioactive waste? *If more than one entity is responsible for different types of waste, please clarify each entity's responsibility in the Additional Comments box.*

	Yes	No
National nuclear regulatory authority	☐	☒
National waste management organization	☐	☒
Regional nuclear regulatory authority	☐	☒
Nuclear utility organization	☐	☒
Commercial waste management company	☒	☐
Other	☐	☒

please specify: ____

Additional comments: For disposal facilties accepting commercial waste, all three are operated by private companies. DOE operates its own disposal facilities for LLW and TRU waste. It should be noted that DOE regulates its own activities, including the disposal facilities it operates. It is generally not thought of as a "national nuclear regulatory authority" however, given its much broader responsibilities.

23. What were the factors that were persuasive in your country's decision to grant responsibilities to the entity(s) charged with managing the disposal of low- and intermediate-level radioactive waste?

Comments: States' wanted the responsibility for providing for commercial LLW disposal. For DOE waste, DOE and its predecessor organizations have always managed waste in conjunction with their other extensive nuclear activities.

24. How are disposal fees for radioactive waste determined?

Yes	No

National disposal fee schedule based on the type of radioactive waste	☐	☒
Waste generators negotiate disposal fees based on the type of radioactive waste	☒	☒
Waste generators pay for disposal space through a tax not related to the type of radioactive waste	☐	☒
Other	☐	☐

please specify: ____

Additional comments: If Texas facility goes into operation, Texas Compact Commission will set rates for Compact waste. Rates for DOE waste disposal at the Texas site will be negotiated. For most sites, there is negotiation of rates, but certain taxes, surcharges, etc. are established by State and are not negotiable.

25. What disposal facility costs are covered by the disposal fees? *If there are different approaches used for more than one disposal facility, please clarify in the Additional Comments box.*

	Yes	No
Facility development costs	☒	☒
Operating costs	☒	☐
Estimated closure costs	☒	☐
Estimated long-term monitoring costs	☒	☐
Financial surety costs	☒	☒
Community economic development surcharges	☒	☒
Profit margin if a commercial facility	☒	☒
Other costs	☐	☐

please specify: ____

Additional comments: Answers vary depending upon the particular facility in U.S. WRT "profit margin," the "no" answer is for the Richland site where the State stipulates a revenue requirement to be met by the operator.

26. Which of the following approaches, if any, does your country use to obtain **community acceptance** for hosting a low- and intermediate-level radioactive waste central storage or disposal facility?

	Yes	No
Allow local communities a veto power in the site selection decision making process	☒	☒
Provide economic development funding to communities that will host a disposal facility	☒	☒
Promote the indirect economic benefit of hosting a disposal facility based on added value	☒	☒
Establish a selection committee comprised of experts, regulators, and community members	☒	☒
Encourage public access to inspect health and safety conditions at the disposal facility	☒	☒
Publicize information on the activities of the disposal facility	☒	☒
Other	☐	☐

please specify: ____

Additional comments: US has four commercial disposal sites, three in operation, one under license review. The particulars vary for each facility, so both "yes" and "no" apply above. We can provide details upon request.

Appendix IV: Volume and Location of LLRW in the United States

The United States is required under international agreement to prepare a national report on the safety of spent fuel and radioactive waste management that includes an inventory of radioactive waste in the country.[1] Even though the DOE has taken lead responsibility for preparing this inventory, there is no designated agency responsible for managing a national LLRW inventory database. The reported information includes data from DOE's own radioactive waste inventory, as well as publicly available information that is compiled from a variety of sources, including DOE's Manifest Information Management System containing information from the three LLRW disposal operators, EIA spent fuel database, Broker and Processor database, and other sources. While DOE can report on the radioactive waste it has in storage or has disposed of, there is limited information on the storage of waste at non-DOE sites. DOE has reported some LLRW storage at waste brokers and processor sites, and the GTCC waste stored at commercial nuclear power plants. NRC and Agreement State radioactive materials licensees are supposed to maintain records of the nuclear material that they possess, but information on the status of use of these materials, particularly disused sealed radiological sources, is not centrally collected. The Electric Power and Research Institute collects proprietary data from nuclear power plant operators on the annual generation of LLRW, but not on the storage of all LLRW, which is constantly changing. The institute estimates that an average plant generates about 12,000 cubic feet of LLRW each year.

The following tables provide some information on non-DOE and DOE radioactive waste volumes and locations. DOE classifies its radioactive waste somewhat differently than waste generated by NRC and Agreement State licensees. DOE reports four classes of radioactive waste, not including mixed waste, that include high-level waste, transuranic waste, low-level waste, and 11(e)(2) byproduct material.[2] DOE's low-level waste category and transuranic waste would clearly fall within the NRC waste

[1]As a contracting member of the International Atomic Energy Agency Joint Convention, the United States is required to submit a national report that must include the following: radioactive waste that is being held in storage at radioactive waste management and nuclear fuel cycle facilities, radioactive waste that has been disposed of, and radioactive waste that has resulted from past practices.

[2]"11(e)(2)" refers to "tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content," as described in section 11(e)(2) of the Atomic Energy Act of 1954 that defines "byproduct" wastes. 42 U.S.C. § 2014(e)(2). These wastes arise in the recovery of uranium and thorium from nuclear energy applications.

classification scheme. Low-level waste would be generally categorized as class A, B, or C waste, and transuranic waste would be categorized as greater-than-class C waste. DOE's 11(e)(2) byproduct material is a special category of radioactive waste.

According to NRC officials, 11(e)(2) byproduct materials and other types of radioactive waste exists in the United States but are not considered LLRW under NRC regulations. The National Research Council of the National Academies has reported that the principal origin of uranium and thorium ore processing waste comes from the recovery of this material for DOE or civilian nuclear applications. Typical examples include mining and mill tailings, process residues, soils and contaminated equipment. Similar waste comes from naturally occurring and technologically enhanced naturally occurring radioactive materials. The principal origins of these materials are from the recovery and processing of mineral resources not related to nuclear applications, and municipal water treatment. Examples of these materials include commercial ore mining residues, phosphate mining and fertilizers, scale and sludge from oil and gas production, water treatment filters, resins, and other sludge. There are large volumes of these wastes, but limited information on the actual quantities that remain at sites around the United States.

Table 3: Total LLRW Disposed at the Three Operating Commercial LLRW Disposal Facilities as of 2005

Disposal Facility	Location	Class A waste volume (cubic feet)	Class B waste volume (cubic feet)	Class C waste volume (cubic feet)	Total volume (cubic feet)
Barnwell	Barnwell, South Carolina	24,815,969	1,643,933	825,833	**27,285,735**
Envirocare	Clive, Utah	66,295,270	0	0	**66,295,270**
Richland	Richland, Washington	13,450,191	137,056	137,233	**13,724,480**

Source: Manifest Information Management System data and United States of America Second National Report for the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, October 2005.

Table 4: Total Disposed LLRW at the Four Closed Commercial Disposal Facilities

Closed commercial disposal facilities	State	Total volume (cubic feet)
Beatty	Nevada	**4,854,178**
West Valley	New York	**2,721,843**
Maxey Flats	Kentucky	**4,777,368**
Sheffield	Illinois	**3,119,486**
Total		**15,472,875**

Source: DOE Integrated Database Report 1997, all four facilities were closed prior to 1993.

