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United States of America
Fifth National Report
for the
Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management

U.S. Department of Energy

In Cooperation with the
U.S. Nuclear Regulatory Commission
U.S. Environmental Protection Agency
U.S. Department of State

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ABSTRACT AND ACKNOWLEDGEMENT

The United States of America (U.S.) ratified the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (Joint Convention) on April 9, 2003. The Joint Convention establishes an international peer review process among Contracting Parties and provides incentives for nations to take appropriate steps to bring their nuclear activities into compliance with general safety standards and practices. The U.S. participated in Review Meetings of the Contracting Parties to the Joint Convention in November 2003, May 2006, 2009 and 2012, in Vienna, Austria. This Fifth Report, an update of the U.S. National Report prepared under the Joint Convention in September 2014, documents spent fuel and radioactive waste management safety in the U.S. under the terms of the Joint Convention. The U.S. Government prepared this report for review by the Contracting Parties.

The U.S. complies with the terms of the Joint Convention. An extensive U.S. legal and regulatory structure ensures the safety of spent fuel and radioactive waste management. The report describes radioactive waste management in the U.S. in both commercial and government sectors, and provides annexes with information on spent fuel and waste management facilities, inventories, and ongoing decommissioning projects. It also provides detailed information on spent fuel and radioactive waste management safety, as well as transboundary movements (imports/exports) and disused sealed sources, as required by the Joint Convention.

The U.S. Department of Energy acknowledges the support and cooperation of the U.S. Environmental Protection Agency, U.S. Nuclear Regulatory Commission, and U.S. Department of State in preparation of this report through the Joint Convention Interagency Executive Steering Committee and Working Group. The information in this report was extracted from publicly available information sources, including regulations and internet web sites of these agencies.

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A. INTRODUCTION

This Fifth United States of America (U.S.) National Report updates the Fourth Report published in October 2011, under the terms of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management[1] (Joint Convention). This report reflects developments in the U.S. through June 2014.

A.1 Purpose and Structure

This report satisfies the requirements of the Joint Convention for reporting on the status of safety at spent fuel and radioactive waste management facilities within the U.S.[2]

This Department of Energy (DOE) report was prepared by a working group composed of staff from DOE, the Department of State (DoS), Environmental Protection Agency (EPA), and Nuclear Regulatory Commission (NRC).

The report format and content follow guidelines as agreed by the Contracting Parties to the Joint Convention. Chapters and annexes (or appendices) in this report have the same titles as in these guidelines, facilitating review by other Contracting Parties. Table A-1 provides a cross-reference between the chapters in this report and the specific reporting provisions in the Joint Convention. Section A.4 and Chapter K provide a concise summary of important changes since the Fourth U.S. National Report.

Table A-1 Joint Convention Reporting Provisions

National Report Section	Joint Convention Section
A. Introduction	
B. Policies and Practices	Article 32, Paragraph 1
C. Scope of Application	Article 3
D. Inventories and Lists	Article 32, Paragraph 2
E. Legislative and Regulatory Systems	Article 18; Article 19; and Article 20
F. General Safety Provisions	Articles 21-26; Articles 4-9; Articles 11-16
G. Safety of Spent Fuel Management	Articles 4-10
H. Safety of Radioactive Waste Management	Articles 11-17
I. Transboundary Movement	Article 27
J. Disused Sealed Sources	Article 28
K. General Efforts to Improve Safety	Multiple Articles
L. Annexes	Multiple Articles

Information in this report is derived from publicly available information sources. See the internet web sites listed in Table A-2 for information that is more detailed. The internet references provided in this report were available to the public and accurate as of the publication date. These uniform resource locators (URLs) may change over time or may no longer be active.

[1] International Atomic Energy Agency, Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, INFCIRC/546, December 24, 1997.

[2] The U.S. ratified the Joint Convention on April 9, 2003.

Table A-2 Key Sources of Information Available on the Internet
Code of Federal Regulations
Access to all regulations: http://www.gpoaccess.gov/cfr/index.html
Energy, Title 10: (Includes DOE and NRC regulations): http://www.gpo.gov/fdsys/pkg/CFR-1999-title10-vol1/content-detail.html
Protection of the Environment, Title 40: http://www.gpo.gov/fdsys/pkg/CFR-2002-title40-vol1/content-detail.html
U.S. Department of Energy
Homepage: http://www.energy.gov
Office of Environment, Health, Safety and Security: http://energy.gov/ehss/environment-health-safety-security
Office of Environmental Management: http://energy.gov/em/office-environmental-management
Office of Nuclear Energy: http://www.energy.gov/ne/office-nuclear-energy
Office of Legacy Management: http://energy.gov/lm/office-legacy-management
Energy Information Administration: http://www.eia.doe.gov/fuelnuclear.html
National Nuclear Security Administration: http://www.nnsa.doe.gov
Orders and directives: http://www.directives.doe.gov
Waste Isolation Pilot Plant: http://www.wipp.energy.gov/wipprecovery/recovery.html
Off-Site Source Recovery Project: http://osrp.lanl.gov
U.S. Nuclear Regulatory Commission
Homepage: http://www.nrc.gov/
Regulations: http://www.nrc.gov/reading-rm/doc-collections/cfr/
Regulatory guides: http://www.nrc.gov/reading-rm/doc-collections/reg-guides/
Statutes and legislation: http://www.nrc.gov/about-nrc/governing-laws.html
Radioactive waste: http://www.nrc.gov/waste.html
Nuclear materials: http://www.nrc.gov/materials.html
Nuclear decommissioning (reactor and materials): http://www.nrc.gov/waste/decommissioning.html
Sealed sources and devices: http://www.nrc.gov/materials/miau/sealed-source.html
Spent fuel storage: http://www.nrc.gov/waste/spent-fuel-storage.html
NARM toolbox; http://nrc-stp.ornl.gov/narmtoolbox.html
High-level waste: http://www.nrc.gov/waste/high-level-waste.html
Export/import: http://www.nrc.gov/about-nrc/ip/export-import.html
Japan Nuclear Accident – Implementing Lessons Learned from Fukushima – Available from http://www.nrc.gov/reactors/operating/ops-experience/japan-info.html.
U.S. Environmental Protection Agency
Homepage: http://www.epa.gov/
Laws: http://www.epa.gov/lawsregs/laws/T
Regulations: http://www2.epa.gov/laws-regulations/regulations
Office of Air and Radiation: http://www.epa.gov/oar
Office of Resource Conservation and Recovery: http://www2.epa.gov/aboutepa/about-office-solid-waste-and-emergency-response-oswer%23orcr#orcr

Table A-2 Key Sources of Information Available on the Internet
Radiation Program: http://www.epa.gov/radiation/
Waste Isolation Pilot Plant oversight: http://www.epa.gov/radiation/wipp/index.html
Environmental monitoring related to Fukushima accident: http://www.epa.gov/japan2011/
Other
U.S. Department of State, Bureau of International Security and Nonproliferation (ISN): http://www.state.gov/t/isn
U.S. Defense Nuclear Facilities Safety Board: http://www.dnfsb.gov/
National Academies: http://www.nationalacademies.org/
National Council on Radiation Protection and Measurements: http://www.ncrponline.org/
U.S. Nuclear Waste Technical Review Board (NWTRB): http://www.nwtrb.gov/
Conference of Radiation Control Program Directors, Inc.: http://www.crcpd.org/
U.S. Customs and Border Protection: http://www.cbp.gov/
U.S. Customs and Border Protection - Radiation Portal Monitor System: http://www.cbp.gov/xp/cgov/border_security/port_activities/cargo_exam/rad_portal1.xml
U.S. Customs and Border Protection - International Initiatives: http://www.cbp.gov/border-security/international-initiatives
U.S. Department of Homeland Security: http://www.dhs.gov/
U.S. Public Health Service: http://www.usphs.gov/
U.S. Army Corps of Engineers Formerly Utilized Sites Remedial Action Program: http://www.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/219/Article/816/formerly-utilized-sites-remedial-action-program.aspx 20TU
Organization of Agreement States: http://agreementstates.org/
Interagency Steering Committee on Radiation Standards (ISCORS): http://www.iscors.org/
Radiation Source Protection and Security Task Force Report: http://www.nrc.gov/security/byproduct/task-force.html
Blue Ribbon Commission on America's Nuclear Future: http://www.brc.gov/
Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste: http://energy.gov/downloads/strategy-management-and-disposal-used-nuclear-fuel-and-high-level-radioactive-waste

A.2 Summary Results from the Previous Review of the U.S. Program

The Guidelines Regarding the Form and Structure of a National Report requires National Reports to contain conclusions from the discussion of the Contracting Party's National Report at the previous Review Meeting. This Fifth U.S. National Report reflects the discussions and conclusions from the Fourth Review Meeting as well as the questions and comments from the other Contracting Parties.

Many of the questions on the previous U.S. National Report were focused on the Blue Ribbon Commission on America's Nuclear Energy Future (BRC), Yucca Mountain litigation, clearance standards, Fukushima-related considerations, regulatory interfaces, and Greater-than-Class C low-level waste (GTCC LLW) disposal. The following topics were raised:

- U.S. options for spent fuel management

- Post Fukushima accident activities in the U.S.
- U.S. activities for disused sealed source management
- Web-based licensing (WBL)
- Continued Storage of Spent Nuclear Fuel decision
- Foreign research reactor spent fuel acceptance program

The good practices recognized included: a very comprehensive response to Fukushima, both within the U.S. and assisting Japan; the U.S. education and training initiatives, such as the Nuclear University Education Program and NRC Nuclear Safety Professional Development Program; and the Global Threat Reduction Initiative (GTRI) activities.

Planned measures to improve safety identified in the Fourth U.S. National Report were recognized in the Review Session. These included: disposal of GTCC LLW and commercial disposal of higher activity disused sealed sources, DOE waste treatment facilities, NRC rulemaking activities, establishing and maintaining international collaboration, waste disposition for commercial medical isotope production, and regulation of residual contamination at military sites. See Section A.4 for progress on these measures. In addition, a number of challenges were identified at the Fourth Review Meeting. See Sections A.4.1.3, A.4.2.2 and A.4.2.3.

A.3 Generic Issues Identified in the Fourth Review Meeting Summary Report

The following four issues were identified for all Contracting Parties to address in their Fifth National Report:

- Management of disused sealed sources;
- Safety implications of very long storage periods and delayed disposal of spent fuel and radioactive waste;
- International cooperation in finding solutions for the long term management and disposal of different types of radioactive waste and/or spent fuel; and
- Progress on lessons learned from the Fukushima accident, in particular regarding strategies for spent fuel management.

A.3.1 Management of Disused Sealed Sources

The U.S. has a mature, integrated and well-established regulatory framework for disused sealed source management. Section J of this report provides an overview of safety- and security-driven programs to prevent illegal trafficking in and entry of such sources domestically and internationally. See http://www.nrc.gov/security/byproduct/ismp.html for additional information on U.S. progress to improving safety management of disused sealed sources.

A.3.2 Safety Implications of Very Long Storage Periods and Delayed Disposal of Spent Fuel and Radioactive Waste

Most commercial spent fuel in the U.S. is currently stored at the nuclear power plant (NPP) site where it was produced. In the absence of an available geologic repository for disposal, spent fuel will continue to be stored either in spent fuel pools (SFP) or in dry cask systems, in facilities licensed by NRC. Spent fuel management practices in the

U.S. are described in Section B.3 of this report. NRC's regulatory framework provides information on the storage of spent fuel for long periods and NRC licensees are responsible for maintaining the continued safe storage of spent fuel during the period of the license.

Licenses for storage of commercial spent fuel are issued by NRC for periods of up to 40 years, and can be renewed for additional terms, under regulations in 10 CFR Part 72. NRC review of applications for storage license renewal includes consideration of time-limited aging management analyses to address potential material degradation processes that could affect performance of the storage system.[3] NRC is currently examining a range of potential technical areas related to the safety implications of extended storage and subsequent transportation of spent fuel, to help inform its reviews of license renewal, and for potential revision of its regulatory framework for storage.[4] See Section B.3.3 for additional information.

In addition, DOE is conducting research and development (R&D) activities related to the safety implications of extended storage, transport, and disposal of spent fuel and high-level waste (HLW). See Section A.4.1.4.

A.3.3 International Cooperation in Finding Solutions for the Long term Management and Disposal of Different Types of Radioactive Waste and/or Spent Fuel

DOE is exploring international commercial fuel management concepts by encouraging collaboration between governments and industry to develop commercially attractive fuel services options, including regional and multinational disposition. DOE is pursuing these concepts through the International Framework for Nuclear Energy Cooperation (IFNEC).[5]

DOE supported the U.S. proposal to continue discussions on comprehensive approaches to the back-end of the fuel cycle at the 2012 Fourth Review Meeting of the Joint Convention, and participated in the 2013 Joint Convention Topical Meeting on Approaches to Back End Fuel Services. See http://energy.gov/ne/international-nuclear-energy-policy-and-cooperation/international-fuel-services-and-commercial for more information. See Section K.5 for additional information on international collaboration.

Although not strictly related to long-term solutions for the management of spent fuel, the U.S. was significantly involved in the assistance to Japan early in the response to the Fukushima accident; moreover, the international community, as a whole, began to heighten its focus on its own nuclear safety domestically. Industry and government alike have made substantial progress in implementing appropriate safety enhancements and have benefitted from international collaboration in areas accomplishing these tasks. Additional information is provided in the following section.

[3] NRC guidance for storage license renewal is in NUREG-1927, *Standard Review Plan for Renewal of Spent Fuel Dry Cask Storage System Licenses and Certificates of Compliance* (2011).
[4] Potential technical areas are described in the NRC Report, *Identification and Prioritization of the Technical Information Needs Affecting Potential Regulation of Extended Storage and Transportation of Spent Nuclear Fuel* (2014) [available from NRC ADAMS, ML14043A423].
[5] For more information on IFNEC, see Section K.5 and www.ifnec.org.

A.3.4 Progress on Implementing Lessons Learned from the Fukushima Accident

The U.S. government has taken significant actions to enhance the safety of nuclear reactors in the U.S. based on the lessons learned from the March 2011 Fukushima accident. NRC has created a webpage to serve as a navigation hub to follow NRC's progress in implementing the many different lessons-learned activities. The site is available at http://www.nrc.gov/reactors/operating/ops-experience/japan-dashboard.html. Specific implementation progress, for each nuclear power reactor, is accessible at http://www.nrc.gov/reactors/operating/ops-experience/japan-dashboard/japan-plants.html.

Information on the near-term analysis of the accident, in the context of U.S. facilities, was reported in the Fourth U.S. National Report available from the International Atomic Energy Agency's (IAEA's) public website.

Much of the information relates to NPP safety, but with particular emphasis regarding strategies for spent fuel management, NRC issued an Order on March 12, 2012, requiring all U.S. NPPs to install water level instrumentation in their SFP. The instrumentation must remotely report at least three distinct water levels: 1) normal level; 2) low level but still enough to shield workers above the pools from radiation; and 3) a level near the top of the spent fuel rods where more water should be added without delay.

NRC is also evaluating the applicability of lessons-learned from the Fukushima event to non-operating reactor and non-reactor facilities. As this evaluation proceeds, these lessons will be reflected in such areas as emergency preparedness and response for other types of regulated facilities, where appropriate.