Table 5: Total LLRW Disposed at the Three Commercial LLRW Disposal Facilities during 2005

Disposal facility	Location	Class A waste volume (cubic feet)	Class B waste volume (cubic feet)	Class C waste volume (cubic feet)	Total volume (cubic feet)
Barnwell	Barnwell, South Carolina	25,111	9,367	8,535	**43,013**
Envirocare	Clive, Utah	15,471,876	0	0	**15,471,876**
Richland	Richland, Washington	19,906	7	191	**20,104**
Total		**15,516,893**	**9,374**	**8,726**	**15,534,993**

Source: Manifest Information Management System data and information provided by DOE on waste disposed in 2005.

Note: The total waste disposed at Envirocare (now Energy Solutions) in 2005 includes class A waste from the Department of Energy.

Table 6 provides information on LLRW that is currently on DOE sites, either in storage or in disposal. The information in this table comes from the waste inventories of each DOE site that has LLRW, as reported in the 2005 U.S. National Report for the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.

Table 6: LLRW in Storage or Disposal at DOE Sites

State	Installation	Total volume (cubic feet)
Idaho	Idaho National Laboratory	2,509,390
Kentucky	Paducah Gaseous Diffusion Plant	335,489
Nevada	Nevada Test Site	27,259,391
New Mexico	Los Alamos National Laboratory	7,592,653
New York	West Valley Demonstration Project	575,276
New York	Brookhaven National Laboratory	2,048
Ohio	Ashtabula Environmental Management Project	108,204
Ohio	Fernald Environmental Management Project	59,962,962
Ohio	Portsmouth Gaseous Diffusion Plant	536,783
South Carolina	Savannah River Site	27,168,738
Tennessee	Oak Ridge Site	22,054,009
Washington	Hanford Site	81,641,859
Multiple states	Small facilities	353
Total		**229,747,155**

Source: United States of America Second National Report for the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, October 2005.

Table 7 provides information on transuranic waste disposed at the Waste Isolation Pilot Plant (WIPP) located in southeastern New Mexico. This facility can only accept defense-related transuranic waste.

Table 7: Transuranic Waste Disposed of or in Storage Awaiting Disposal at WIPP

DOE site	State	Volume disposed of at WIPP (cubic feet)	Volume in storage awaiting disposal at WIPP (cubic feet)
Hanford Site	Washington	52,972	1,539,719
Idaho National Laboratory	Idaho	204,825	2,171,852
Lawrence Livermore National Laboratory	California	-	12,431
Los Alamos National Laboratory	New Mexico	24,720	441,433
Nevada Test Site	Nevada	-	28,781
Oak Ridge Site	Tennessee	-	86,097
Rocky Flats Site	Colorado	529,720	-
Savannah River Site	South Carolina	250,734	459,091
Small Quantity Sites	-	20,836	21,754
West Valley Demonstration Project	New York	-	30,017
Total		**1,083,807**	**4,791,175**

Source: 2004 Sandia National Laboratories WIPP Compliance Recertification Application Performance Assessment Baseline Calculation, and the United States of America Second National Report for the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, October 2005.

Table 8 shows the number of disused sealed radiological sources that have been collected and sent to disposal by the former DOE Off-Site Source Recovery Project, which is now under the DOE's Global Threat Reduction Initiative.

Table 8: Central Storage and Disposal of Disused Sealed Radiological Sources Recovered by DOE's Off-Site Source Recovery Project

Location of collected sealed radiological sources in storage or disposed	State	Total number of sources
Sealed radiological sources in storage		
Los Alamos National Laboratory	New Mexico	9,920
Los Alamos National Laboratory (for Pu 239 sources)	New Mexico	1
National Naval Medical Center	Maryland	22
Nevada Test Site - Pu 239 Storage	Nevada	39
NSSI Sources and Services Inc.	Texas	484
Southwest Research Institute	Texas	135
Sealed radiological sources in disposal		
Barnwell	South Carolina	474
Nevada Test Site	Nevada	345
Waste Isolation Pilot Plant	New Mexico	2,397
Total		**13,817**

Source: DOE's Off-Site Source Recovery Project, June 28, 2006.

Note: The disused sealed radiological sources in storage are not considered to be waste until they are packed for disposal.

Appendix V: Status of Class B and C Waste Disposal and Potential Effects of Reduced Access to South Carolina Disposal Facility

Limiting waste generator access to the LLRW disposal facility in South Carolina to only the three compact member states by mid-2008 will require waste generators to store their class B and C waste until another disposal option becomes available. We reported in June 2004 that 99 percent of the class B and C waste disposed in this country went to the Barnwell, South Carolina, disposal facility, the only option available to waste generators in 39 states. Generators in the 11 other states have access to the LLRW disposal facility in Richland, Washington. In total the class B and C waste that is disposed at both of these facilities amounts to slightly less than 0.5 percent of all LLRW that was disposed of commercially in the United States between 1999 and 2003.

We conducted a further analysis of data in the DOE managed Manifest Information Management System for 2001 to 2005 for the waste generators that use the two disposal facilities that can accept class B and C waste (Barnwell, South Carolina, and Richland, Washington), and the types and quantities of waste disposed at these facilities during this time period. In order to compare the waste types disposed as these two facilities, we had to come up with a categorization scheme that captured the different types of class B and C waste. For the purpose of our analysis, we consolidated these waste types into groups as shown in the table 9.

Table 9: Class B and C Waste Type Groups

Waste type group	Waste type
Dry active waste (DAW)	Charcoal
	Incinerator ash
	Soil
	Demolition rubble
	Glassware or labware
	Compactable trash
	Non-compactable trash
Oil, gas, EPA or state hazardous, paint or plating (OGEP)	Paint or plating
Liquids and sludge	Aqueous liquid
	Evaporator bottoms/sludge/concentrates
	Solidified liquids
Filters, filter media & resins	Filter media
	Mechanical filter
	Cation ion-exchange media
	Mixed bed ion-exchange media
	Non-cartridge filter media
Equipment and material	Contaminated equipment
	Activated material
	Activated reactor hardware
Sealed radiological sources	Sealed source/device
	Sealed sources
Biological materials	Animal carcass
Other	Other
	Dry solid
	Non-compacted dry active waste
	Solidified chelates
	Combination

Source: GAO determination from analysis of Manifest Information Management System records.

Table 10 shows the volume and activity of the class B and C waste that was disposed between 2001 and 2005 by waste type group. Filters, filter media, and resins contributed the greatest volume of waste (44 percent of total disposed volume), but only about 3 percent of total disposed activity. Equipment and materials, by contrast, contributed only about 28 percent of the total disposed volume but accounted for 86 percent of the disposed

activity. According to a nuclear industry official, contaminated equipment and material is highly radioactive and will need to be stored on-site similar to spent fuel rods, if there is no disposal option for this type of waste.