EPA's current activities in emergency preparedness and response and environmental monitoring include update of the 1992 Protective Action Guides (PAGs) Manual for response to a radiological incident or accident. The new 2013 Interim final PAGs Manual[6] supersedes the 1992 PAG Manual. Based on the experiences at Fukushima and within the U.S., the new edition of EPA's PAG includes several updates. The 1992 PAG Manual was primarily used for response to NPP accidents. The new PAG Manual covers any form of incident or accident related either to NPP, Radiological Dispersal Devices (RDD's), Improvised Nuclear Devices (IND) or any other incidents or accidents that involve radiological or nuclear materials. U.S. emergency planners divide a radiological incident into three phases: early phase, intermediate phase and late phase[7]. EPA usually manages the intermediate and late phases, with support by other Federal agencies during the late phase. The planning process for cleanup and waste management is presented as a new chapter in the new PAG Manual. The late phase chapter provides recommendations and guidelines for planning and removal of radioactive waste as well as recommendations on waste management responsibilities for local, state, and Federal agencies.

[6] 2013 PAG Manual: http://www.epa.gov/radiation/rert/pags.html.
[7] 2013 Federal Emergency Management Agency (FEMA) Radiological Emergency Preparedness Program Manual: http://www.fema.gov/technological-hazards-division/radiological-emergency-preparedness-program.

DOE's current activities in emergency response addresses two time periods of response. Early and intermediate phase response to a radiological incident or accident, is coordinated by DOE's National Nuclear Security Administration (DOE/NNSA), which leads the Federal Radiological Monitoring and Assessment Center (FRMAC) with participation from other Federal agencies. FRMAC also coordinates and manages all Federal radiological environmental monitoring and assessment activities during a nuclear or radiological incident within the U.S. in support of State, local, and Tribal governments. DOE's intermediate and late phase response activities support EPA, which assumes lead agency responsibility as the response progresses. DOE provides support and recommendations to EPA during its planning and execution efforts for cleanup and radioactive waste management, by providing Operational Guidelines. Operational Guidelines[8] are pre-derived levels of radiation that trigger certain activities or responses. These can be compared to field radiation measurements to quickly determine if EPA PAG values are exceeded and actions for protection of the public need to be implemented (i.e., cleanup and utilization of roads and bridges, use of mass transit, hospitals, release of property from radiological controlled areas, and cleanup of real and personal property). DOE's Operational Guidelines serve as a decision tool to help EPA, as well as state and local officials, determine which facilities and infrastructures may be used without immediate cleanup and where cleanup efforts are needed to reduce public dose. They also provide recommended radiological exposure limits for cleanup workers. See Sections F.5.3 and H.4.

A.4 What is New Since Last Report

The following sections summarize progress made in several important areas since the previous report.

A.4.1 Spent Fuel and HLW Disposition

A.4.1.1 Continued Storage of Spent Nuclear Fuel

In 1984, NRC made a generic determination, referred to as the Waste Confidence Rule (10 CFR 51.23), that, if necessary, spent fuel generated in any reactor can be stored safely and without significant environmental impacts for at least 30 years beyond the licensed life for operation of that reactor. NRC updated the generic determination in 1990 and in 2010. On June 8, 2012, the U.S. Court of Appeals for the District of Columbia found that some aspects of the 2010 update did not satisfy NRC's obligations under the National Environmental Policy Act (NEPA) and vacated the Rule.

On September 13, 2013, NRC proposed revising its generic determination on the environmental impacts of the continued storage of spent nuclear fuel (78 FR 56776). NRC has prepared a draft generic Environmental Impact Statement (EIS) to support this rulemaking. The public comment period closed on December 20, 2013 and August 26, 2014, following consideration of the public comments, NRC approved publication of the final rule. NRC anticipates publishing a final rule and final generic EIS on September 19, 2014. This rule is now referred to as "Continued Storage of Spent Nuclear Fuel." These activities are described in Section B.3.3 of this report.

[8] Preliminary Report on Operational Guidelines Developed for Use in Emergency Preparedness and Response to a Radiological Dispersal Device Incident, 2009. http://ogcms.energy.gov/register.cfm.

A.4.1.2 Review of Yucca Mountain License Application

In August 2013, the U.S. Court of Appeals for the District of Columbia Circuit ordered NRC to continue with the legally mandated licensing process for DOE's Yucca Mountain construction authorization application, until Congress authoritatively says otherwise or there are no appropriated funds remaining. After the Court's decision, in November 2013, NRC decided to complete the Safety Evaluation Report (SER) for the application. NRC is currently proceeding with its safety review of the application and preparing the necessary SER. NRC's adjudicatory proceeding for the Yucca Mountain application remains suspended. See Section B.3.2.2 for additional information.

A.4.1.3 Spent Fuel Management Strategy

The BRC on America's Nuclear Future issued a comprehensive review of policies for managing the back end of the nuclear fuel cycle in January 2012.[9] It provided "…comprehensive recommendations for creating a safe, long term solution for managing and disposing of the nation's spent nuclear fuel and high-level radioactive waste." The conclusions in the final report and subsequent activities were reported during the Fourth Review Meeting of the Parties of the Joint Convention (May 2012).

In January 2013, the Administration's *Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste*[10] was published. It serves as a statement of Administration policy regarding the importance of addressing the disposition of spent fuel and HLW; lays out the overall design of a system to address the issue; outlines the reforms needed to implement such a system; and represents the Administration's response to the BRC recommendations. In conjunction with the development of the Administration's Strategy, DOE will lay the groundwork for implementing the interim storage aspects of the Strategy (including associated transportation), identify alternatives and conduct scientific research and technology development on storage and disposal of spent fuel and wastes generated by existing and future nuclear fuel cycles, and develop a foundation for a new nuclear waste management organization. See Section B.3.2.1 for additional information.

A.4.1.4 DOE Research and Development Activities for Spent Fuel and HLW

The objectives of the U.S. Research and Development (R&D) Program are to develop and initiate activities for an integrated management plan to implement interim storage, improve the overall integration of storage as a planned part of the waste management system, and develop foundational information, resources, and capabilities needed to support future disposal implementation decisions and actions. In support of the Administration's Strategy, DOE is performing R&D that will address critical scientific and technical issues associated with the long-term management of spent fuel, including storage, transportation and disposal.

The principal focus of DOE's R&D activities is to develop a suite of options that will enable future decision makers to make informed choices about how best to manage the spent fuel from reactors. An additional objective is the demonstration of technologies

[9] See www.brc.gov.

[10] *Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste*. January 2013. http://energy.gov/downloads/strategy-management-and-disposal-used-nuclear-fuel-and-high-level-radioactive-waste.

necessary to allow commercial deployment of solutions for the sustainable management of spent fuel that is safe, economic, and secure.

A sound technical basis for evaluating multiple viable disposal options will increase confidence in the robustness of generic disposal concepts and develop the science and engineering tools needed to support disposal concept implementation. Additionally, science-based information is needed to support extended storage and eventual large-scale transport of spent fuel and HLW for future disposal. R&D activities will examine topics to identify those technical gaps related to extended storage of spent fuel. Significant testing, modeling, and demonstration activities will be conducted to enhance the technical basis for safe storage and disposal of spent fuel, particularly as spent fuel discharge burn-up is increased and as storage times extend beyond what was originally intended. Collaboration with the private sector and other organizations is important to develop and implement concepts that ensure safe, secure, and timely storage and disposal of spent fuel and HLW.

Other R&D focuses on identifying multiple viable geologic disposal options, addressing technical challenges for generic disposal concepts in various host media (e.g., mined repositories in salt, clay/shale, and granitic rocks, and deep borehole disposal in crystalline rock). R&D will transition to site-specific challenges as national policy advances. R&D goals at this stage are to reduce generic sources of uncertainty that may impact the viability of disposal concepts, to increase confidence in the robustness of generic disposal concepts, and to develop the science and engineering tools needed to select, characterize, and ultimately license a repository.

DOE is actively involved in international and bilateral R&D activities, in order to provide the U.S. with an understanding of the fuel cycle activities of other countries. This involvement allows the participants to leverage their expertise and gain cost benefits in conducting technical assessments for different geologic media and waste forms. The U.S. will also collaborate with other countries to conduct joint experiments or data exchanges associated with underground research laboratories (URLs). Active collaboration with international programs, initiatives, or projects is beneficial to the U.S. disposal research program, providing access to decades of experience gained in various disposal environments. See Section K.5.

As part of this international coordination, the Extended Storage Collaboration Program (ESCP) is a consortium of organizations coordinated by the Electric Power Research Institute (EPRI) to investigate aging effects and mitigation options for the extended storage of spent fuel, followed by transportation. In December 2013, EPRI convened a workshop of over 40 representatives of the nuclear industry, Federal government, regulatory agencies, national laboratories, and suppliers and international organizations associated with spent fuel dry storage systems. The topic of discussion was potential safety issues associated with extended dry storage of spent fuel, i.e., storage for periods that involve multiple renewals for term periods in current NRC regulations.

ESCP meets two times a year and serves as the fulcrum point to: review and develop consensus on specific data gaps that need to be addressed; present the work of individual organizations that have common interest to the group; and discuss future needs. The Office of Nuclear Energy within DOE is active in this program, and uses it as an effective way to collaborate with both industry and the regulator to enhance the technical basis for extended storage and subsequent transportation of spent fuel.

A.4.1.5 Processing of DOE's Aluminum-Clad Spent Fuel Inventory

In March 2013, DOE made a decision to process a limited quantity of its aluminum-clad spent fuel inventory at the Savannah River Site (SRS) in South Carolina. This processing campaign is scheduled to begin in 2014.

A.4.2 Commercial LLW Disposal

Since the Fourth Review meeting, a significant past challenge for commercial low-level waste (LLW) disposal in the U.S. has been resolved through the opening of the Texas Compact disposal facility, establishment of the Texas Compact Commission, and adoption of Compact rules and fees (See Section H.1.1 for additional information on compacts). As a result of these activities, all U.S. LLW generators now have access to disposal for Class A, B, and C LLW. Disposal of LLW, however, is subject to the waste acceptance criteria for the individual disposal facilities, which currently exclude the disposal of certain radioactive materials. Requests for LLW disposal from generators outside Texas and Vermont are handled via "import rules" under the Texas Compact, which are part of the Texas Administrative Code.[11]

Notwithstanding new disposal capacity, some disposal challenges remain because of high disposal cost and limitations in waste acceptance criteria. The following are some issues government, industry, and others are addressing:

A.4.2.1 Concentration Averaging

NRC regulations in 10 CFR Part 61 provide requirements for land disposal of radioactive waste. One approach used to comply with Part 61 is concentration averaging. The regulation states that the concentrations of radionuclides that are used to determine the waste classification may be averaged over the volume or weight of the waste. The term "concentration averaging" is averaging of the radionuclide activities in waste over its volume or over its mass.

In addition to using mathematical averaging, licensees may physically mix some types of LLW. This type of physical mixing is referred to as "blending". For example, licensees may mix higher activity LLW (Class B and C concentrations) with lower activity waste (Class A) to form a Class A mixture, meeting waste acceptance criteria of a commercial facility accepting Class A waste. The approach mainly involves mixing ion exchange resins that have different radionuclide concentrations at a commercial LLW processing facility.

In October 2010, NRC adopted a new risk-informed and performance-based position on LLW blending. In part, because of potential increased average concentration of Class A and B waste as a result of blending, NRC has commenced a rulemaking (revision of 10 CFR Part 61) to require disposal facilities to conduct a site-specific performance assessment for disposal of LLW, including wastes blended at an offsite processing facility. In addition, NRC is in the process of revising its guidance related to LLW concentration averaging, particularly regarding the required homogeneity for blended mixtures.

[11] For additional information see: http://www.tllrwdcc.org/imports/.

A.4.2.2 Depleted Uranium Disposal

Depleted uranium (DU) is a source material as defined by the Atomic Energy Act of 1954 (AEA), as amended, and, if treated as a waste, would meet the definition of LLW.

One of NRC's responsibilities is to ensure safe disposal of commercially generated LLW. When NRC regulations (10 CFR Part 61) on LLW disposal were developed, there were no commercial facilities generating significant quantities of DU waste. Consequently, the impacts of disposal of large amounts of DU were not considered in the development of Part 61. As a result, DU is considered to be Class A LLW. NRC issued licenses for four commercial uranium enrichment facilities (in 2007, 2010, 2011 and 2012). These facilities could generate quantities of DU significantly larger than considered during the development of 10 CFR Part 61. In addition, DOE has a significant DU inventory and may consider disposal at commercial facilities. NRC is in the process of amending its regulations to require a site-specific analysis for disposing of waste streams not considered in the development of Part 61, including DU. The rulemaking is expected to be completed in 2016.

Since the Fourth Review meeting, DOE announced it will engage in negotiations with Global Laser Enrichment (GLE) for the sale of certain DU hexafluoride inventories. GLE proposed licensing, constructing, and operating a new laser enrichment facility that could potentially provide compensation to DOE for its DU hexafluoride inventories, as well as supporting U.S. policy interests. In addition, DOE also announced it will enter into negotiations with AREVA for the sale of certain off-specification uranium hexafluoride inventories. The AREVA proposal is to utilize its nuclear fuel fabrication facility in Richland, Washington, to process the off-specification uranium hexafluoride as blend stock for domestic nuclear reactor fuel. The proposed opportunities will create value for the U.S. government while lowering overall program costs for surveillance and maintenance and/or disposal of uranium materials.

A.4.2.3 New Disposal Capacity

As reported at the Fourth Review Meeting of the Parties, Waste Control Specialists (WCS), a commercial LLW disposal facility, located near Andrews, Texas, began operations of a near surface commercial LLW disposal facility in 2012, the first new commercial LLW disposal facility in the U.S. for many decades. The site is privately owned and regulated by the State of Texas. The member states of the Texas Compact Commission are Texas and Vermont. The Compact Waste Facility is also available for the 34 U.S. states that do not have access to other LLW compact disposal facilities. Out-of-compact generators must submit an import petition to the Texas Compact Commission for approval prior to shipping. Currently, the State of Texas also limits total non-compact waste disposed at the facility to thirty percent of the facility's licensed capacity of 65400 cubic meters (2.3 million cubic feet) and 1.44 E 17 Bq (3.9 million curies) of disposal space. It is projected that 6000 disused sealed sources from small generators will be disposed of through this effort.

On June 6, 2013, WCS completed commissioning and opened a separate new Federal Waste Disposal Facility (FWF) which will accept LLW for which the Federal Government is responsible under Sections 3(b)(1)(A)-(C) of the Low-Level Radioactive Waste Policy Amendments Act of 1985 (LLRWPAA). Although construction will continue in phases through the licensing period, FWF has a licensed capacity to reach 736000 cubic meters

(26 million cubic feet) and 2.1 E 17 Bq (5.6 million curies) total. It is licensed by the State of Texas for 15 years with provision of 10-year renewals. All hazardous and radioactive waste is encapsulated in a robust liner and cover system, featuring a seven-foot thick liner system, which includes a one-foot thick layer of reinforced concrete and a Resource Conservation and Recovery Act (RCRA) compliant geosynthetic layer.

A.4.3 Nuclear Material Return to the U.S. and Russia

DOE/NNSA works in partnership with the IAEA, the Russian Federation, and other nations to remove and protect vulnerable nuclear material located at civilian sites worldwide. Accomplishments as of December 2013 include:

- Removed and/or dispositioned more than 5060 kilograms of HEU and plutonium – enough material to produce 200 nuclear weapons.
- Secured more than 10 metric tons (MT) of HEU and 3 MT of weapons-grade plutonium from Kazakhstan's BN-350 reactor and transferred the material to long-term storage.
- Removed all HEU material from 27 countries/locations: Austria, Brazil, Bulgaria, Chile, Colombia, Czech Republic, Denmark, Georgia, Greece, Hungary, Iraq, Latvia, Libya, Mexico, Philippines, Portugal, Romania, Serbia, Slovenia, South Korea, Spain, Sweden, Taiwan, Thailand, Turkey, Ukraine, and Vietnam.

A.4.4 Sealed Source Recovery

Since September 2012, DOE/NNSA GTRI Off-Site Source Recovery Project (OSRP) has recovered over 5100 sources consisting of over 2.98E+15 Bq of radioactive material that represented threats to national security and/or public health and safety. In total OSRP has recovered over 36000 sources consisting of over 3.4E+16 Bq since inception in 1997. OSRP anticipates its activity total exceeding 3.70E+16 Bq by the end of September 2014.

GTRI also obtained a shipping container (Type B) to support the recovery of higher activity sources because of the limited availability of these shipping containers. Since the beginning of September 2012, 19 recovery/disposal shipments have been made with 30 additional shipments scheduled by October 2014. Also, the Conference of Radiation Control Program Directors' (CRCPD) Source Collection and Threat Reduction (SCATR) program organized a nation-wide program to recover Class A, B, and C sealed source waste using Energy*Solutions* Utah facility's one year license variance for Class A sealed sources as well as WCS allowance of out of compact waste. SCATR is offering a fifty percent cost-share with the licensees participating in the program as an incentive. The Energy*Solutions* Utah one year waste acceptance period started on September 30, 2013, with a drum arriving from a SCATR contracted broker containing over 20000 sealed sources that were Class A LLW. The acceptance period ends September 29, 2014. Several other drums containing hundreds of sources that are Class B and C LLW have been disposed of at WCS as well.

A.4.5 Waste Isolation Pilot Plant

DOE operates the Waste Isolation Pilot Plant (WIPP), a geologic repository in bedded salt, authorized for the disposal of transuranic (TRU) waste generated by atomic energy defense activities ("defense-generated" TRU waste). WIPP is the cornerstone of DOE's

cleanup effort as the nation's first repository for permanent disposal of defense-generated TRU radioactive waste left from research and production of nuclear weapons. WIPP now has over 15 years of operations, and as of February 2014, DOE has disposed of over 90900 cubic meters (m^3) of defense-generated TRU waste and received over 11800 shipments. By statute, DOE must apply every five years to EPA for recertification of the facility. In 2010, WIPP was recertified by EPA, and its hazardous waste facility permit (HWFP) was renewed by the State of New Mexico. The third recertification application was submitted to EPA in March 2014.

Two events occurred in February 2014 temporarily impacting the ability to dispose of TRU wastes at WIPP. A fire occurred in the underground on February 5, 2014 when an underground vehicle used to transport salt caught fire. All personnel safely evacuated. All disposal operations at WIPP ceased at the time of the fire and the timing for the resumption of operations is unknown at this time. An investigation team was deployed to determine the cause of the fire and released their findings on March 13, 2014. The report is available at http://energy.gov/em/downloads/accident-investigation-report.

A second incident occurred on February 14, 2014, when a continuous air monitor detected a radiological release underground. High efficiency particle air (HEPA) filters onsite immediately engaged and minimized releases to the environment. Concentrations during the incident and its aftermath remain well below a level of public or environmental hazard; sampling confirmed these findings. Some workers on site February 14 and February 15 were exposed to extremely low levels of americium and plutonium.

The fire accident investigation team was supplemented with additional experts to investigate the radiological incident. Part I of the report was released on April 24, 2014, and is available at http://www.wipp.energy.gov/pr/2014/Radiological_Event_Report.pdf. Part II of the report, which addresses the cause of the radiological incident, will be released after the accident investigation team completes its assessment.

WIPP is actively implementing procedures and training to enhance emergency management practices and aid in the protection of workers and the public from any potential events in the future. Additional information will be provided in the U.S. presentation during the Fifth Review Meeting of the Parties.

A.4.6 Waste Disposition for Commercial Medical Isotope Production

DOE is working to accelerate the establishment of reliable commercial production of the medical isotope molybdenum-99 (^{99}Mo) in the U.S., without the use of HEU. DOE is supporting the U.S. private sector to accelerate independent, non-HEU-based technical pathways to produce ^{99}Mo in the U.S. in cooperation with commercial partners and the U.S. national laboratories. NRC or an Agreement State will be responsible for the licensing of any new commercial production facility. The projects are currently under development and production has not yet commenced at the time this report was written.

Some expected waste streams from the production of ^{99}Mo are likely to include radioactive waste for which there is currently no commercial disposal path; however, disposition of waste and spent nuclear fuel considerations impact the technical and economic viability of each of the projects. The American Medical Isotopes Production Act of 2012, enacted on January 2, 2013, directs DOE to establish a Uranium Lease and Take-Back Program to make LEU available through lease contracts for the production of

^{99}Mo for medical uses. The Act further specifies that DOE will retain responsibility for the final disposition of spent fuel created by the irradiation, processing or purification of the leased LEU, and take title to and be responsible for the final disposition of radioactive waste created by the irradiation, processing, or purification of the leased LEU for which DOE determines the producer does not have access to a disposal path. DOE's ^{99}Mo Uranium Lease and Take-Back program is currently under development and will be implemented using cost recovery principles, consistent with the legislation.

A.4.7 Decommissioning Planning Rule

This rule amended NRC regulations to prevent future legacy sites, (i.e., facilities in decommissioning with complex issues and owners incapable of completing decommissioning because of financial or technical difficulties). One set of changes revised 10 CFR 20.1406 and 20.1501 to require licensees conduct their operations to minimize the introduction of residual radioactivity at the site, including the subsurface, and to keep contamination survey results with records important for decommissioning. A second set of changes revised regulations in 10 CFR Parts 30, 40, 50, 70, and 72 to provide tighter control of decommissioning financial assurances and more detailed reporting by licensees of their decommissioning cost estimates. The final rule was published in the Federal Register (FR) at 76 FR 35512 on June 17, 2011, and took effect in January 2013, except for certain financial assurance status reporting provisions, which took effect in March 2013.

A.4.8 Integrated Regulatory Review Service Follow-up Report

In October 2010, at the request of the U.S. Government, an international team of safety experts conducted an Integrated Regulatory Review Service (IRRS) Mission, for the purpose, of reviewing the regulatory framework for safety of the operating NPP in the U.S. and the effectiveness of regulatory functions implemented by NRC. The follow-up mission was conducted in February 2014 and is documented in a preliminary report (IAEA-NS-2014/01).[12]

The IRRS team recognized NRC for having "… acted promptly and effectively… in the interests of the public health and safety" following the March 2011 Fukushima nuclear accident. The IRRS team reacted favorably to NRC putting in place "… measures to clarify that the prime responsibility for safety lies with the reactor licensees and enhanced the role of safety and security through improved analyses of operating experience and expanded its emergency preparedness requirements." The follow-up team commended NRC for effectively addressing one of two recommendations and 19 of 20 suggestions from the original IRRS mission. NRC continues to address the remaining recommendation and suggestion and will address the team's new suggestion on consolidating rules and guidance for plants permanently ceasing operation and moving to decommissioning.[13]

Although the mission focused on operating commercial NPP safety, there was a suggestion raised by the IRRS Team with regard to decommissioning. The report

[12] See http://www.nrc.gov/reactors/operating/ops-experience/preliminary-report.pdf.

[13] NRC's Strides in Post-Fukushima Efforts, Enhancing Regulation Featured in International Atomic Energy Agency Report. NRC News Releases. 14-007. February 11, 2014. Public Affairs. ADAMS Accession Number: ML14042A485.

specifically cited: “The NRC should consider developing a consolidated rulemaking and corresponding guidance in order to facilitate the orderly transition from operation to decommissioning.” Prior to receiving the preliminary report, NRC began to review the existing process for transitioning regulatory responsibilities from the operating to the decommissioning phase of a commercial NPP. An NRC Decommissioning Working Group was formed in response to the IRRS team report’s recommendations and meets weekly to discuss issues related to facility transition. Furthermore, NRC is in the process of identifying rulemakings to clarify and expedite the process of transitioning NPPs from operational to decommissioning.

NRC and industry (Nuclear Energy Institute) began to cooperatively evaluate the process of transitioning to decommissioning and have established decommissioning transition working groups, that will be meeting soon to further examine the facility transition process. NRC has also initiated a Strategic Assessment of Decommissioning to begin with NPPs and, if deemed appropriate, material sites. This review of the existing transition process has already resulted in clarification of proper procedures for changing key facility documents and staffing requirements at shutdown facilities.

A.4.9 U.S. Review Matrix

During the review meeting, a summary matrix is prepared for each Contracting Party by the country group rapporteur. To provide continuity from the Fourth Review Meeting and facilitate review, the U.S. revised its rapporteur’s matrix with citations to explanatory sections of the U.S. National Report. Table A-4 presents the revised matrix with an overview of the U.S. program.

Table A-4 Overview of U.S. Spent Fuel and Radioactive Waste Management				
Type of Liability	**Long-term Management Policy**[14]	**Funding of Liabilities**	**Current Practice/Facilities**	**Future Facilities**
Spent fuel	Following the report and recommendations of the BRC, the Administration released its strategy for managing and disposing of spent fuel and HLW See A.3.3, A.4.1, B.3.1, B.3.2, B.3.3, G.1, G.3, G.7, K.1	Fee for electricity generated and sold collected from utilities and deposited in the Nuclear Waste Fund to pay for disposal; access to monies in the Fund subject to annual Congressional appropriation; collection of fees suspended until the Yucca Mountain project resumes or Congress authorizes alternative See F.2.3.2	Onsite and away from reactors wet & dry interim storage (private & government property) NRC completed a rulemaking on Continued Storage of Spent Nuclear Fuel and preparing a supporting EIS; integrated spent fuel regulatory strategy. Acceptance of foreign research reactor fuel See B.3, C.1, D.1, G, K.6, Annex D-1	Awaiting outcome of Continued Storage of Spent Nuclear Fuel and EIS NPP and ISFSI licensing activities. Based on "Administration Strategy" and pending legislative approval; plans to develop a pilot interim storage facility by 2021, a consolidated storage facility by 2025, and a geologic repository by 2048 See A.4.1, B.3.1-3, D.1.2, G, K.1, K.6
Nuclear fuel cycle wastes (all LLW included in Non-Nuclear fuel cycle wastes for brevity)	HLW: See above Uranium & Thorium (U&Th) recovery sites: Near surface disposal See B.3.1, B.4, E.2.2.4, K.1	All: Producer pays U&Th recovery sites: Long Term Surveillance Fund Financial assurance required by license See F.2.3.3	HLW: Interim storage U&Th recovery sites: surface disposal locally See B.2.3.2, B.4, D.2.2.3, E.2.1.2, E.2.2.4, F.4.2.5, H.3, Annexes D-2A (HLW), D-3 (U&Th)	HLW: See above U&Th recovery sites: additional license applications expected See B.3.1, B.4., D.2.2.3

[14] Refer to LIST OF ACRONYMS AND ABBREVIATIONS at the end of the report.

Table A-4 Overview of U.S. Spent Fuel and Radioactive Waste Management				
Type of Liability	**Long-term Management Policy**	**Funding of Liabilities**	**Current Practice/Facilities**	**Future Facilities**
Non-Nuclear fuel cycle wastes	Defense HLW: See above TRU waste: geologic disposal LLW: near surface disposal Class A, B and C; GTCC LLW disposal path to be determined See A.4.2, A.4.5, B.1., B.2.3.2, B.4, K.1, K.2	All: Producer pays Defense HLW and TRU waste: public funds LLW: licensees required to demonstrate financial qualifications See F.2.3.1	Defense HLW: interim storage Defense TRU waste: disposal at WIPP LLW: 4 commercial sites plus multiple government (DOE) facilities Storage of GTCC LLW pending disposal availability See B.2.3.2, B.4, D.2.1, D.2.2.1, D.2.2.2, E.2.1.3, H.1, H.2.5, K.2, K.3, Annexes D-2A and D-2B	Defense HLW Disposal: See above Additional Defense HLW Treatment Facilities GTCC LLW disposal (environmental impact assessment in progress; By law DOE to report to Congress and await Congressional action prior to implementation) See D.2.1,K.3, K.7
Decommissioning liabilities	NPPs: Decontamination & Decommissioning (D&D) to be completed within 60 years Defense, U&Th recovery and other sites: Based on risk See B.5, D.3, E.2.1.4, F.6, F.7.2, H.1.4	NPPs: D&D fund required by law Non-legacy Sites: Producer pays Defense sites: Public funds for defense liabilities See F.2.3.4	Large number of facilities undergoing decommissioning/ remediation See D.3, E.2.1.4, F.6, Annexes D-4, D-5, D-6, D-7	Large number of facilities planned for decommissioning/ remediation See Annexes D-4, D-5, D-6, D-7
Disused Sealed Sources	Disposal or recycle See A.3.1, B.1, J	Licensee or governmental responsibility in support of public health, safety or national security See Section J	Disposal at commercial disposal sites & government sites; storage of sources on site by licensees pending disposal Global Threat Reduction Initiative: Off-site Source Recovery Project See B.2.2, D.2.2, I.1, J	GTCC LLW disposal (environmental impact assessment in progress; by law DOE to report to Congress and await Congressional action prior to implementation) See D.2.2, K.3

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B. POLICIES AND PRACTICES

This section summarizes United States of America (U.S.) policies and practices for spent fuel and radioactive waste management and related nuclear activities.

B.1 U.S. National Nuclear Activities Policy

The U.S. Government promotes the development of commercial nuclear power and nuclear technology for beneficial uses in medicine, industry, and research. The promotional and regulatory duties for commercial activities are assigned to different agencies.

The Nuclear Regulatory Commission (NRC) is an independent agency authorized to regulate the commercial sector and certain government nuclear facilities, regulating the possession and use of nuclear materials as well as the siting, construction, and operation of nuclear facilities. It performs its mission by issuing regulations, licensing commercial nuclear reactor construction and operation, licensing the possession of and use of nuclear materials and wastes, safeguarding nuclear materials and facilities from theft and radiological sabotage, inspecting nuclear facilities, and enforcing regulations. NRC regulates commercial nuclear fuel cycle materials and facilities, and commercial sealed sources, including disused sealed sources. Three types of commercial nuclear materials are regulated: source material, special nuclear material and byproduct material.[15]

NRC is also responsible for licensing commercial nuclear waste management facilities, independent spent fuel management facilities, and disposal facilities for high-level waste (HLW) and spent fuel. NRC also oversees certain state programs where NRC has relinquished limited regulatory authority to the individual states; this is known as the Agreement State Program.

The Department of Energy (DOE) has responsibility for, among other matters, nuclear energy development and promotion, nuclear weapons programs, nuclear and radiological weapons nonproliferation, radioactive waste management, and for environmental remediation of contaminated sites and surplus facilities. DOE has regulatory authority over its nuclear activities and facilities, and those operated or conducted on its behalf, except where NRC is specifically authorized by statute to regulate certain DOE facilities and activities.

Although NRC and DOE use different regulatory schemes for regulating management of radioactive materials, the criteria for safe management are generally consistent.

The Environmental Protection Agency (EPA) establishes generally applicable environmental standards to protect the environment from hazardous materials and certain radioactive materials. EPA has authority to establish standards for remediating active and inactive uranium milling sites and other properties contaminated with radioactive materials from the milling sites, environmental standards for the uranium fuel cycle, and environmental radiation protection standards for management and disposal of spent fuel, HLW, and transuranic (TRU) waste. EPA promulgates standards for and

[15] For definition, see http://www.nrc.gov/materials.html.

certifies compliance at the Waste Isolation Pilot Plant (WIPP) for disposal of defense-generated TRU waste. EPA standards, under the Clean Air Act (CAA), limit airborne emissions of radionuclides from DOE sites. Section E describes the regulatory roles of U.S. agencies for nuclear activities.