Table 10: Total Class B and C Waste Disposed at Richland and Barnwell by Waste Type Group, 2001-2005

	Volume (in cubic feet)		Activity (in curies)	
Waste type group	**Total**	**Percent**	**Total**	**Percent**
Dry active waste	**7,849**	5	**34,490**	2
Oil, gas, EPA or state hazardous, paint or plating	**1**	0	**0**	0
Liquids and sludge	**2,222**	2	**7,729**	0
Filters, filter media and resins	**63,814**	44	**63,825**	3
Equipment and material	**39,856**	28	**1,797,562**	86
Sealed radiological sources	**4,995**	3	**92,287**	4
Biological materials	**18**	0	**86**	0
Other	**25,335**	18	**83,044**	4
Total[a]	**144,090**	**100**	**2,079,023**	**100**

Source: Manifest Information Management System records for 2001-2005.

[a]Column percentages may not add up to 100 percent due to rounding.

Table 11 shows the number of generators of a particular waste type distributed across the generator types. No total is provided for the number of different generator types because in some cases one generator may be disposing of different types of waste. Providing a total by generator type would result in an over count of the total number of generators.

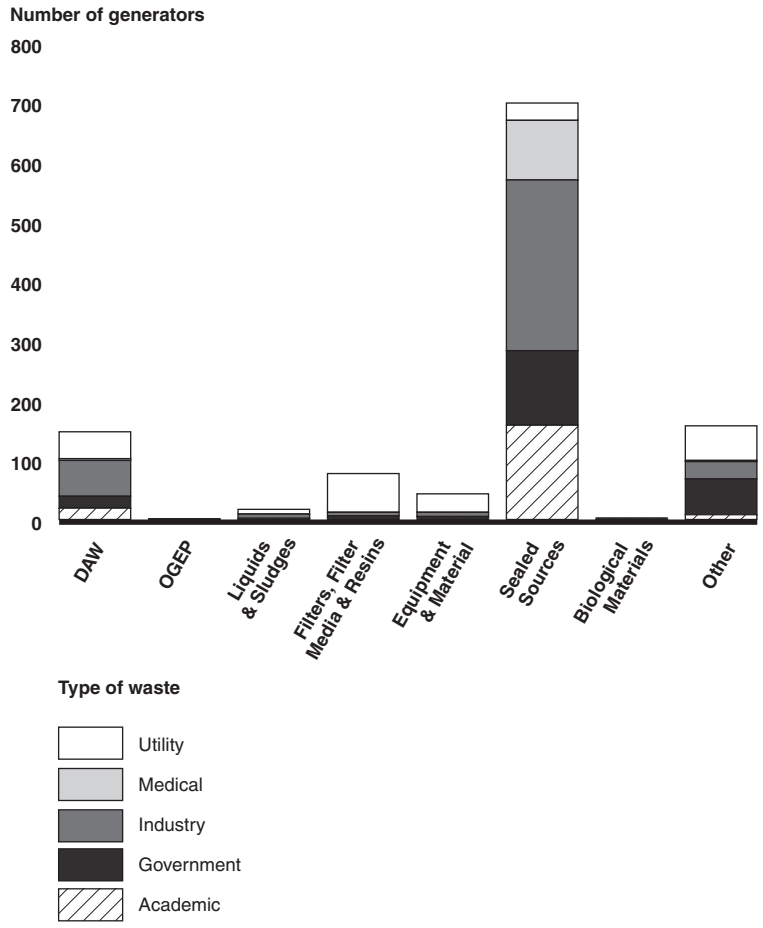
Table 11: Number of Generators That Disposed of Class B and C Waste at Richland and Barnwell by Generator Type and Waste Type, 2001-2005

Waste type Group	Academic	Government	Industry	Medical	Utility	Total
Dry active waste	19	20	60	3	45	**147**
Oil, gas, EPA or state hazardous, paint or plating	0	0	0	0	1	**1**
Liquids and sludge	1	1	7	0	8	**17**
Filters, filter media and resins	0	6	6	0	65	**77**
Equipment and material	1	4	7	0	31	**43**
Sealed radiological sources	158	125	286	100	29	**698**
Biological materials	1	0	1	0	0	**2**
Other	8	60	29	2	58	**157**

Source: Manifest Information Management System records for 2001-2005.

[a]"Sealed Sources" and "Other" Includes one U.S. Army waste generator outside of the United States.

Figure 9: Number of Generators That Disposed of Class B and C Waste at Richland and Barnwell by Generator Type and Waste Type, 2001-2005



Source: GAO based on Manifest Information Management System records for 2001-2005.

Note: The amounts across the chart above do not add to 854 because some generators disposed of more than one type of waste.

Table 12 shows that the volume of class B and C waste ranges from year to year across the waste generator types. The average volume of class B and C waste between 2001 and 2005 was about 28,800 cubic feet.

Table 12: Range of Class B and C Waste Disposed Annually at Richland and Barnwell by Generator Type, 2001-2005

	Volume (in cubic feet)				Activity (in curies)			
Generator	**Average**	**Min**	**Max**	**Total**	**Average**	**Min**	**Max**	**Total**
Academic	113	51	263	**564**	139	10	337	**694**
Government	916	220	1,643	**4,581**	20,135	111	88,159	**100,673**
Industry	1,308	712	2,285	**6,542**	15,888	7,906	30,213	**79,442**
Medical	36	23	61	**178**	7	2	16	**33**
Utility	26,445	17,054	33,698	**132,225**	379,636	122,851	499,854	**1,898,182**
Total[a]	**28,818**	**18,060**	**37,950**	**144,090**	**415,805**	**130,880**	**618,579**	**2,079,024**

Source: Manifest Information Management System records for 2001-2005.

[a]Column percentages may not add up to 100 percent due to rounding.

Note: DOE recognizes that as the industry category includes brokers and processors that collect waste from other generator categories, the contribution of waste disposed by industry generators is overestimated; however, DOE has not done the analysis to determine the extent of this overestimation.

The next two tables provide a distribution of class B and C waste (both volume and activity) disposed at Richland and Barnwell from 2001 to 2005 by waste generator type. Table 13 shows that utilities contributed the about 92 percent of the volume and 91 percent of the activity of class B and C waste disposed at Richland and Barnwell from 2001 to 2005. Table 14 shows the distribution of class B and C waste across generator types excluding utility generators. In this table, industry disposed of about 55 percent of class B and C waste, which amounted to about 44 percent of the total activity. Government, on the other hand, contributed about 39 percent of the volume, but about 56 percent of the activity.

Table 13: Distribution of Class B and C Waste Disposed Annually at Richland and Barnwell by Generator Type, 2001-2005

	Percent of Volume (in cubic feet)			Percent of Activity (in curies)		
Generator	**Richland**	**Barnwell**	**Total**	**Richland**	**Barnwell**	**Total**
Academic	0.5	0.4	**0.4**	0.0	0.0	**0.0**
Government	18.8	3.0	**3.2**	1.1	4.9	**4.8**
Industry	37.7	4.2	**4.5**	96.4	2.9	**3.8**
Medical	0.1	0.1	**0.1**	0.0	0.0	**0.0**
Utility	42.9	92.2	**91.8**	2.5	92.2	**91.3**
Total[a]	**100**	**100**	**100**	**100**	**100**	**100**

Source: Manifest Information Management System records for 2001-2005.