B.2 Government and Commercial Entities

B.2.1 Commercial Sector

Owners and operators of Nuclear Power Plants (NPPs) and other types of facilities generating radioactive waste manage the spent fuel and radioactive waste generated by their facilities prior to disposal generally under their NRC operating license. U.S. Federal or state governments regulate waste disposal sites. Government custody may occur at different stages of the waste management scheme depending on the type of radioactive waste and generating activity. Section F.7.3 addresses the interdependencies between the steps in spent fuel and radioactive waste management. See Sections G and H for additional information on commercial spent fuel and radioactive waste management, respectively. Decommissioning activities generate radioactive waste in both the commercial and government sectors. Section F.6 describes decommissioning activities.

B.2.2 Government Sector

DOE is responsible for and performs most of the spent fuel and radioactive waste management activities for government-owned and generated waste and materials, which are mostly located on government-owned sites. These activities include managing spent fuel from defense reactor operations, which ceased in the early 1990s, and the HLW from reprocessing the spent fuel and the spent fuel generated from a number of research and test reactors since then. DOE also provides safe storage for spent fuel from the decommissioned Fort St. Vrain gas-cooled reactor under NRC license and spent fuel from the Three-Mile-Island Unit 2 reactor damaged in a 1979 accident.

DOE has a system for managing government spent fuel and radioactive waste that includes numerous storage facilities and processing facilities (treatment and conditioning). Operating disposal facilities for low-level waste (LLW) and TRU waste are further described in Section D.2.2 of this report. Other waste management treatment and disposal systems support cleanup and closure of facilities, which no longer serve a DOE mission. See Section D for more information on spent fuel and radioactive waste facilities in the government sector.

The U.S. also continues activities to remove and/or secure high-risk nuclear and radiological materials both domestically and internationally. Part of this initiative is continuing the program of accepting U.S. origin foreign research reactor spent fuel back into the U.S. for safekeeping and the recovery of disused sealed sources.

B.2.3 Spent Fuel and Radioactive Waste Classification

Regulations addressing various aspects of the generation and control of radioactive wastes and other nuclear activities are in the U.S. Code of Federal Regulations (CFR) specifically Title 10 (Energy) and Title 40 (Protection of the Environment) of the CFR. These regulations address the storage, treatment, possession, use and disposal of spent fuel and radioactive waste. Section E discusses various regulations. The U.S.

classification system has two separate subsystems. One classification subsystem applies to commercial waste and is defined in NRC regulations. The other classification subsystem applies to DOE spent fuel and waste. The two systems are used for different purposes and in different situations so conflicts do not occur. If ownership of radioactive waste is transferred from DOE to a commercial entity licensed by NRC, the waste is then subject to NRC regulation (and classification).

B.2.3.1 Spent Fuel

The U.S. defines "spent nuclear fuel" (spent fuel) as fuel that has been withdrawn from a nuclear reactor following irradiation, the constituent elements of which have not been separated by reprocessing. Although, U.S. law uses the term "spent nuclear fuel", DOE has begun using the term "used fuel" to acknowledge that in the future, the material may have residual value through recycling. For purposes of this report, used fuel is referred to as spent fuel in accordance with the Joint Convention terminology.

B.2.3.2 Radioactive Waste

Radioactive wastes in the U.S. have many designations depending on their hazards and the circumstances and processes creating them. NRC regulates most, but not all, sources of radioactivity, including LLW and HLW disposal, and residues from the milling of uranium and thorium (U&Th).[16] Uranium mill tailings, the final byproduct of uranium ore extraction, are considered radioactive wastes. Radioactivity can range from just above background to very high levels, such as parts from inside the reactor vessel in an NPP. The day-to-day trash generated in medical laboratories and hospitals, contaminated by medical radioisotopes, is also designated radioactive waste.

NRC regulations in 10 CFR Part 61 classify LLW in the commercial sector as Class A, Class B, and Class C.[17] NRC is currently in the process of revising and updating 10 CFR Part 61 to recognize current International Commission on Radiological Protection (ICRP) recommendations, allow for site specific analyses, and accommodate disposal of previously unanticipated waste streams. This classification is based on potential LLW hazards, and disposal and waste form requirements. Class A LLW contains lower concentrations of radioactive material than Class B LLW, which has lower concentrations than Class C LLW. Table B-1 provides the commercial waste classes.

Radioactive waste owned or generated by DOE is classified as HLW, TRU waste, or LLW. In addition, DOE manages large quantities of uranium mill tailings and other residual radioactive material.[18] Waste may also contain hazardous waste constituents. Waste with both radioactive and hazardous constituents in the U.S. is called "mixed" waste (mixed LLW or mixed TRU waste). DOE considers spent fuel to be nuclear material, and not a waste. Generally, the source of HLW is reprocessed spent fuel. TRU waste generally consists of protective clothing, tools, glassware, equipment, soils, and sludge contaminated with man-made radioisotopes beyond or "heavier" than

[16] Referred to in Section 11(e).2 of the Atomic Energy Act as byproduct material.

[17] This classification system is primarily based on protection of the inadvertent intruder. Waste that exceeds the specific activity of Class C LLW (referred to as Greater-than-Class C LLW) is considered generally unacceptable for near surface disposal absent additional specific safety requirements.

[18] This residual radioactive material was the result of the Manhattan Project and the Nation's early atomic energy program and is managed under the UMTRCA Title I. See Section D.2.2.3.

uranium on the periodic table of the elements (long-lived alpha-emitting waste with concentrations greater than 3700 Bq/g [100 nCi/g]).[19]

Table B-1 U.S. Commercial Radioactive Waste Classification

Waste Class	Description
HLW	The highly radioactive material resulting from the reprocessing of spent fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations and other highly radioactive material that NRC determines by rule requires permanent isolation.
Class A LLW	Class A waste is determined by characteristics listed in 10 CFR 61.55(a)(2)(i) and physical form requirements in 10 CFR 61.56(a). (U.S. does not have a minimum threshold for Class A waste).
Class B LLW	Waste that must meet more rigorous requirements on waste form than Class A waste to ensure stability.
Class C LLW	Waste that not only must meet more rigorous requirements on waste form than Class B waste to ensure stability but also requires additional measures at the disposal facility to protect against inadvertent intrusion.
GTCC LLW	LLW not generally acceptable for near-surface disposal.
AEA Section 11e.(2) Byproduct Material	Tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content, including discrete surface wastes resulting from uranium solution extraction processes. Underground ore bodies depleted by such solution extraction operations do not constitute "byproduct material" within this definition.[20]

B.2.3.3 Other Regulated Radioactive Materials

NRC regulates other radioactive materials, but does not designate them as waste in the context of the Atomic Energy Act of 1954 (AEA), as amended. The definition of byproduct material was expanded by the Energy Policy Act of 2005 (EPAct05) to include discrete sources of ^{226}Ra, other naturally occurring radioactive materials (NORM) of similar hazard, and accelerator produced radioactive material designated as 11e.(3)[21] and 11e.(4). This material is not defined to be waste, as such; it can be disposed of in either a licensed radioactive waste or a permitted non-radioactive waste disposal facility.

NRC can relinquish this regulatory authority to individual states[22] to regulate these radioactive materials.[23] The AEA provided for this transfer of regulatory authority under specific priorities. Individual states usually regulate conventional mining of uranium and the radioactive materials not regulated by NRC.[24]

[19] DOE considers LLW to be radioactive waste that is not spent fuel, HLW, TRU waste, or byproduct material as defined in Section 11e.(2),(3),or (4) of the AEA.
[20] Title 10 CFR, Part 40, *Domestic Licensing of Source Material* (Section 40.4).
[21] The nomenclature 11e.(3) refers to the citation in the AEA; i.e. Section11; paragraph e; subparagraph (3).
[22] In this context, "states" within the U.S. are similar to provinces or departments indicating the next level of government below the Federal level.
[23] More information is available from NRC's NARM Toolbox at http://nrc-stp.ornl.gov/narmtoolbox.html.
[24] E.g. diffuse NORM.

Disused sources originating in a country other than the U.S. are considered to be radioactive waste[25] and a specific license for import is required by NRC for commercial licensees.

NRC regulates the cleanup activities at military sites contaminated with depleted uranium (DU) from past testing of munitions. The EPAct05 has resulted in NRC's regulatory authority over discrete sources of ^{226}Ra and accelerator-produced radioactive material, including some military ^{226}Ra. There is still a jurisdictional issue over what military ^{226}Ra should fall under NRC's regulatory authority. There have been a series of meetings with the various military services to resolve these jurisdictional issues and approaches for NRC involvement with military cleanup. Other radionuclides that may have been disposed of at military sites include ^{90}Sr. For military sites undergoing cleanup with direct EPA involvement, NRC is relying on EPA's regulatory oversight and implementing its "stay-informed approach," as defined in SECY-08-0077.[26]

The Office of Surface Mining of the U.S. Department of Interior and the individual states regulate uranium ore mining. If there are elevated levels of diffuse radium or other NORM, then EPA and individual states have jurisdiction. Other extraction mining and refinement operations for metals, phosphates, etc., may concentrate naturally occurring radionuclides in these tailings materials. NRC specifically licenses some mineral extraction processes (not for nuclear content), because they incidentally result in the use, or concentration, of material above 0.05 percent by weight of source material. Identified processors are required to obtain an NRC license.

B.3 Spent Fuel Management Policies and Practices

This subsection provides information on spent fuel storage and disposal practices in the U.S.

B.3.1 Spent Fuel Storage

The U.S. produces spent fuel in commercial NPPs and research reactors. Currently 100 licensed nuclear power reactors provide about 20 percent of U.S. electricity. Information on U.S. nuclear power reactors is provided in the Convention on Nuclear Safety U.S. National Report.[27] All operating nuclear power reactors are storing spent fuel in NRC licensed onsite spent fuel pools (SFP) and over half are storing spent fuel in NRC-licensed independent spent fuel storage installations (ISFSIs) located onsite (see Annex D-1D).

Most NPPs that have been decommissioned or are undergoing decommissioning also have spent fuel stored on site pending disposal. Most permanently-shutdown commercial nuclear power reactors currently have or are planning to have their spent fuel stored at onsite ISFSIs. NRC amended its regulations in 1990 allowing licensees to store spent fuel in NRC-certified dry storage casks at licensed power reactor sites, under either a site-specific license or a general license tied to the reactor operating license. Dry storage systems were developed as the preferred alternative (versus new pool

[25] NRC regulations exclude disused sources that are being returned to an authorized entity from the regulatory definition of radioactive waste.
[26] Available at http://www.nrc.gov/reading-rm/doc-collections/commission/secys.
[27] http://www-ns.iaea.org/conventions/nuclear-safety.asp?s=6&l=41.

construction). In the most commonly used designs, spent fuel is loaded in canisters with inert gas and welded closed. The canisters are then placed in storage casks or vaults/bunkers. Some cask designs can be used for both storage and transportation. Sections D.1.1 and G provide additional information on spent fuel storage. Spent fuel is also stored at several research reactor sites licensed by NRC.

NRC is considering technical issues related to the long-term management of spent fuel, and remains focused on its regulatory responsibilities, for the safety and security for continued onsite storage of spent fuel. Current sites likely will be active for many decades to come, given license renewals and with the potential for new NPPs at existing reactor sites. NRC's ongoing review of its spent fuel programs will help maintain the safety and security of continued interim storage of spent fuel. In the past three years, no new specific licenses for ISFSIs have been issued; however, there are nine general licensees authorized for storing spent fuel in dry casks at current or former NPP sites:

- Braidwood in November 2011,
- Comanche Peak in February 2012,
- DC Cook in October 2012,
- LaCrosse in July 2012,
- Nine Mile Point in September 2012,
- Perry 1 in September 2012,
- Turkey Point in July 2011,
- Waterford in November 2011, and
- Zion in January 2014.

As of April 2014, two site-specific ISFSI license renewal applications are under review -- Prairie Island and Calvert Cliffs. A renewal application from Energy*Solutions* for the VSC-24 storage cask system is also under review. At present, there are a total of 66 separate ISFSIs, including four that have both general and site-specific licenses. Thirty-four states have at least one ISFSI.

The spent fuel DOE manages from defense activities and domestic and foreign research reactors, and limited quantities of spent fuel from commercial activities are stored at DOE's Savannah River Site (SRS), Hanford site, Idaho National Laboratory (INL), and Fort St. Vrain prior to further disposition. DOE continues to receive spent fuel from foreign and domestic research reactors. The program for receipt of foreign research reactor spent fuel is planned to be completed in 2019. No date has been set for completing receipt of spent fuel from domestic research reactors.

B.3.2 Spent Fuel Disposal

The Nuclear Waste Policy Act (NWPA) of 1982, as amended, establishes the Federal responsibility for the disposal of spent fuel and HLW. The NWPA assigns responsibilities for the disposal of spent fuel and HLW to three Federal agencies:

- DOE for developing permanent disposal capability for spent fuel and HLW;
- EPA for developing generally applicable environmental protection standards; and
- NRC for developing regulations to implement EPA standards, deciding whether or not to license construction, operation, decommissioning and closure of the

repositories, and certifying packages used to transport spent fuel and HLW to the licensed repositories.

B.3.2.1 Current Status of Nuclear Waste Disposal Strategy

The NWPA, as amended in 1987 by the Nuclear Waste Policy Amendments Act, directed DOE to characterize a site at Yucca Mountain, Nevada, for its potential use as a deep geologic repository. However, in 2009, the Administration announced that it had determined that developing a repository at Yucca Mountain, Nevada, would not be a workable option and the Nation needs a different solution for nuclear waste disposal. The Secretary of Energy established a Blue Ribbon Commission (BRC) on America's Nuclear Future in January 2010 to evaluate alternative approaches for managing spent fuel and HLW from commercial and defense activities. The BRC released its report to the Secretary of Energy in January 2012; the report contains eight recommendations for legislative and administrative action to develop a new strategy to manage nuclear waste:[28]

1. A new consent-based approach to siting future nuclear waste management facilities.
2. A new organization dedicated solely to implementing the waste management program and empowered with the authority and resources to succeed.
3. Access to the funds nuclear utility ratepayers are providing for the purpose of nuclear waste management.
4. Prompt efforts to develop one or more geologic disposal facilities.
5. Prompt efforts to develop one or more consolidated storage facilities.
6. Prompt efforts to prepare for the eventual large-scale transport of spent nuclear fuel and HLW to consolidated storage and disposal facilities when such facilities become available.
7. Support for continued U.S. innovation in nuclear energy technology and for workforce development.
8. Active U.S. leadership in international efforts to address safety, waste management, non-proliferation, and security concerns.

In January 2013, the Administration released its *Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste*, containing the Administration policy on addressing the disposition of used nuclear fuel and high-level radioactive waste. The Strategy is a "framework for moving toward a sustainable program to deploy an integrated system capable of transporting, storing, and disposing of used nuclear fuel and high-level radioactive waste from civilian nuclear power generation, defense, national security and other activities." The document outlines a plan that:

- Sites, designs, licenses, constructs, and begins operations of a pilot interim storage facility by 2021, with an initial focus on accepting used nuclear fuel from shut-down reactor sites;
- Advances toward the siting and licensing of a larger interim storage facility to be available by 2025 that will have sufficient capacity to provide flexibility in the waste management system and allows for acceptance of enough used nuclear fuel to reduce expected government liabilities; and

[28] BRC recommendations were discussed during the formal U.S. presentation at the Fourth Review Meeting.

- Makes demonstrable progress on the siting and characterization of repository sites to facilitate the availability of a geologic repository by 2048.

Full implementation of this Strategy will require legislation, although a bill was introduced in April 2013 in the U.S. Senate to implement many of the BRC recommendations; it has not been enacted into law.