[a]Column percentages may not add up to 100 percent due to rounding.

Note: DOE recognizes that as the industry category includes brokers and processors that collect waste from other generator categories, the contribution of waste disposed by industry generators is overestimated; however, DOE has not done the analysis to determine the extent of this overestimation.

Table 14: Distribution of Non-Utility Class B and C Waste Disposed Annually at Richland and Barnwell by Generator Type, 2001-2005

	Percent of Volume (in cubic feet)			Percent of Activity (in curies)		
Generator	**Richland**	**Barnwell**	**Total**	**Richland**	**Barnwell**	**Total**
Academic	0.8	5.1	**4.8**	0.0	0.4	**0.4**
Government	32.9	39.1	**38.6**	1.1	62.5	**55.7**
Industry	66.1	54.3	**55.1**	98.9	37.0	**43.9**
Medical	0.1	1.6	**1.5**	0.0	0.0	**0.0**
Total[a]	**100**	**100**	**100**	**100**	**100**	**100**

Source: Manifest Information Management System records for 2001-2005.

[a]Column percentages may not add up to 100 percent due to rounding.

Note: DOE recognizes that as the industry category includes brokers and processors that collect waste from other generator categories, the contribution of waste disposed by industry generators is overestimated; however, DOE has not done the analysis to determine the extent of this overestimation.

Table 15 shows the total volume and activity of class B and C waste, by compact, that was disposed of at both Richland and Barnwell from 2001 to 2005. The last two columns show the percent contribution that each compact made to total volume and activity of disposed class B and C waste at Richland and Barnwell from 2001 to 2005. If Barnwell closed to non-compact states and the current pattern of disposal remained the same,

waste generators in these states would accumulate over 100,000 cubic feet of class B and C waste over a 5-year period.

Table 15: Disposed Class B and C Waste at Richland and Barnwell by LLRW Compact, 2001-2005

	Richland		Barnwell		Total		Percent	
Compact	**Volume**	**Activity**	**Volume**	**Activity**	**Volume**	**Activity**	**Volume**	**Activity**
Appalachian	0	0	10,417	499,433	10,417	499,433	7.2	24.0
Atlantic	0	0	38,196	215,884	38,196	215,884	26.5	10.4
Central	0	0	4,306	13,286	4,306	13,286	3.0	0.6
Central Midwest	0	0	15,520	480,153	15,520	480,153	10.8	23.1
Midwest	0	0	6,235	74,168	6,235	74,168	4.3	3.6
Northwest	1,448	19,257	280	161	1,728	19,418	1.2	0.9
Rocky Mountain	69	1,402	5	0.1	74	1,402	0.1	0.1
Southeast	0	0	21,991	329,245	21,991	329,245	15.2	15.8
Southwestern	0	0	6,490	7,774	6,490	7,774	4.5	0.4
Texas	0	0	5,345	6,680	5,345	6,680	3.7	0.3
Unaffiliated	0	0	33,787	431,582	33,787	431,582	23.5	20.8
Total[b]	**1,517**	**20,659**	**142,572**	**2,058,366**	**144,089**	**2,079,025**	**100**	**100**

Source: Manifest Information Management System records for 2001-2005.

[a]Includes one U.S. Army waste generator outside of the United States that accounted for 16.34 cubic feet of waste that contained 27.4 curies of activity.

[b]Column percentages may not add up to 100 percent due to rounding.

Table 16 summarizes one way to show the affects of eliminating access to waste generators in 36 states that will not have disposal access for class B and C waste in 2008 because they are not affiliated with the Atlantic, Northwest or Rocky Mountain Compacts. Using the past 5 years of disposal data as an indicator, the closing of Barnwell to these generators would affect 73 percent of the disposed volume and about 90 percent of the disposed activity. Almost all of the remaining volume going to Barnwell would come from the Atlantic LLRW Compact.

Table 16: Class B and C Waste Disposed at Barnwell from Atlantic, Northwest, and Rocky Mountain Generators, and Other Generators, 2001-2005

	Barnwell		Percent of Barnwell	
Compact	**Volume**	**Activity**	**Volume**	**Activity**
Atlantic, Northwest, and Rocky Mountain	38,482	216,046	27.0	10.5
Other	104,091	1,842,320	73.0	89.5
Total	**142,573**	**2,058,366**	**100**	**100**

Source: Manifest Information Management System records for 2001-2005.

[a]Column percentages may not add up to 100 percent due to rounding.

Another way to illustrate the affects of eliminating access to the Barnwell disposal facility is the number of waste generators that would no longer have a place to dispose of their disused, sealed radiological sources and would thus have to store these sources on-site. Table 17 shows the compacts where these generators are located.

Table 17: Number of Waste Generators That Disposed of Sealed Radiological Sources at Richland and Barnwell Ranked by Compact, 2001-2005

Compact	Total generators	Percent of total	Impacted by Barnwell closure
Unaffiliated	138	20	138
Southeast	98	14	98
Southwestern	92	13	92
Appalachian	82	12	82
Midwest	82	12	82
Atlantic	70	10	
Texas	45	6	45
Central Midwest	43	6	43
Central	21	3	21
Northwest	17	2	0
Rocky Mountain	9	1	0
Total[a]	**697**	**100**	**601**

Source: Manifest Information Management System records for 2001-2005.

[a]Excludes one U.S. Army waste generator outside of the United States.

Appendix VI: Comments from the Nuclear Regulatory Commission and Our Response

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

See pages 38-40 for GAO's response to this letter.

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

February 21, 2007

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

Dear Mr. Aloise:

Thank you for the opportunity to review and submit comments on the January 2007 draft of the U.S. Government Accountability Office's (GAO's) report entitled "Low-Level Radioactive Waste Management: Approaches Used by Foreign Countries Would Provide Useful Lessons for Managing U.S. Radioactive Waste" (GAO-07-221). The U.S. Nuclear Regulatory Commission (NRC) appreciates the time and effort that you and your staff have taken to prepare this report.

In the report, GAO identifies a number of low-level radioactive waste (LLRW) management approaches used in other countries. The GAO recommends that the NRC and the U.S. Department of Energy (DOE) evaluate and report back to Congress within one year on the usefulness to the U.S. of adopting certain LLRW management approaches discussed in the report and the potential costs to develop a U.S. national radioactive waste management plan.

For the reasons discussed below and in the Enclosure, NRC believes a stand-alone study may not be the most effective means to evaluate the usefulness of adopting many of the LLRW management approaches discussed in the report. We believe it would be more effective to consider the LLRW management approaches through ongoing efforts being conducted in the U.S., such as NRC's assessment to identify needed improvements to the LLRW regulatory program, and through organizations with broad representation of U.S. stakeholders, such as the Interagency Steering Committee on Radiation Standards. The results of such efforts could be reported in our annual letter to Congress that addresses progress in completing actions in response to recommendations in multiple GAO reports.

It is important to note that systems for LLRW management in various countries have evolved differently than in the U.S., due to many factors such as culture and public sentiment, systems of government, public policy, and geography. Such differences have precluded adoption in the U.S. of some of the approaches used in other countries. It is important to consider these factors in comparing systems for LLRW management and assessing the transferability of best practices among countries.

As noted in the GAO report, NRC is currently conducting a strategic assessment of its LLRW program to ensure that NRC's regulatory framework will continue to ensure the safe management of LLRW. Many of the waste management practices noted by GAO are being evaluated in the strategic assessment. Further, NRC and other U.S. stakeholders have previously considered and evaluated several of the approaches discussed in the GAO draft report, and either determined that the approaches were not practical or not necessary to ensure safety and security of LLRW. The report could be better informed by acknowledging these past

and ongoing U.S. efforts to consider approaches used to manage LLRW in other countries, especially in cases where the approaches ultimately were not implemented.

Additional information on the above general comments and our detailed comments, along with those of the Chairman of the NRC's Advisory Committee on Nuclear Waste, are enclosed. If you have any questions on our comments or would like to discuss these issues further, please contact Ms. Melinda Malloy of my staff at (301) 415-1785.

Sincerely,

Luis A. Reyes
Executive Director
for Operations

Enclosure: Comments on Draft Report

See comment 1.

See comment 2.

See comment 3.

General Comments

NRC Staff

1. The U.S. Government Accountability Office (GAO) report states that the U.S. is lacking an integrated national radioactive waste management plan. However, GAO does not identify the national problem that it believes could be solved by the implementation of such a plan. The report did not acknowledge that, in large measure, the Low-Level Radioactive Waste Policy Amendments Act (LLRWPAA) was an attempt to formulate and encourage States to implement such a plan, nor did the report refer to efforts of various States in forming low-level radioactive waste (LLRW) compacts with the purpose of developing regional disposal facilities. It is considered by many that the LLRWPAA did not achieve its desired outcome. Legislative changes would likely be needed before the development of a national radioactive waste management plan could substantively improve the U.S. system. The U.S. Nuclear Regulatory Commission (NRC) notes that the costs to develop a U.S. radioactive waste management plan would be significant, and that the benefits of such a plan are unclear, particularly given the complex composition of the current U.S. system.

2. It is important to note that systems for LLRW management in various countries have evolved differently than in the U.S., due to many factors such as culture and public sentiment, systems of government, public policy, and geography. The U.S. system relies on a broad spectrum of private and public entities to manage radioactive wastes, while most European Union (EU) countries rely on national (government) disposal solutions. The U.S. program is highly complex, involving numerous governmental and commercial organizations that generate, process, dispose of LLRW, and regulate these activities, under different legislative authorities and a patchwork of laws that speak to the various forms and origins of radioactive waste. Within the EU, most national authorities have primacy over the LLRW management program, and there are no provisions to relinquish regulatory authority to the individual provinces in Europe. Developing a waste management plan for the U.S. would be much more difficult and complex, owing to the nature of the program, than for many countries that have programs with a limited number of organizations and waste generation rates. It is important to consider these factors in comparing systems for LLRW management and assessing the transferability of best practices among countries.

3. While most of the U.S. LLRW stakeholder group representatives interviewed by GAO for this study suggested the need to evaluate alternative ways to manage LLRW in the U.S., they did not cite the development of a national waste management plan as a means for accomplishing this. The GAO report states that, in the absence of a national radioactive waste management plan, interested parties in the U.S. lack a means to identify radioactive waste quantities and locations, forecast future storage and disposal needs, assess research and development opportunities, determine appropriate safety and security requirements, and prepare contingency plans. While the current U.S. radioactive waste management system is complex and diffuse, these issues are addressed in large part by the current system. For example, safety and security requirements are specified by Federal agencies and Agreement State authorities, while LLRW storage and disposal needs and research opportunities are forecasted by a combination of public and private sector entities. Contingency planning is performed by the respective groups that comprise the system according to their roles.

Enclosure

See comment 4.

See comment 5.

See comment 6.

See comment 7.

4. It is important to note that the national radioactive waste management plans for France, Germany, and Spain, which are cited as examples in the report, were formulated by either a national-level ministry or national waste management organization that does not exist in the U.S. system. The NRC agrees that in some instances, an integrated approach by Federal and State authorities is needed to make progress toward improvements in the U.S. system. However, NRC believes that groups such as the Interagency Steering Committee on Radiation Standards (ISCORS) constitute a more appropriate and efficient mechanism for achieving this coordination. Both State and Federal officials (including the U.S. Department of Energy (DOE)) participate in ISCORS.

5. Before finalizing the current report, it is suggested that the GAO contributors conduct a thorough examination of the wealth of information and data provided, analyzed and peer-reviewed in the international Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (the Joint Convention). The basis for lessons to the U.S. LLRW program would be more completely informed by reviewing the National Reports required by the Joint Convention. All but one of the 20 surveyed countries (Mexico is not a Contracting Party to the Joint Convention) were subject to detailed review of their LLRW management program, including inventories of waste stored and disposed. Furthermore, questions and comments were provided to all of the Contracting Parties on details of their waste management programs, after thorough review by all of the other Contracting Parties. There are now 44 Contracting Parties, including the U.S., the Peoples Republic of China, and Russia.

6. The NRC and DOE have mature, robust programs for international information exchange and are actively engaged in learning about successful radioactive waste management practices used in other countries as well as sharing best practices from the U.S. This learning and exchange occurs through mechanisms such as participation in the Joint Convention, in International Atomic Energy Agency (IAEA) meetings and the development of IAEA safety standards and guides, in the Nuclear Energy Agency (NEA) Radioactive Waste Management Committee, and via a number of other formal and informal interactions. In carrying out these activities, the U.S. is looked to as a world leader in safely managing radioactive waste and plays a leadership role in developing international regulatory practices. The NRC will continue its efforts to share best practices with its international and domestic counterparts and to incorporate those practices that can be implemented within the U.S. regulatory system.

7. The NRC is focused on the continuous improvement of its programs, including its LLRW regulatory program. As noted in the report, NRC is currently conducting a strategic assessment of its LLRW program to ensure that NRC's regulatory framework will continue to ensure the safe management of LLRW and will promote regulatory stability, reliability, and efficiency. Many of the waste management practices noted in the GAO report are being evaluated in the strategic assessment. Further, NRC has previously considered and commented on several of these practices. For example, in our response to GAO's 2004 report on LLRW disposal availability (GAO-04-604), we commented on the utility of a national LLRW tracking system and noted that the regulatory costs of implementing such a system are not balanced by the negligible benefits. Disposal capacity needs have been and will continue to be accurately forecasted absent a national radioactive waste inventory database through a combination of public and private sector efforts by DOE, waste generators, disposal site operators, and other industry groups. The NRC continues to believe that implementation of a national database is

not needed to ensure safe LLRW management and would impose an unnecessary burden on Agreement States, NRC, and U.S. licensees. NRC also believes that agency resources can best be used to continue efforts that have already been identified as needed improvements to the LLRW regulatory program.

See comment 8.

8. Because the U.S. is one of the countries considered in the survey process, it would be informative and instructive for the comparison tables throughout the report to include the U.S. in one of the columns. This would help provide a better insight into which countries may have approaches which could result in improvements to the U.S. program.