B.3.2.2 Current Status of the Yucca Mountain Application Review

On March 3, 2010, DOE filed a motion with NRC's Atomic Safety and Licensing Board seeking permission to withdraw its application for authorization to construct a HLW repository at Yucca Mountain, Nevada. The Board denied that request in June 2010. In September 2011, NRC suspended the adjudicatory proceeding on the license application.

On August 13, 2013, a panel of the U.S Court of Appeals for the District of Columbia Circuit ordered NRC to resume the Yucca Mountain licensing process until Congress authoritatively says otherwise or there are no appropriated funds remaining. In November 2013, the NRC decided to complete the Safety Evaluation Report (SER) for DOE's application to construct the Yucca Mountain repository as the next step in the licensing process. NRC's adjudication regarding DOE's application remains in abeyance.

In 2008, NRC determined that DOE's Environmental Impact Statement (EIS) needed supplementation in limited areas. In February 2014, DOE advised NRC that it would not prepare a supplemental EIS, but would provide an updated version of a July 2009 technical report on post closure groundwater impacts of a geologic repository in the vicinity of Yucca Mountain. The updated report will provide NRC with technical information to prepare a supplement to the EIS. NRC now plans to develop and issue the necessary supplement to the EIS if sufficient resources are available following completion of the SER.

The Licensing Support Network (LSN)[29] was an electronic system established by NRC to provide access to documents relevant to NRC's Yucca Mountain licensing proceeding. However, the LSN ceased operation in 2011. Prior to the LSN shut down, parties to the adjudication provided copies of their LSN document collections to NRC. NRC plans to take steps to make the LSN document collection publicly available, as funds remain following completion of the SER.

B.3.3 Continued Storage of Spent Nuclear Fuel

In 1984, NRC made a generic determination, referred to as the Waste Confidence Rule (10 CFR 51.23), that, if necessary, spent fuel generated in any reactor can be stored safely and without significant environmental impacts for at least 30 years beyond the licensed life for operation of that reactor. The licensed life includes the period of any revised or renewed license. The storage can be at spent fuel storage "basin" (more commonly called a spent-fuel pool), an onsite or offsite ISFSI or both. NRC updated the generic determination in 1990.

[29] http://www.nrc.gov/reading-rm/dcollections/nuregs/brochures/br0301/#pub-info.

In 2010, NRC updated its Waste Confidence Rule to express its confidence that spent fuel can be stored safely and without significant environmental impacts for at least 60 years beyond the licensed life of any reactor. The updated Rule also determined that sufficient mined geologic repository capacity will be available when necessary.

On June 8, 2012, the U.S. Court of Appeals for the District of Columbia found that some aspects of the 2010 update did not satisfy NRC's obligations under the National Environmental Policy Act (NEPA) and vacated the Rule. The Court specifically identified the need to analyze the impacts of failing to secure permanent disposal for spent nuclear fuel, and to enhance the agency's analysis of the impacts of potential spent-fuel pool leaks and spent-fuel pool fires. NRC determined that it would issue no final licenses until the Court's decision has been appropriately addressed.

Following the Court's decision, NRC decided to prepare a generic EIS and a proposed revision of 10 CFR 51.23 to address the Court's ruling. The proposed rule and the draft generic EIS were issued for public comment on September 13, 2013. NRC received over 33,000 public comments. During the public comment period, NRC asked four specific questions, one of which was, "Should the title of the rule be changed in light of a GEIS being issued instead of a separate Waste Confidence Decision?" NRC received an overwhelming number of comments in favor of changing the name of the Rule; therefore, the title of the rulemaking has been changed to "Continued Storage of Spent Nuclear Fuel." Furthermore, the title of the GEIS has been changed to, "Generic Environmental Impact Statement for Continued Storage of Spent Nuclear Fuel" to be consistent with the title of the rulemaking. The final generic EIS and rule will be published on September 19, 2014. This rule is now referred to as "Continued Storage of Spent Nuclear Fuel."

B.3.4 Reprocessing in the U.S.

Commercial reprocessing, a process by which plutonium, uranium, or both are recovered from spent fuel to be used again in a reactor, was abandoned in the U.S. in the 1970s because of nuclear proliferation concerns. Prior to this decision to abandon commercial processing, several reprocessing ventures were considered in the 1960s and early 1970s, including General Electric Company's planned construction of a commercial reprocessing facility near Morris, Illinois, in the late 1960s. However, only the spent fuel storage facility was completed and remains in operation today.

Nuclear Fuel Services operated a reprocessing facility at West Valley, New York, from 1966 to 1972. This facility processed 640 metric tons of heavy metal (MTHM) from government and commercial NPPs, resulting in 2.3 million liters of liquid HLW. This was the only commercial reprocessing plant operated in the U.S. The U.S. declared a moratorium on domestic spent fuel reprocessing in 1977. The moratorium was rescinded in 1981, but commercial reprocessing never resumed.

DOE recognizes that research and development (R&D) of sustainable fuel cycles and waste management activities are important to support the expansion of nuclear energy.[30] DOE is conducting R&D in nuclear fuel and waste management technologies that will enable a safe, secure, and economic fuel cycle. The long-term R&D strategy is to

[30] http://energy.gov/ne/fuel-cycle-technologies.

investigate the technical challenges in developing sustainable systems that reduce waste while improving resource utilization and safety.

B.4 Radioactive Waste Management Practices

Commercial generators of LLW in the U.S. must treat these wastes to remove free liquids and stabilize or destroy other hazardous components contained in the waste. Wastes are also often treated to reduce the final disposal volume through compaction and incineration. Private companies provide processing (e.g., packaging and treatment) and brokerage services to facilitate safe storage, transportation and, ultimately, disposal of LLW at one of four commercial disposal facilities. Some of these waste processor/ brokers serve a limited clientele, while others perform these services for a wider body of clients.

Commercial LLW is disposed in near surface facilities; (i.e., a land disposal facility in which radioactive waste is disposed within the upper 30 meters of the earth's surface). These facilities are designed, constructed, and operated under licenses issued by either NRC or an Agreement State, based on NRC health and safety regulations governing waste disposal quantities, forms, and activity levels (10 CFR Part 61, *Licensing Requirements for Land Disposal of Radioactive Waste*). See Sections E.2.1.3 and H.1.1 for additional information on LLW management. Section D.2.1 provides additional information on storage and treatment.

Greater-than-Class C (GTCC) LLW is a form of low-level radioactive waste containing long-and short-lived radionuclides with properties requiring a more robust disposal strategy[31] than for other classes of LLW. The authority to possess this type of radioactive material is included in NRC or Agreement State licenses. GTCC LLW is generally grouped into the following three types: sealed sources, activated metals, and other waste. Other GTCC LLW includes contaminated equipment, trash, and scrap metal from miscellaneous industrial activities, such as manufacturing of sealed sources and laboratory research. Most GTCC LLW is activated metal, generated by decommissioning NPPs, and disused sealed sources. Typical radionuclides associated with GTCC LLW are ^{14}C, ^{59}Ni, ^{94}Nb, ^{99}Tc, ^{55}Fe, ^{90}Sr, ^{238}Pu, ^{239}Pu, ^{241}Am, and ^{137}Cs.

The Low-Level Radioactive Waste Policy Amendments Act (LLRWPAA) of 1985 assigned the Federal government responsibility for disposal of GTCC LLW that results from NRC-licensed activities and specified that GTCC LLW designated a Federal responsibility pursuant to section 3(b)(1)(D) of the LLRWPAA that results from activities licensed by NRC be disposed in a NRC-licensed facility. There are no facilities currently licensed by NRC for the disposal of GTCC LLW.

In addition, the EPAct05 requires DOE to complete several actions related to the preparation of an EIS and Record of Decision for the disposal of GTCC LLW. DOE is performing the NEPA analyses of potential GTCC LLW disposal alternatives, including developing an EIS and report to Congress. DOE published the Draft Environmental Impact Statement (DEIS) for public review and comment in February 2011 and received over 4000 comments. The DEIS contains evaluations of various locations and

[31] In the context of the National Report, "more robust" means a greater degree of isolation, durability, and performance than is associated with near surface disposal for other classes of low-level radioactive wastes. This could include intermediate level waste as defined by some nations.

technologies to optimize disposal of various types of GTCC LLW, as well as GTCC-like waste for which there is currently no disposal path. The DEIS considers alternatives for disposal in a geologic repository (WIPP), intermediate depth boreholes, enhanced near surface trenches, and above grade vaults. A preferred alternative may be a combination of the aforementioned disposal options. The DEIS also addresses candidate locations in various states and generic commercial disposal sites in four regions of the U.S. DOE continues to work on the Final EIS. Section 631 of EPAct05 directs DOE to submit a report to Congress regarding the disposal alternatives considered in the EIS and await Congressional action before making a final decision on the disposal alternative(s) to be implemented.

DOE manages TRU waste from former weapons production and R&D activities. TRU waste from atomic energy defense activities is disposed in the WIPP geologic repository. Section D.2.2.1 provides information on TRU waste disposal. Section D.2.1 provides additional information on TRU waste and defense HLW treatment.

HLW from commercial reprocessing activities was vitrified and is stored at the former reprocessing plant in West Valley, New York, awaiting disposal in a Federal repository. Defense HLW is stored, managed, and treated at three DOE sites (Savannah River Site, Hanford Site, and Idaho National Laboratory) while awaiting disposal in a Federal repository.

The Uranium Mill Tailings Radiation Control Act of 1978, as amended (UMTRCA) classified the tailings from processing of uranium ore either as residual radioactive material or AEA Section 11e.(2) byproduct material depending on the status of the facility at the time UMTRCA was passed in 1978. UMTRCA Title I applies to facilities that were closed or abandoned prior to1978 and since passage of UMTRCA activities at Title I sites were largely focused on decommissioning and cleanup of residual radioactive material by U.S. governmental entities. UMTRCA Title II applies to sites under an active license in or after 1978; waste at Title II sites is designated as 11e.(2) byproduct material.

Uranium recovery is the extraction or concentration of uranium from any ore processed primarily for its source material content.[32] The uranium recovery processes result in wastes that typically contain relatively low concentrations of radioactive materials associated with the natural uranium decay chain. The wastes, in both solid and liquid forms, are classified as AEA Section11e.(2) byproduct material. See Table B-1 for information on classification of radioactive waste. For conventional mills, the waste is primarily the onsite disposal of tailings (residual ore after the uranium was leached).

NRC and EPA established requirements and standards to be met prior to NRC's termination of a license for a specific facility. The requirements include long-term stability of uranium mill tailings disposal piles, radon emissions control, water quality protection and cleanup, and remediation of land and buildings. Once a license is terminated, ownership is transferred under provisions in 10 CFR 40.28, to a governmental entity for long-term care of the 11e.(2) byproduct material licensed for disposal at conventional mill or heap leach facilities. For in situ facilities, no tailings are generated; no permanent surface disposal options are licensed. The subsurface ore zones that were subjected to the leaching process do not constitute 11e.(2) byproduct

[32] Similarly, thorium was also extracted or processed in the past.

material and are exempt from requirements of the Safe Drinking Water Act (SDWA) by EPA. Ground-water restoration requirements for the ore zones following termination of mineral extraction are specified in 10 CFR Part 40. Any remaining liquid or solid residues from evaporation ponds are collected and disposed of at an 11e.(2) byproduct material licensed off-site waste disposal facility. Alternatively, liquid 11e.(2) byproduct material wastes collected at the surface can be disposed of by deep well injection at the site of in situ operations. For general information on uranium recovery in the U.S., refer to the backgrounder at: http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/uranium-recovery-bg.html

B.4.1 Depleted Uranium Tailings

The product from uranium recovery facilities is processed to enrich the fissile content. Tailings containing DU are a byproduct of the enrichment process. Depending on available quantities, long-term and short-term needs, and cost/benefit analysis of potential uses, DU could be a resource for variety of applications and uses. If DU is not a resource, it is categorized as LLW. When 10 CFR Part 61 was developed, the disposal of large quantities of DU was not anticipated, so by default it is classified by NRC as Class A LLW. However, with the licensing of new fuel enrichment facilities, which will produce large quantities of DU waste, concerns have been raised about whether it is appropriate to dispose of this material in near-surface facilities without further restrictions. NRC initiated a rulemaking to require site-specific analysis for disposal of large quantities of DU and the technical requirements for such analysis. As an interim measure, NRC has issued interim guidance to states, which regulate the disposal of large quantities of DU.[33]

Currently, DOE and private corporations (e.g., U.S. Enrichment Corporation and Louisiana Energy Services (LES)) process and store DU. This DU continues to be managed as source material available for reuse. Prior to processing, the uranium is in the form of uranium hexafluoride, which is converted to uranium oxide for reuse or disposal. If a decision is made to dispose of the material, it can be disposed in DOE or commercial LLW disposal facilities, provided the waste meets the facilities' waste acceptance requirements.

B.4.2 Ocean Disposal

Ocean disposal of radioactive waste was discontinued in 1970.[34] See the Third U.S. National Report for further discussion.

B.5 Decommissioning

Decommissioning generally happens at the end of operation of commercial and governmental nuclear facilities. Governmental agencies' recommendations, and in some cases requirements, include provision for decommissioning planning in the pre-operational design and strategy. Waste from decommissioning is managed within the waste classes previously described. See Section F.6 for additional information.

[33] http://pbadupws.nrc.gov/docs/ML1002/ML100250501.html.

[34] For additional information on the history and background of ocean disposal of radioactive waste, see History and Framework of Commercial Low-Level Radioactive Waste Management in the U.S.

Applicants for licenses are required to describe how facility design and procedures will facilitate eventual decommissioning.[35] NRC has published regulatory guidance in Regulatory Guide 4.21, *Minimization of Contamination and Radioactive Waste Generation: Life Cycle Planning*, June 2008 for implementing this requirement.[36] U.S. Governmental agencies work closely with industry, stakeholders, and members of the public to ensure lessons learned from decommissioning can be appropriately factored into the next generation of nuclear facilities (e.g., NPPs, uranium mill facilities, and enrichment facilities).

Decommissioning activities at conventional uranium mills include mill demolition, groundwater cleanup, soil cleanup, and closure of tailings impoundment. Decommissioning activities at in situ recovery (ISR) facilities are focused on restoring groundwater quality to pre-operational conditions, soil cleanup, and building demolition.

[35] Regulations are stipulated in 10 CFR Part 20, Section 20.1406 of the U.S. Code of Regulations.
[36] http://www.nrc.gov/reading-rm/doc-collections/reg-guides/environmental-siting/rg/division-4/division-4-21.html or from ADAMS accession number ML080500187.

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C. SCOPE OF APPLICATION

This section covers the application of the Joint Convention in the United States of America (U.S.), (Article 3) of the Joint Convention. As well as the U.S. position on the application of the Joint Convention to reprocessing of spent fuel, naturally occurring radioactive material (NORM), and defense/military programs. This section also provides a definition of what the U.S. considers spent fuel and waste management facilities under the provisions of the Joint Convention.

C.1 Spent Fuel Reprocessing

The U.S. has no commercial reprocessing facilities; therefore, no declaration is needed under Article 3.1. If a decision is made in the future to proceed with construction of a reprocessing facility, the U.S. will make a declaration under Article 3.1 at that time.

C.2 Naturally Occurring Radioactive Materials

The U.S. does not consider NORM outside the nuclear fuel cycle to be within the scope of its Joint Convention obligations as permitted by Article 3, paragraph 2, except for those classes of byproduct material (designated as 11e.(3) and 11e.(4) byproduct material) regulated under the aegis of the Atomic Energy Act (AEA) provisions. NRC regulates 11e.(3) and 11e.(4) byproduct material under 10 CFR Part 30. These materials include discrete sources of ^{226}Ra and other NORM, as well as accelerator produced material. Certain concentrations and quantities are exempt from the regulations.[37] NRC does not regulate the movement or concentration of diffuse NORM such as scale from pipes used in the fossil fuel industry, fly ash from coal power plants, or phosphate fertilizers.