See comment 9.

9. The GAO report notes that other countries make extensive use of landfills for disposal of low-activity radioactive waste, and that several countries allow materials with small amounts of residual radioactivity to be exempted from regulatory control. The NRC currently has a case-by-case exemption process to allow for the alternate disposal of some low-activity radioactive waste in landfills or hazardous waste facilities. The NRC and the U.S. Environmental Protection Agency have explored options for a general exemption or clearance provision for low activity waste, but have faced significant opposition to these proposals. In the 1992 Energy Policy Act, Congress gave States the authority to regulate the disposal of LLRW exempted from regulation by NRC in response to State concerns regarding NRC plans at that time to exempt certain low activity materials. Then in 2002, NRC initiated a rulemaking to facilitate the disposition of certain solid materials with no, or very small amounts of, residual radioactivity resulting from licensed operations, but deferred action on this rulemaking in 2005. The reasons for deferring action were that NRC was faced with several high priority and complex tasks, that the current approach to review specific cases on an individual basis is fully protective of public health and safety, and that the immediate need for this rule had changed due to the shift in timing for reactor decommissioning.

See comment 10.

10. The NRC has financial assurance requirements for many aspects of LLRW management, including provisions that apply to many non-utility LLRW generators. The NRC continues to evaluate this very important aspect of regulation, and is currently pursuing a rulemaking associated with financial assurance for "legacy" decommissioning sites. As noted in the GAO report, a recent report from the Interagency Radiation Source Protection and Security Task Force, which was chaired by NRC, recommended an additional evaluation of financial assurance requirements associated with licensees that possess Category 1 and Category 2 radioactive sources.

See comment 11.

11. A careful examination of terminology is necessary to fully appreciate how different Nations employ terms such as "practices," "waste," "clearance," "background," and others. For example, the "Front End of the Nuclear Fuel Cycle" means different things in the international arena. For regulatory purposes, the front end of the U.S. nuclear fuel cycle is the uranium processing of ore, sometimes referred to as milling. For other countries the term would include conventional mining of uranium or thorium ore and the associated mine spoil, which is at radioactivity levels typical of mine spoils from other industrial resource development.

See comment 12.

12. There appears to be an interchangeable use of terms such as LLRW and orphaned sources. Although high-activity sources are generally LLRW, albeit greater than Class C (GTCC), not all LLRW forms are composed of disused sealed sources.

See comment 13.

13. Throughout the report the Radiation Source Protection and Security Task Force (Task Force) is referred to as the U.S. Nuclear Regulatory Commission (NRC) Task Force. This is misleading. The Task Force was chaired by NRC, as directed by the Energy Policy Act, but it was an interagency task force and should be referred to as such.

See comment 14.

14. The authors may need to view and evaluate the U.S. LLRW management program through integration of the functions and activities of Federal and State authorities and the private sector. In addition, the authors should recognize the safe management of LLRW in the U.S. over the past decades considering actual data for: (a) volume of waste disposed; (b) workers exposure records; (c) public exposure records; and (d) environmental impacts.

Comments from the Chairman, Advisory Committee on Nuclear Waste (ACNW)

Observation: The GAO report specifically addresses GTCC wastes (higher activity yet short-lived) and low activity wastes. GAO observed that much can be done to improve the management of these wastes. They examined how the Europeans manage these wastes and also sought advice from stakeholders in the regulated and regulator communities.

See comment 1.

1. The GAO report makes two recommendations for Congress to consider: (1) that the NRC Chairman and the U.S. Department of Energy (DOE) Secretary evaluate the usefulness of adopting European LLRW management practices described in their report; and (2) that the NRC Chairman and the DOE Secretary identify the steps, authorities, and potential costs associated with developing a (comprehensive) radioactive waste management plan. Note: The report is silent on the role of the U.S. Environmental Protection Agency (EPA) in setting generally applicable standards for radioactive waste management. While currently shared among several Federal agencies and State agencies through the Agreement States program, the U.S. does have a comprehensive radioactive waste management program. It is just not centralized in one agency and has developed over time.

See comment 2.

2. The GAO report would be strengthened by including the detailed information that is included in the ACNW's final report on LLRW regulation in the U.S. (NUREG-1853). Some of the issues that the GAO report addresses have been addressed in the ACNW's letter of August 16, 2006, that accompanied the NUREG-1853 report. The NUREG report and the ACNW letter may provide some additional insights to GAO and would be a useful foundation for any further discussions.

See comment 3.

3. The focus of the GAO report is primarily on the management of commercial LLRW at high concentration and low concentration ends of the LLRW classification system. One key difference is that the U.S. radioactive waste management system relies on a mix of private and government initiatives to manage radioactive wastes. Most European countries rely on national government disposal solutions.

See comment 4.

4. The GAO report makes reference to radioactive waste management practices focused on the Organization for Economic Cooperation and Development (OECD)/Nuclear Energy Agency (NEA) Member States. However, there is no detail for each country's programs. Such information is available in the OECD/NEA publication, "Radioactive Waste Management Programmes in OECD/NEA Member Countries," Issy-les-Moulineaux, NEA Radioactive Waste

Management Committee, 2005. It is a compendium report covering radioactive waste management practices in 20 OECD/NEA Member Countries.

See comment 5.

5. GAO makes reference to the need to exempt certain radioactive wastes from regulation. However, the GAO report does not acknowledge in their report past NRC experience with de minimis wastes and Below Regulatory Concern policy, on which Congress later pre-empted Commission action. This is discussed in NUREG-1853.

See comment 6.

6. The first GAO recommendation would be clearer if a new table to the report that correlates European and U.S. management practices used as the basis for the recommendation. It would be helpful if the GAO report recommended specific practices that should be considered for adoption in the U.S.

NRC provided 14 specific comments about our report accompanying its letter. Our response to each comment follows.

1. We acknowledge that our past reports have not found the lack of a national radioactive waste management plan as a limitation in the management of LLRW in the United Sates. Nevertheless, in the course of conducting our study, we found that most countries in our survey use national radioactive waste management plans to guide the management of these wastes. Our report discussed the LLRW Policy Act, but not to extent that we have in previous GAO reports, and we agree with NRC that the act has not achieved its desired outcome of establishing regional disposal facilities for LLRW. NRC's suggestion that legislative changes would likely be needed before the development of a national radioactive waste management plan could substantially improve the U.S. system is in line with our recommendation to evaluate the steps involved in developing such a plan. Finally, we considered NRC's concerns about the potential costs and unclear benefits of developing a national radioactive waste management plan and observe that an evaluation of these concerns would be better placed in the report we recommended that NRC and DOE prepare for the Congress.

2. We believe that the complexity of the U.S. LLRW management system should provide a further rationale for evaluating the usefulness of developing a national radioactive waste management plan that could integrate the various radioactive waste management programs that reside at the federal and state levels into a single source document.

3. While the LLRW stakeholder group representatives that we interviewed did not identify a need to develop a national radioactive waste management plan, we believe that their support for the need to evaluate alternative ways to manage LLRW in the United States is consistent with our recommendation to evaluate the usefulness of developing such a plan. We acknowledge that much of the information on radioactive waste management is already available from a variety of sources. We concluded on pages 37-38 of our report that a national radioactive waste management plan could help integrate these activities into a single source document.