C.3 Defense Activities

The Joint Convention does not apply to the safety of spent fuel or waste within defense or military programs unless declared specifically (Article 3.3). The U.S. Government has determined the Joint Convention does not apply to spent fuel or waste managed within the military programs in the U.S., but spent fuel and radioactive waste from military programs fall within the Joint Convention when transferred for permanent disposal in facilities operated by the Department of Energy (DOE).

U.S. military programs are primarily in the Department of Defense (DoD) and the National Nuclear Security Administration (DOE/NNSA). DOE/NNSA is a separately organized agency within DOE, overseeing the military application of nuclear energy; maintaining and enhancing the safety, security, reliability, and performance of the U.S. nuclear weapons stockpile; improving nuclear security through its defense nuclear nonproliferation programs; and developing naval propulsion plants for the U.S. Navy, among other functions. The amount of spent fuel and radioactive waste from military programs is relatively small compared to the commercial nuclear power sector. Spent fuel and radioactive waste in military programs are managed, however, in accordance with the objectives stated in Article 1 of the Joint Convention.

[37] More specific information on discrete NORM sources can be accessed at http://www.nrc.gov/materials/byproduct-mat.html.

C.4 Radioactive Waste and Spent Fuel Management Facilities

The Joint Convention defines radioactive waste management as all activities, including decommissioning, handling, pretreatment, treatment, conditioning, storage, and disposal excluding off-site transportation. The U.S. has both commercial and Government radioactive waste management facilities under the Joint Convention.

The Joint Convention defines storage as holding radioactive waste in a facility for containment, with the intention of retrieval. The U.S. does not consider facilities to be radioactive waste storage facilities where, for a short period of time (less than a year), a waste generator collects radioactive waste for shipment or processing before sending it to a treatment or disposal facility. This distinction excludes low-level waste (LLW) inventories at nuclear power plants (NPP), hospitals, universities, research facilities, industries, and other facilities where radioactive waste is generated and shipped to disposal sites. These facilities are subject to the regulations under licenses to possess nuclear materials. All such facilities, though not reported, subscribe to the same objectives of Article 1 of the Joint Convention.

Article 3 of the Joint Convention allows Contracting Parties to declare facilities undergoing decommissioning as radioactive waste management facilities. The U.S. has some onsite disposal facilities for radioactive waste being generated during cleanup. This report further discusses ongoing decommissioning (including site remediation) activities in Section D.3 and F.6.

D. INVENTORIES AND LISTS

Radioactive waste inventories reported in this section are classified according to the waste classification definitions described in Section B of this report.

D.1 Spent Fuel Management

The United States of America (U.S.) nuclear power industry generated 71700 MT heavy metal (MTHM) of spent fuel as of the end of 2013. Of this, 22000 MTHM is in dry storage at nuclear power plant (NPP) sites. Most U.S. commercial spent fuel will remain stored at NPPs until a disposition path is identified. Some spent fuel is also being stored away from NPPs. The Department of Energy (DOE) spent fuel storage facilities include those used to store foreign research reactor and U.S. research reactor spent fuel transferred to DOE. Spent fuel management practices are discussed in Sections F and G.

D.1.1 Spent Fuel Storage

As previously noted, spent fuel in the U.S. is stored either in wet (pool) or dry storage. Dry storage systems include both bolted-lid steel and concrete casks and welded canister-based designs. There are two primary canister-based dry cask storage systems for spent fuel.[38] One system design involves placing canisters vertically or horizontally in a concrete vault used for radiation shielding and protection of the canister. The other design places canisters vertically on a concrete pad and uses both metal and concrete storage overpacks for radiation shielding and canister protection.[39] Spent fuel storage cask designers and manufacturers must comply with the quality assurance (QA) requirements in 10 CFR Part 72 Subpart G. The Nuclear Regulatory Commission (NRC) inspects storage designers, manufacturers, and licensees to verify QA procedures comply with their approved QA plan, and fabrication and use are done according to their QA program. See Section F.3 for additional information.

Table D-1 summarizes the types and numbers of U.S. spent fuel storage facilities and complete lists of spent fuel storage facilities are provided in Annex D-1D. Figure D-1 shows the location of independent spent fuel storage installations (ISFSI) and other spent fuel storage facilities.

NRC regulations 10 Code of Federal Regulations (CFR) Part 50 provide general licenses to store spent fuel in dry storage systems at a site already licensed to operate or possess fuel for a nuclear power reactor. NRC has already approved a variety of dry storage systems potential licensees may consider. These systems have Certificates of Compliance and are listed in NRC regulations (10 CFR 72.214). No applications or Safety Analysis Reports are required for a license to use these design.

[38] http://www.nrc.gov/waste/spent-fuel-storage/diagram-typical-dry-cask-system.html.
[39] http://www.nrc.gov/waste/spent-fuel-storage/designs.html.

Table D-1 Spent Fuel Storage Facilities				
Function	**Number of Facilities[40]**	**Inventory[41]**	**Units[42]**	**Annex**
Government				
Wet Storage	8	34	MTHM	D-1A
Dry Storage[43]	7	2420	MTHM	D-1A
University Research Facilities				
Wet Storage	21	1042	kg U	D-1B
Dry Storage	0	0	kg U	D-1B
Other Research and Nuclear Fuel Cycle Facilities				
Wet Storage	3	36	kg U	D-1C
Dry Storage	1	102	kg U	D-1C
On Site Storage at NPPs[44]				
Wet Storage	66	50390	MTHM	D-1D
Dry Storage	61	20114	MTHM	D-1D

D.1.2 Spent Fuel Disposal

The U.S. currently has no facility for spent fuel disposal.

D.2 Radioactive Waste Management

Section D.2.1 describes waste storage and treatment facilities and their associated inventories. Section D.2.2 describes disposal facilities in the U.S.

D.2.1 Radioactive Waste Storage and Treatment

Radioactive wastes are treated primarily to produce a structurally stable, final waste form and minimize the release of radioactive and hazardous components. The U.S. does not commonly make a distinction between the terms treatment and conditioning, although the distinction is made between the terms by the international community. Conditioning is defined in the international community as an operation producing a waste form suitable for handling, such as conversion of a liquid to a solid, enclosure of the waste in containers, or over packing. Treatment is defined as those operations intended to improve the safety and/or economy by changing the characteristics of the waste through volume reduction, removal of radionuclides, and change in composition. U.S. terminology covering both conditioning and treatment is generally referred to as treatment or processing. Treatment is used in this broader context in this report.

[40] In some instances multiple facilities at a given installation are counted as a single facility such as in the case of shared storage pools or ISFSIs.
[41] Reflects inventory as of December 2010 for government, university and other research reactors and as of June 2013 at NPPs.
[42] MTHM = Metric tons of heavy metal.
[43] Includes NRC-licensed facilities at the DOE Idaho Site and Fort St. Vrain in Colorado.
[44] Includes GE Morris and Utah Private Fuel Storage, which are not located at a nuclear power source. Moreover, Utah Private Fuel Storage has no inventory.

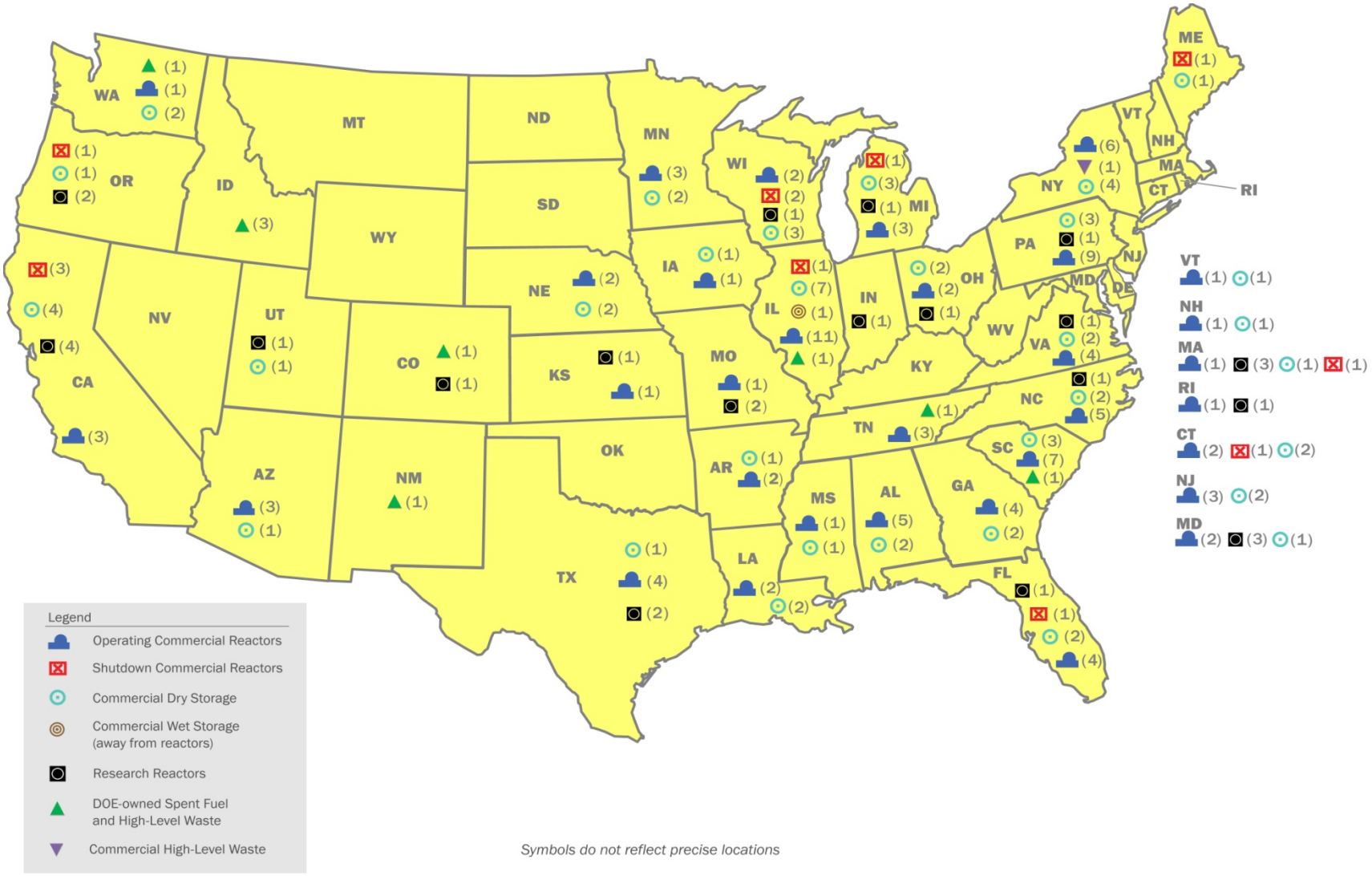

Figure D-1 U.S. Spent Fuel and HLW Storage Installations by State

Table D-2 summarizes the U.S. radioactive waste treatment and storage facilities and the inventory in storage.[45] Annex D-2 provides a list of facilities, their location, main purpose, and essential features. The following sections provide a brief description of the major types of radioactive waste management facilities. Annex D-2 also includes a listing of waste processors.[46]

Table D-2 Radioactive Waste Storage and Treatment Facilities

Sector	Function	Material Type	Number[47]	Inventory	Units	Annex
Government	Storage/ Treatment	HLW	6	3.65E+05	m^3	D-2A
		TRU	11	4.91E+04	m^3	D-2A
		LLW[48]	17	3.29E+04	m^3	D-2A
		Residual radioactive material	1	1.99E+05	m^3	D-2A
		Sealed Sources	2	1.96E+03	Containers	D-2A
Commercial/ Other	Treatment/ Processing	LLW	56	Small volumes for collection		D-2B
	Storage	Residual radioactive material	1	2.12E+04	m^3	D-2B

Treatment facilities for defense waste are among the largest and most complex radioactive waste facilities in the U.S. Hundreds of millions of liters of high-level waste (HLW) in tanks remain from decades of defense materials production activities.

DOE is building the world's largest radioactive waste treatment plant at the Hanford Site in southeastern Washington State to manage defense HLW stored for decades in 177 large underground tanks. The Waste Treatment and Immobilization Plant (WTP) will separate radioactive liquid waste and turn it into a stable glass form suitable for disposal. The radioactive liquid waste will be vitrified and poured into stainless steel canisters. The plant is designed to operate for 40 years. This has been a challenging and complex project due to its size and technical scope. The Fourth U.S. National Report provides additional information on this project.

DOE also has or is constructing large treatment facilities for tank waste at the Idaho Site and Savannah River Site (SRS). At the Idaho Site, where most of the legacy tank waste has been treated and is stored as calcine, a new Sodium Bearing Waste Treatment Plant (known as the Integrated Waste Treatment Unit) for treatment of remaining tank waste has been constructed and is in the commissioning process. This first-of-a-kind facility will treat 3.4 million liters of the remaining tank waste at the Idaho Site, allowing closure of the four remaining underground tanks.

Tank waste continues to be treated at SRS. As part of the treatment process, the waste is separated into two fractions – a high-activity/low-volume stream and a low-

[45] Stored inventories for LLW/MLLW are as of 9/30/2013 per the DOE FY2014 BLDD. Stored inventories for TRU are as of 12/31/2012 per the Annual Transuranic Waste Inventory Report - 2013. Disposed inventories for LLW/MLLW in active facilities are as of 9/30/2013 per the DOE FY2014 BLDD. Disposed TRU inventory (WIPP) is as of 12/31/2013.
[46] D-2A Government, D-2B Commercial.
[47] In some instances, multiple facilities at a given installation are counted as a single facility.
[48] Includes mixed LLW.

activity/high-volume stream. The high-activity fraction is sent to the Defense Waste Processing Facility where it is vitrified for eventual geologic disposal. The low-activity fraction is disposed on site in a grout (cement-like) waste form. In order to expedite the treatment process a new separations facility is being constructed, namely – the Salt Waste Processing Facility (SWPF). The SWPF will greatly increase the separations capacity of the process thereby accelerating the life-cycle treatment schedule.

In addition, treatment and certification of transuranic (TRU) waste continues at multiple DOE sites in preparation for disposal. Large treatment facilities are operating at the Idaho Site (Advanced Mixed Waste Treatment Facility) and Oak Ridge Reservation (Transuranic Waste Processing Center). Some of the other sites processing TRU waste are Argonne National Laboratory, Los Alamos National Laboratory, Hanford Site, and SRS. The legacy inventory of TRU waste continues to decrease as waste is retrieved and processed for disposal.

D.2.2 Radioactive Waste Disposal

The cumulative inventory of disposed radioactive waste[49] is shown in Table D-3. Annex D-2 provides detailed information on the quantities of material for each disposal facility.

Table D-3 Radioactive Waste Disposal Facilities

Sector	Facility Type	Waste Type	Number	Inventory	Units	Annex
Government	Geologic Repository (WIPP)	TRU	1	9.10E+04	m^3	D-2A
	Closed NNSS Greater Confinement Disposal (boreholes)	TRU	1	2.00E+02	m^3	D-2A
	Near Surface Disposal	LLW[50]	18	1.51E+07	m^3	D-2A
				1.25E+02	Reactor Compartments	D-2A
Commercial	Operating Near Surface Disposal	LLW (Class A, B, C)	4	4.63E+06	m^3	D-2B
		AEA Section 11e.(2)	1	1.40E+06	m^3	D-2B
	Closed Near Surface Disposal	LLW	4	4.38E+05	m^3	D-2B
Government/ Commercial	Title I UMTRCA Disposal	Residual Radioactive Material (tailings)	22	2.45E+08	Dry MT[51]	D-3A
Commercial	Title II UMTRCA Disposal	AEA Section 11e.(2)	44			D-3A
Government	Other Closed Disposal Cells (Weldon Spring Site and Monticello)	Residual Radioactive Material (tailings)	2	3.03E+06	m^3	D-2A

[49] Disposed inventories for LLW/MLLW in active facilities are as of 9/30/2013 per the DOE FY2014 BLDD. Disposed TRU inventory (WIPP) is as of 12/31/2013.
[50] Includes MLLW.
[51] Annex D-3 has additional quantities reported in units other than Dry Metric Tons.

D.2.2.1 Transuranic Waste Disposal

The Waste Isolation Pilot Plant (WIPP) is a geologic repository to dispose, safely and permanently, TRU waste generated by atomic energy defense activities.[52] WIPP began operations on March 26, 1999, after more than 20 years of scientific study, public input, and regulatory review of the facility.

WIPP is located in southeastern New Mexico, about 80 kilometers from Carlsbad. The repository consists of disposal rooms mined 655 meters underground in a 600-meter thick salt formation. This formation has been stable for more than 200 million years. WIPP-bound TRU waste is currently stored at multiple locations nationwide (see Annex D-2A). Over 90900 cubic meters (m^3) of defense-generated TRU waste was emplaced as of December 2013. The disposal limit, as defined in the WIPP Land Withdrawal Act (WIPP LWA), is 175500 m^3. As of the publication date of this report, disposal operations at WIPP are suspended pending recovery from an underground vehicle fire and a subsequent unrelated radiological event in February 2014. See Section A.4.5.

WIPP has the physical capacity to accept all DOE defense-generated TRU waste in storage, and projected future waste generation. WIPP is authorized to only receive TRU waste generated by atomic energy defense activities.

D.2.2.2 Low-Level Waste (LLW) (Near Surface) Disposal

There are currently four active, licensed commercial LLW disposal sites.

- Energy*Solutions*/Chem-Nuclear, (near Barnwell, South Carolina) — Access is limited to LLW generators within three states composing the Atlantic Compact (South Carolina, Connecticut, and New Jersey). Barnwell disposes of Class A, B, and C LLW up to 0.37 TBq (10 Ci) (which precludes many higher activity sealed sources).
- US Ecology (on DOE's Hanford Site near Richland, Washington) — restricts access to only the Northwest and Rocky Mountain Compacts. See Figure H.1 for states in these compacts. US Ecology disposes of Class A, B, and C LLW. The US Ecology site can also accept radium and other NORM and accelerator produced radioactive waste without compact restrictions.
- Energy*Solutions* (Clive, Utah) — accepts Class A LLW and mixed LLW for LLW generators without access to other compact facilities.
- Waste Control Specialists (WCS) (near Andrews, Texas) — accepts Class A, B, and C LLW from generators within the Texas Compact (Texas and Vermont). LLW from generators outside the Texas Compact is accepted for disposal by approval of the Compact. In April 2013, WCS opened the Federal Waste Facility to accept certain DOE LLW and mixed LLW. The entire site is privately owned and is regulated by the State of Texas.

Commercial LLW sites now closed are: Beatty, Nevada (closed 1993); Maxey Flats, Kentucky (closed 1977); Sheffield, Illinois (closed 1978), and West Valley, New York (closed 1975).

[52] More information on WIPP can be found at http://www.wipp.energy.gov/index.html.

For additional detail on commercially-disposed LLW, please refer to the following website http://mims.apps.em.doe.gov/.

Commercial LLW remains within NRC's regulatory purview regardless of the radioactive concentration. However, NRC regulations' provide alternative waste disposal approval processes that allow for the disposal of some low-activity LLW in landfills designed and regulated for other purposes (e.g., hazardous waste disposal or industrial debris disposal). See Section H.1.3 for additional information on management strategies for these types of low-activity wastes (LAW).

Figure D-2 depicts the location of DOE LLW and mixed low-level waste (MLLW) generators and waste disposal sites. MLLW is LLW that contains hazardous (non-radiological) waste constituents.

D.2.2.3 Uranium Mill Tailings Disposal

DOE completed surface remediation and groundwater cleanup at the listed Uranium Mill Tailings Radiation Control Act (UMTRCA) Title I inactive uranium milling sites at which the uranium was processed solely for sale to the U.S. Government. Residual radioactive material is the term for radioactive tailings from the original operations at Title I sites. This material had not been regulated as radioactive waste prior to 1978. It consists of the tailings and any windblown contamination resulting from the tailings. This material was collected under the Title I cleanups and stabilized into one or more cells on the site or transported and consolidated in another location because of site conditions. This was handled on a site-specific manner by DOE with NRC concurrence in the remedial action. Tailings, including any wind-blown dust, have been consolidated into a single cell or perhaps relocated to a cell constructed on another site. These cells are now under long-term surveillance by DOE (and licensed by NRC under provisions in 10 CFR 40.27). Annual site inspections are performed as part of the long-term surveillance program at 22 Title I disposal sites. See Annex D-3 for a list of sites.

Forty-eight UMTRCA Title II facilities have been licensed and consist of conventional uranium and thorium (U&Th) mills (27), heap leach facilities (2), in situ recovery (ISR) facilities (14), AEA 11e.(2) byproduct material disposal facilities (2), a resin transfer facility, an oxide-hexafluoride conversion facility and a former mining facility. Twenty-four facilities are located within and regulated by Agreement States.[53] There are five Agreement States (Colorado, Illinois, Texas, Utah, and Washington) licensing 11e.(2) byproduct material. The remaining 24 facilities are regulated by NRC and located within Nebraska, New Mexico, Oklahoma, South Dakota, or Wyoming.[54] Annex D-3 lists both – NRC and Agreement State – regulated uranium recovery facilities.

[53] NRC is required to determine applicable standards and requirements have been met before termination of the licenses at sites located in Agreement States.
[54] The WNI Sherwood site in the state of Washington is regulated under NRC general license to DOE for long-term surveillance.

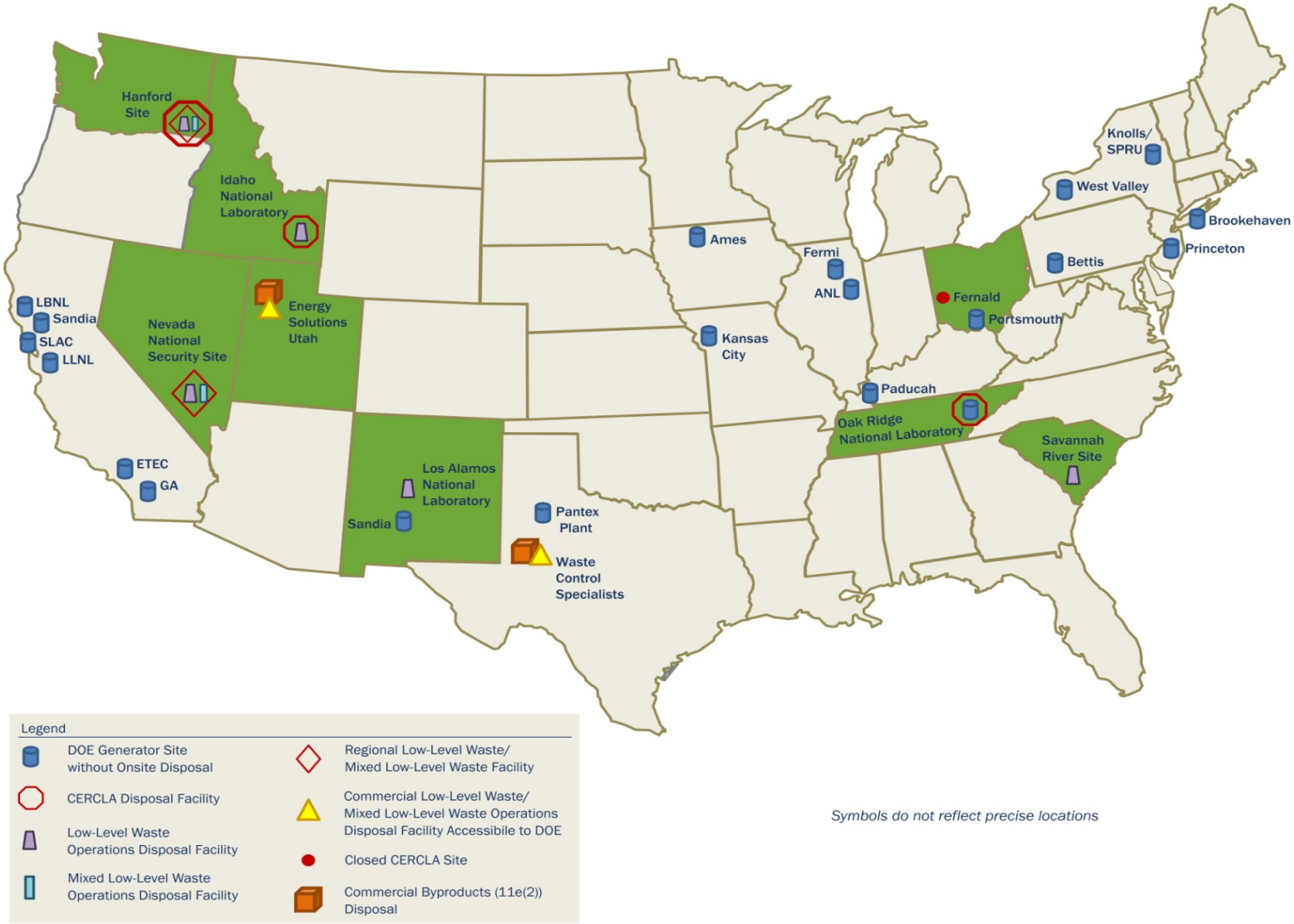

Figure D-2 Location of DOE LLW/MLLW Generators and Waste Disposal

Separate 11e.(2) byproduct material disposal cells are: the White Mesa site and the Energy*Solutions* Utah facility – both regulated by the State of Utah under Agreement State authority; the WCS facility in Andrews County, Texas, regulated by Texas under Agreement State authority; and the Pathfinder/Shirley Basin, Wyoming site, which is directly regulated by the NRC. The Energy*Solutions* and WCS sites have separate 11e.(2) cells from those for LLW disposal. All four facilities are listed under the Radioactive Waste Management Facilities (See Annex D-2B). Section B.4 describes uranium recovery facilities in the U.S.

D.2.2.4 Mine Overburden Remediation

Mine overburden is not classified as radioactive waste requiring restricted disposal, but an estimate of mine overburden is provided at the request of other Contracting Parties to the Joint Convention.[55] Although there are about 4000 mines with documented production, a database compiled by the Environmental Protection Agency (EPA) with information from other Federal, state, and Tribal governmental lands, includes 15000 mine locations, mostly in 14 western states.[56] Most of these locations are in Colorado, Utah, New Mexico, Arizona, and Wyoming, with about 75 percent of those on Federal and Tribal lands. The majority of these sites were conventional (open pit and underground) mines. With the drop in market price of uranium beginning in the 1980s, U.S. producers turned to ISR operations as a principal means of extracting uranium from ore bodies. There were 10 uranium mines operating in 2013 according to DOE's Energy Information Administration.[57]

Mining of uranium ores by surface and underground methods produces large amounts of radioactive waste material classified as naturally occurring radioactive materials (NORM) or Technologically Enhanced NORM (TENORM), including overburden, un-reclaimed sub-economic ores (protore),[58] "barren" rock, and drill cuttings. The volume of waste produced by surface, open-pit mining is a factor of approximately 45 times greater than for underground mining, based on their respective averages. Thus, the amount of overburden generated from open-pit mines far exceeds underground mine overburden. The U.S. Geological Survey, in an estimate for EPA, found the amount of waste rock generated by approximately 4000 conventional mines in their data files, ranged from one billion to nine billion MT of waste, with a likely estimate of three billion MT.[59] Given the larger number of mine locations identified by EPA the amount of waste rock is likely to be higher. Additional historical information is provided in the Third U.S. National Report.

[55] Unless otherwise noted, this information can be found at http://www.epa.gov/radiation/tenorm/uranium.html.
[56] U.S. Environmental Protection Agency, *Uranium Location Database Compilation*, EPA 402-R-05-009, August 2006.
[57] U.S. Energy Information Administration, 2014, *2013 Domestic Uranium Production Report* http://www.eia.gov/uranium/production/annual/pdf/dupr.pdf.
[58] Protore is material containing uranium that cannot be produced at a profit under existing conditions but may become profitable with technological advances or price increases; mineralized material too low in concentration to constitute ore, but from which ore may be formed through secondary enrichment.
[59] Technologically Enhanced Naturally Occurring Radioactive Materials from Uranium Mining; Volume 1: Mining and Reclamation Background; EPA 402-R-08-005; Revision April 2008. http://www.epa.gov/rpdweb00/docs/tenorm/402-r-08-005-voli/402-r-08-005-v1.pdf.

D.3 Nuclear Facility Decommissioning

Table D-5 summarizes ongoing U.S. decommissioning activities within the scope of the Joint Convention. See Table D-5 for more information provided in the subsections corresponding to each of the entries.

Table D-5 Summary of Decommissioning Activities in Progress

Sector	Type	Number
Government	DOE Nuclear/Radioactive Facilities for which Decommissioning is Ongoing or Pending	1063
Government/ Commercial	Formerly Utilized Sites Remedial Action Program (FUSRAP)	24[60]
	Decommissioning Materials Sites Regulated by NRC	15
	Decommissioning Material Sites in NRC Agreement States	41
Commercial	NPPs	17
	Other Non-Power Reactor Facilities	7
	Uranium Recovery Facilities (NRC)	11
	Uranium Recovery Facilities (Agreement States)	13

D.3.1 DOE Sites with Decommissioning/Remediation Projects

The U.S. has a legacy of radioactive waste from past government activities spanning five decades. A total of 107 sites covering more than 0.8 million hectares (two million acres) of land have been used by the U.S. Government for nuclear research and development (R&D) and nuclear weapons production activities. Most of the land at these sites is not contaminated. Within the boundaries of these sites are numerous radiological-controlled areas with thousands of individual facilities, encompassing 10860 discrete contaminated locations ("release sites"). Over 7553 of these release sites have been cleaned up (553 since the last report). Full remediation is complete at 90 of 107 DOE sites[61] (1 since last report), and 660 nuclear or radiological facilities are decommissioned (192 since the last report).

The U.S. Government continues to safeguard its nuclear materials, dispose of waste, remediate extensive surface and ground water contamination, and deactivate and decommission thousands of excess contaminated facilities.

DOE's Office of Legacy Management's mission is to fulfill the DOE's post-closure responsibilities and ensure the future protection of human health and the environment. Legacy Management protects human health and the environment through effective and efficient long-term surveillance and maintenance of legacy sites; preserves, protects, and makes accessible legacy records and information. Legacy Management has control and custody of legacy land, structures, and facilities and is responsible for maintaining them at levels consistent with DOE's long-term plans.

[60] Source: US Army Corps of Engineers, *Formerly Utilized Sites Remedial Action Program Update*, January 2014.
[61] http://energy.gov/em/cleanup-sites.