4. We concur with NRC that in some instances an integrated approach by federal and state authorities is needed to make progress toward improvement in the U.S. system. In our view, one way to bring stakeholders together to discuss ways to improve radioactive waste management would be in the context of developing a national

radioactive waste management plan. NRC and DOE can decide the most appropriate means to evaluate the usefulness of developing such a plan and who should participate in the process.

5. As our report notes, we reviewed the national reports to the Joint Convention of the countries surveyed and other international reports addressing each country. For the most part, our survey was designed to collect information that was not available in these existing reports.

6. We commented in our report on the agencies' engagements in international information exchanges regarding radioactive waste management practices. We also observe that NRC and DOE encouraged us to collect information on the LLRW management approaches used in other countries, as this information was not readily available from other sources.

7. In our view, the LLRW management approaches identified in this report should help direct NRC's strategic assessment of its LLRW program. Moreover, NRC should include in its report to Congress the results of any previous and ongoing evaluations of the LLRW approaches that we cited in our report.

8. We provided the response of the United States to the survey in appendix III of our report.

9. We commented on NRC's evaluation of and decision on a rule to facilitate the disposition of certain solid materials with no, or very small amounts of residual radioactivity (very low-level radioactive waste) in appendix I of our report. We observe that NRC's current position on this issue contrasts with the management practices of most other countries and differs from the opinions we obtained from most LLRW stakeholder representatives.

10. We identified some of the current gaps in financial assurance requirements for those licensed to use radioactive materials in the United States in appendix I of our report. We also pointed out in our report that there is no national database on those licensees that move into bankruptcy and cannot afford to disposition their sealed radiological sources. Our report identified approaches used in some other countries to reduce the government cost to recover and disposition these disused sources.

11. Interpretation of terms is always an issue with questionnaires. We pretested the questionnaire in two other countries and with

international experts to identify problematic terms. We attempted to use terms that are generally understood internationally by referring to NEA and IAEA technical guidance, and reports from other countries.

12. We revised our report to clarify this point.

13. We revised our report to clarify this point.

14. The purpose of our report was to determine the extent to which other countries use LLRW management approaches in areas that GAO has identified as needing some improvement. We did not attempt to identify approaches other countries use to increase the safe use of radioactive materials.

The Chairman, Advisory Committee on Nuclear Waste, provided 6 specific comments about our report with the NRC letter. Our response to each comment follows.

1. While the totality of the various federal and state programs addressing LLRW management may be comprehensive when aggregated, we view this collection of programs as not representing a national radioactive waste management plan. We identified some potential benefits of such a plan on pages 37-38 of this report.

2. We referred to the Advisory Committee's 2006 letter in our report, but the final report of the advisory committee was not available when we sent the draft copy of our report to the NRC. We have added a reference to the final version of the advisory committee report in our report.

3. We point out that a third of the countries in our survey are not members of the European Union. Our survey found that most countries take a national perspective to the management of LLRW; however, those entities that are responsible for providing and operating LLRW disposal and storage facilities are not always government agencies. For example, the LLRW system in Japan relies primarily on nuclear utility companies, operating under stringent government regulation, to construct and operate radioactive waste treatment, storage, and disposal facilities.

4. We reviewed country reports, including those provided to NEA, IAEA, and the Joint Convention, as a check on and supplement to the information that we obtained directly from the 18 countries in our survey.

5. We did not recommend in our report that the United States needs to exempt certain radioactive wastes from regulation. Our report identifies LLRW management practices in other countries, and the level of support for these approaches among representatives from LLRW stakeholder groups and in some recent LLRW management reports. We commented on NRC's evaluation of a rule to exempt very level radioactive waste from regulation as LLRW in appendix I.

6. We provided the response of the United States to the survey in appendix III of our report.

Appendix VII: Comments from the Department of Energy and Our Response

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

Department of Energy
Washington, DC 20585

March 7, 2007

Mr. Gene Aloise
Director
Natural Resources and Environment Team
United States Government Accountability Office
Washington, D.C. 20548

Dear Mr. Aloise:

See pages 38-40 for GAO's response to this letter.

My office has reviewed the draft report entitled *Low-Level Radioactive Waste Management: Approaches Used by Foreign Countries Would Provide Useful Lessons for Managing U.S. Radioactive Waste* (GAO-07-221). This letter provides the Department of Energy's (DOE) consolidated comments on the report; it has been coordinated with the National Nuclear Security Administration.

The report provides information on other countries' experiences in radioactive waste management. It also provides observations on the United States (U.S.) low-level radioactive waste (LLRW) management programs and continuing efforts to manage disused radioactive sealed sources. The report summarizes previous Government Accountability Office studies on the U.S., and specifically DOE LLRW efforts, as well as recent efforts by the Federal Government to analyze and address programmatic vulnerabilities, such as the Interagency "Radiation Source Protection and Security Task Force Report." For these reasons, DOE regards this draft report as a useful comparison of the U.S. LLRW programs to comparable international programs. I am happy to note that the draft report does not identify any new programmatic vulnerabilities or challenges within our domestic LLRW programs.

We do not believe there are significant vulnerabilities in the DOE's LLW management programs or the commercial LLW program of which Congress has not yet been informed. Also, DOE is very aware of international waste management practices through our participation in numerous international forums, including International Atomic Energy Agency activities and the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. Due to the extent and quality of our programs, the U.S. is respected as a world leader in radioactive waste management. We will continue to actively monitor international policies and practices, as well as domestic commercial waste management programs.

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The draft report recommends that DOE and the Nuclear Regulatory Commission (NRC) evaluate and report to Congress within one year on the usefulness of adopting the LLRW approaches used in other countries and the steps and authorities necessary for their implementation. DOE accepts the recommendation for continued evaluation of these approaches, but does not agree that a report to Congress is necessary at this time.

The draft report also recommends DOE and NRC report on the potential cost to develop a national radioactive waste management plan containing strategies for the interim storage and disposal of all types of radioactive waste and the steps and authority necessary to develop such a plan. We are concerned with this recommendation, as it goes beyond the scope and focus of this LLRW-related study. Further, the survey on which the report findings are based only addressed LLRW streams, not transuranic and high-level waste streams. DOE strongly believes that the current U.S. statutory framework adequately defines the strategies for management of the nation's radioactive waste streams. It is correct that the regulatory authorities and responsibilities for the nation's various radioactive waste streams involve numerous agencies and entities. We acknowledge that a single document synthesizing these efforts would facilitate understanding of these complex programs. However, we are concerned that development of such a document would provide limited utility to the actual implementation of these strategies, yet would require diversion of significant resources from actual waste management efforts. We note that the U.S. Second National Report to the Joint Convention, which was developed in 2005, provides a summary of the existing national waste management strategies, issues and progress.

As we continue to evaluate the international approaches summarized in this draft report, we remain ready to brief Congress on the status of our radioactive waste management efforts if such a briefing is requested.

The enclosure provides our specific comments on the draft report. If you have any questions, please contact Mr. Frank Marcinowski, Deputy Assistant Secretary for Regulatory Compliance, at (202) 586-0370.

Sincerely,

James A. Rispoli
Assistant Secretary for
Environmental Management

Enclosure

Enclosure

Department of Energy Comments on Draft GAO Report (GAO-07-221)
Low-Level Radioactive Waste Management: Approaches Used by Foreign Countries Would Provide Useful Lessons for Managing U.S. Radioactive Waste

These specific comments are additions to those general reactions provided in the response memorandum from James Rispoli, Assistant Secretary for Environmental Management

See comment 1.

Title: The report concludes, without evidence, that foreign approaches would be useful to the United States (U.S.), as noted in the title of the document. This is inconsistent with the recommendation that the agencies evaluate and report on whether the approaches would be useful. We recommend the title be revised to "Approaches Used by Foreign Countries May Provide Useful Lessons for Managing U.S. Radioactive Waste."

See comment 2.

General: The report implies that just because nations have different waste management practices that these practices would be beneficial to the U.S. In fact, many of the approaches cited in this report, as well as other international practices, have been considered previously by the Department. The report does not acknowledge these previous – even recent – evaluations, nor the reasons why these approaches were not implemented.

See comment 3.

General: The report does not provide justification for the conclusion that a national waste management plan is needed for all waste types. The report also fails to recognize the existing legal framework that defines the nation's strategies for the various waste management streams. The report simply cites potential disposal shortage for higher-activity LLRW in 2008 and other items related to LLRW as evidence that a national strategy is needed. There is no basis for the extrapolation from commercial LLRW to all radioactive waste streams. Further, the scope of the review and survey was limited to LLRW.

See comment 4.

General: In one instance, the report acknowledges that a national management plan would provide improved information access to those interested in radioactive waste (page 40). This benefit differs significantly from the report conclusions that a national management plan is needed to define strategy for management of the wastes.

See comment. 5

General: The report would benefit from additional context on the U.S.'s nuclear programs relative to those of the international respondents. There is no attempt to identify or explain the differences between the U.S. and other nations. Most of the respondents have small nuclear programs. For example, the U.S. has 104 of the 435 nuclear power reactors cited on page 11, while the other 30 countries share 331. Some of the countries surveyed do not have nuclear power plants at all. Thousands of licensees

exist in the U.S. under dozens of regulatory agencies, most of which are state and not federal, e.g., all the commercial U.S. LLRW disposal facilities are licensed by states.

See comment 6.

General: The draft report does not take into account that the Low-Level Radioactive Waste Policy Act provides the national strategy for commercial LLW disposal. The authority and responsibility falls on the States and regional compacts. Development of a national LLRW management plan by a federal agency does not appear reasonable while implementation of the strategy is the responsibility of the states and regional compacts.

See comment 7.

General: Also, the report fails to explain that the disposition of commercial LLRW is provided within a market driven industry, consistent with existing laws. This market influence contributes to the way waste streams are managed, and it would be directly impacted by adoption of some of the recommended approaches. The report fails to acknowledge this or the fact that the market factors of the U.S. commercial LLRW program differ vastly from most of the international respondents.

See comment 8.

General: In several instances the report appears to incorrectly extrapolate conclusions that apply to disused sealed sources to all LLRW. There are instances where "higher-activity LLRW" appears to be equated with disused sealed sources, e.g., titles of sections versus text discussion on page 19. Further, it is imprecise to assume that all disused sealed sources are, by definition, managed as wastes. It is possible a disused source could be redeployed to beneficial reuse.

See comment 9.

General: The report references the recent Interagency "Radiation Source Protection and Security Task Force Report." In several cases, the findings and recommendation of that report are taken out of context. Also, this draft GAO report fails to explain that the Task Force Report was required by the Energy Policy Act of 2005 and has been provided to Congress for their review. It also fails to explain that subsequent Task Force Report updates are required by the Energy Policy Act of 2005, and that an interagency implementation plan has already been developed.

See comment 10.

General: The report discusses storage of LLRW in many instances, yet several important contextual facts are not provided. It should be noted that not all storage, even at generator sites, is unsafe. It should be noted that, commercial generators are responsible for storage of greater than class C wastes that cannot yet be disposed. Finally, the commercial market has provided for off-site storage at commercial facilities, for example Waste Control Specialists.

DOE provided 10 specific comments about our report in accompanying its draft letter. Our response to each comment follows.

1. We have revised the title of our report.

2. Our report discussed previous actions by the agencies to respond to our recommendations and to evaluate some of the LLRW management approaches that are similar to those identified as in use in other countries. This discussion is in appendix I of our report. In our view, the fact that some of these LLRW management approaches have already been evaluated by NRC and DOE does not lessen the need for their inclusion in a report to the Congress.

3. We revised the draft recommendation to more clearly reflect the need to evaluate and report on the usefulness of developing a national radioactive waste management plan and to conduct further analysis if deemed appropriate. Our views on the potential usefulness of such a plan are provided on pages 37-38 of this report.

4. We revised our second recommendation to clarify this point.

5. The purpose of our report was to identify the extent to which other countries use approaches to address four areas of U.S. LLRW management that we identified in previous reports as having some limitations. We did not recommend adopting any of the approaches identified as in use on other countries, only to evaluate and report to the Congress on their usefulness to improve management of this waste in the United States.

6. In our view, assigning responsibility for waste disposal in the LLRW Policy Act is not synonymous with establishing a national radioactive waste management plan. We revised our recommendation to clarify that NRC and DOE need to evaluate and report on the usefulness of developing such a plan. We did not suggest how the agencies should conduct this evaluation or which entities should participate in the evaluation process.

7. We did not attempt to provide a detailed discussion of how market forces operate in the United States in the disposition of commercial LLRW in our report. This level of discussion was not an objective of our report. Our previous reports have described the conditions surrounding the management of LLRW in the United States.

8. Our report associates disused sealed sources with higher-activity LLRW, as this is, for the most part, international practice. Our report further states that a holder of a disused source can return it to a supplier, place it in a recognized installation (central storage or disposal facility), or transfer it to another authorized holder when it is no longer wanted.

9. We cannot comment on this DOE observation, as the department provided no specific information to substantiate this claim. We believe that our characterization of the findings and recommendations of the task force report are accurate. Moreover, we referenced a previous 2005 GAO report that provides more information on the origin and purpose of the radiation source protection and security task force. Our intent in referring to the task force and other recent reports was to point out that these reports suggested and recommended approaches that were similar to what other countries indicated in our survey that they use.

10. We agree with DOE that not all storage of radioactive waste is unsafe. Our report referred to international experts that claim that the storage of disused sealed radiological sources at user sites poses a greater risk of being lost from regulatory control.

Appendix VIII: GAO Contact and Staff Acknowledgments

GAO Contact

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Staff Acknowledgments

In addition to the person named above, Daniel Feehan, Assistant Director, and Kevin Bray, John Delicath, Doreen Feldman, Bart Fischer, Peter Grana, Susan Iott, Erin Lanier, Thomas Laetz, and Amanda Miller made key contributions to this report.

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