D.3.2 Formerly Utilized Sites Remedial Action Program

The Formerly Utilized Sites Remedial Action Program (FUSRAP) began in 1974 to identify, investigate, and cleanup or control sites where the Manhattan Engineer District and later the Atomic Energy Commission (AEC) conducted defense and energy research activities in the early days of the Nation's atomic energy program (generally the 1940s - 1960s). Congress transferred FUSRAP management to the U.S. Army Corps of Engineers (USACE) in 1997. USACE continues to cleanup sites started by or newly identified by DOE, or assigned by Congress. FUSRAP sites are distinct from the formerly licensed facilities, addressed in Section H.1.2.[62] FUSRAP sites are returned to DOE for long-term stewardship when remediation is completed. DOE's Office of Legacy Management has responsibility for all FUSRAP sites remediated by DOE and those transferred back to DOE by USACE.[63] The contaminants at FUSRAP sites are primarily low levels of uranium, thorium, and radium, with their associated decay products. Materials containing low levels of radioactive residues are excavated, packaged, and transported for disposal at licensed commercial disposal sites, or to hazardous waste landfills, as appropriate. Annex D-4 lists FUSRAP sites with ongoing remediation activities. In some cases, the FUSRAP sites are also considered as complex material decommissioning sites, and are listed in Annex D-5.

D.3.3 NRC Facility Decommissioning

NRC regards complex sites as those that are required to provide a decommissioning plan (DP) or sites that require formal NRC or State approval prior to being decommissioned. NRC has taken a comprehensive approach to its decommissioning program to achieve better effectiveness. Of the 56 complex materials sites that are currently undergoing decommissioning in the U.S., NRC currently regulates 15 sites, located in 10 states, overseen by the agency's four regional offices. See Section F.6.1 for additional information.

As of April 2014, 17 nuclear power and early demonstration reactors, eight research and test reactors, 15 complex decommissioning materials facilities, two fuel cycle facilities, 22 Title I sites, and 11 Title II uranium recovery facilities are undergoing non-routine decommissioning or are in long-term safe storage, under NRC jurisdiction. Annex D-5 provides a list of these 15 "complex sites" subject to decommissioning. Additional specific information on the decommissioning status of NRC regulated sites can be found at NRC's website,[64] including specific status information for each complex site.

Under the provisions of the AEA, NRC can relinquish regulatory authority to individual states (Agreement State), including regulation of decommissioning material sites in those states. Currently, 13 of the 37 Agreement States are regulating the decommissioning of 41 complex materials sites, with technical support from NRC's regional offices, as needed. See Section E.2.4.2 for additional information. Annex D-5

[62] More FUSRAP information can be found at: http://www.usace.army.mil/Portals/2/docs/Environmental/FUSRAP/FUSRAP_Stakeholder_ReportFINALWeb_2010-10.pdf.

[63] Extensive FUSRAP-related information (including information on specific sites) is available on the Legacy Management web page at http://www.lm.doe.gov. Legacy Management has also developed the Considered Sites Database (CSD) to provide public information documenting site eligibility and characterization, remediation, verification, and certification for all FUSRAP sites. CSD is available at http://www.lm.doe.gov/Considered_Sites/.

[64] http://www.nrc.gov/waste/decommissioning.html.

also lists those facilities undergoing decommissioning in the Agreement States. The NRC Agreement State program is described in detail at: http://www.nrc.gov/about-nrc/state-Tribal/agreement-states.html.

NRC has regulatory oversight responsibility for decommissioning 17 power reactors as of April 2014. NRC also provides oversight for decommissioning of research and test reactors. The eight research and test reactors identified in Annex D-6 are undergoing decommissioning.

NRC provides project management and technical review for decommissioning and reclamation of facilities regulated in 10 CFR Part 40, Appendix A [under the Uranium Mill Tailings Radiation Control Act (UMTRCA) Title II]. These licensees include conventional uranium mills, heap leach facilities, and ISR facilities. Annex D-3 shows these sites. NRC also provides licensing oversight and decommissioning project management for fuel cycle facilities, including conversion plants, enrichment plants, and fuel manufacturing plants. NRC continues to work closely with the states and EPA to regulate remediation of unused portions of fuel cycle facilities. There are two fuel cycle facilities undergoing partial decommissioning; these are the Nuclear Fuels Services site in Erwin, Tennessee, and the Honeywell Metropolis Works facility located in Metropolis, Illinois.

D.3.4 EPA Site Remediation

EPA remediates radiologically-contaminated sites using its Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) authority or can under the same authority require “potentially responsible parties” to cleanup those sites. Since the passage of CERCLA in 1980, 58 radiologically-contaminated sites have been placed on the National Priorities List (NPL) for CERCLA (out of 1701 sites listed – 1326 sites are currently on the NPL). Cleanup has been completed or the selected remedy implemented (e.g., construction of a groundwater treatment system that may operate over a number of years) at 38 of the radiologically-contaminated sites. Radiologically-contaminated NPL sites have included uranium mines, DOE facilities, NRC licensees, and sites being addressed through FUSRAP.

E. LEGISLATIVE & REGULATORY SYSTEMS

E.1 Legislative System

The policy on regulatory control of radioactive waste management in the United States of America (U.S.) has evolved through a series of laws establishing Federal Government agencies responsible for the safety of radioactive materials. Federal legislation is enacted by Congress and signed into law by the President. U.S. laws apply to all 50 states and its territories. Legislation on the safety of spent fuel and radioactive waste can be traced back for several decades. Table E-1 in the Fourth U.S. National Report,[65] identifies key U.S. laws governing radioactive waste management.

E.2 Regulatory System

The regulatory system for spent fuel and radioactive waste management in the U.S. involves several agencies: NRC, regulating the commercial nuclear sector; Environmental Protection Agency (EPA), establishing environmental standards; and Department of Energy (DOE), regulating its government programs. Some Nuclear Regulatory Commission (NRC) regulatory authority — excluding spent fuel, special nuclear material sufficient to form a critical mass, and high-level waste (HLW) — can be relinquished to the 50 states of the U.S. (including territories, Puerto Rico, and the District of Columbia) under its Agreement State Program. This is a provision of Section 274 of the Atomic Energy Act of 1954 (AEA), as amended. This authority includes regulating commercial low-level waste (LLW) disposal sites and uranium mill tailings sites, and regulatory authority over disposal of mill tailings. Some states also have regulatory authority delegated to them by EPA, such as for discharges from some industrial or mining practices. These are referred to as EPA Authorized States. See Section E.2.4.1.

The general regulations for the three Federal agencies responsible for radioactive waste regulation are contained in Title 10 (for NRC and DOE) and Title 40 (for EPA) of the U.S. Code of Federal Regulations (CFR). U.S. Government regulations are developed through an open process, including the opportunity for public comment. New regulations are published in the Federal Register (FR), in proposed or final forms. Specific regulations for each Agency and their available information are provided in Table E-1.

DOE Orders are internal directives, which function similar to regulations for DOE and DOE contractor activities. Compliance with such orders is mandatory for DOE and is enforced through contract provisions for DOE contractors.

The separation between EPA's standard-setting function and NRC's implementing function for environmental standards reflects a nearly 40-year old Congressional policy of centralizing environmental standard setting in a single agency. When EPA was established, it was given environmental authorities scattered among several older agencies, including NRC's predecessor, the Atomic Energy Commission (AEC). There are advantages to having an agency both set and implement standards, and NRC does so in many subject areas, most especially in reactor design and operation. Nonetheless, there are also advantages to having environmental standards set on a national basis by

[65] http://energy.gov/em/downloads/fourth-national-report-joint-convention-safety-spent-fuel-management-and-safety.

a single agency whose jurisdiction is wide enough to permit the agency to rank risks from many sources, including nuclear.

Table E-1 Spent Fuel, Radioactive Waste, and Disused Sealed Sources Management Regulations
NRC Regulations, Guidance and Communications
High-Level Waste Disposal Regulations, Guidance, and Communications
http://www.nrc.gov/waste/hlw-disposal/regs-guides-comm.html
Low-Level Waste Disposal Regulations, Guidance, and Communications
http://www.nrc.gov/waste/llw-disposal/regs.html
Uranium Recovery Regulations, Guidance and Communications
http://www.nrc.gov/materials/uranium-recovery/regs-guides-comm.html
Decommissioning Regulations, Guidance and Communications
http://www.nrc.gov/waste/decommissioning/reg-guides-comm.html
Spent Fuel Storage Regulations, Guidance and Communications
http://www.nrc.gov/waste/spent-fuel-storage/regs-guides-comm.html
Source Materials Facilities Regulations, Guidance and Communications
http://www.nrc.gov/materials/src-materials-facilities/regs-guides-comm.html
Medical, Industrial, Academic Uses of Nuclear Materials Regulations, Guidance and Communications
http://www.nrc.gov/materials/miau/regs-guides-comm.html (includes sealed sources and orphan sources)
Export-Import of Radioactive Materials
http://www.nrc.gov/about-nrc/ip/export-import.html
Emergency Preparedness and Response
http://www.nrc.gov/about-nrc/emerg-preparedness.html (reactors) http://pbadupws.nrc.gov/docs/ML1322/ML13227A120.pdf (ISFSI) http://pbadupws.nrc.gov/docs/ML1316/ML13165A140.pdf (fuel facilities)
Special Nuclear Material
http://www.nrc.gov/materials/sp-nucmaterials.html
U.S. Department of Energy
10 CFR Part 765, *Reimbursement of Costs for Remedial Action at Active Uranium and Thorium Processing Sites* 10 CFR Part 766, *Uranium Enrichment Decontamination and Decommissioning Fund; Procedures for Special Assessment of Domestic Utilities* 10 CFR Part 820, *Procedural Rules for DOE Nuclear Facilities* 10 CFR Part 830, *Nuclear Safety Management* 10 CFR Part 835, *Occupational Radiation Protection* 10 CFR Part 960, *General Guidelines for the Recommendation for Sites for Nuclear Waste Repositories* 10 CFR Part 963, *Yucca Mountain Site Suitability Guidelines* 10 CFR Part 1021, *National Environmental Policy Act Implementing Procedures*
The following DOE directives are applicable to safety[66]:

[66] For DOE Directives: https://www.directives.doe.gov/.

Table E-1 Spent Fuel, Radioactive Waste, and Disused Sealed Sources Management Regulations
Order 151.1C, *Comprehensive Emergency Management System* Policy 226.1B, *Department of Energy Oversight Policy* Order 226.1B, *Implementation of Department of Energy Oversight Policy* Order 231.1A, *Environment, Safety, and Health* Order 360.1B, *Federal Employee Training* Order 414.1D, *Quality Assurance* Order 420.1B, *Facility Safety* Guide 421.1-2, Guide 423.1-1; DOE Guide 424.1-1B, *Implementation Guides for 10 CFR 830 Order 422.1, Conduct of Operations* Order 425.1D, *Startup and Restart of Nuclear Facilities* Order 430.1B, *Real Property Asset Management* Order 433.1B, *Maintenance Management Program* Order 435.1, *Radioactive Waste Management* Order 440.1B, *Worker Protection Management for DOE Federal and Contractor Employees* Order 470.2B, *Independent Oversight and Performance Assurance Program* Order 458.1, *Radiation Protection of the Public and the Environment* Order 426.2, *Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities* Order 462.1*, Import and Export of Category 1 and 2 Radioactive Sources and Aggregated Quantities.*
U.S. Environmental Protection Agency
40 CFR Part 61, *National Emission Standards for Hazardous Air Pollutants*
http://www.epa.gov/radiation/neshaps/index.html
40 CFR Part 190, *Environmental Radiation Protection Standards for Nuclear Power Operations*
http://www.epa.gov/radiation/laws/190/index.html
40 CFR Part 191, *Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-level and Transuranic Radioactive Wastes*
http://www.gpo.gov/fdsys/pkg/CFR-2013-title40-vol26/pdf/CFR-2013-title40-vol26-part191.pdf
40 CFR Part 192, Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings
http://www.epa.gov/radiation/tenorm/index.html
40 CFR Part 194, *Criteria for the Certification and Recertification of the Waste Isolation Pilot Plant's (WIPP) Compliance with the 40 CFR Part 191 Disposal Regulations*
http://www.epa.gov/radiation/wipp/index.html
40 CFR Part 197, *Public Health and Environmental Radiation Protection Standards for Yucca Mountain, Nevada*
http://www.epa.gov/radiation/yucca/index.html

Other Title 40, Code of Federal Regulations relating to radiation protection include:
Part 141, *National Primary Drinking Water Regulations* http://water.epa.gov/drink/ Part 147, *State Underground Injection Control Programs* Part 148, *Hazardous Waste Injection Restrictions* http://water.epa.gov/type/groundwater/uic/index.cfm Part 195, *Radon Proficiency Programs* http://www.epa.gov/radon/ Parts 220 and 133, *Ocean Dumping* http://water.epa.gov/type/oceb/oceandumping/dredgedmaterial/dumpdredged.cfm Part 300, *National Oil and Hazardous Substances Pollution Contingency Plan* Part 302, *Designation, Reportable Quantities, and Notification* http://www.epa.gov/radiation/rert/ncp.html Part 440, *Ore Mining and Dressing Point Source Category (Uranium, Radium, and Vanadium Ores subcategory)* http://water.epa.gov/scitech/wastetech/guide/index.cfm

E.2.1 U.S. Nuclear Regulatory Commission

NRC is an independent regulatory agency created from the former AEC by Congress under the Energy Reorganization Act of 1974 to assure protection of the public health and safety and the environment, and to promote the common defense and security in the civilian use of byproduct, source, and special nuclear materials.

NRC regulates:

- Commercial nuclear power, non-power research, test, and training reactors;
- Fuel cycle facilities, medical, academic, and industrial uses of nuclear materials;
- Storage and disposal of nuclear materials and waste; and
- Certain DOE activities and facilities over which Congress has provided NRC licensing and related regulatory authority.

NRC regulates manufacture, production, transfer or delivery, receiving, acquisition, ownership, possession, and use of commercial radioactive materials, including the regulation of the associated radioactive waste. The key elements of NRC's regulatory program are described in detail at: http://www.nrc.gov; this information is also available from previous U.S. National Reports.

Specifically, NRC regulates management and disposal of LLW and HLW and decontaminating and decommissioning facilities and sites. NRC is also responsible for establishing the technical bases for regulations and provides information and technical bases for developing acceptance criteria for licensing reviews. Table E-2 lists the links to NRC regulations, guidance and communications.

An important aspect of NRC's regulatory program is inspection and enforcement. NRC has four regional offices, which inspect licensed facilities in their regions, including

nuclear waste facilities.[67] NRC's Office of Federal and State Materials and Environmental Management Programs communicates with state, local and Tribal governments, and oversees the Agreement State Program. NRC Agreement States are discussed in Section E.2.4.2.

E.2.1.1 Uranium Recovery Regulation

Section B.4 introduced the Uranium Mill Tailing Radiation Control Act (UMTRCA). NRC is responsible for planning and implementing regulatory programs under UMTRCA. UMTRCA amended the AEA to require EPA to issue generally applicable standards for controlling uranium mill tailings and other residual radioactive materials. EPA issued standards for both Title I (residual radioactive material) and Title II (AEA Section 11e.(2) byproduct material) sites in 1983. The Title I program established a joint Federal/state funded program for remedial action at abandoned mill tailings sites, with final Federal ownership under NRC license. NRC, under Title l, must evaluate DOE designs and agree DOE actions meet standards set by EPA. NRC and DOE have a memorandum of understanding (MOU) to clarify their roles and responsibilities, (e.g., to minimize or eliminate duplication of effort between the two agencies).[68]

UMTRCA Title ll involves planning and directing activities for active, licensed uranium recovery facilities, including facility licensing and operation, and mill tailings management and decommissioning. Title II deals with NRC or Agreement States sites. NRC regulations are found in 10 CFR Part 40, Appendix A, and are consistent with EPA Title II standards and meet UMTRCA requirements. NRC has authority under Title II to control radiological and non-radiological hazards, and ensure NRC-licensed and Agreement State-licensed sites meet all standards and requirements during operations and before termination of licenses. NRC reviews Title II license applicant's plans for operating, reclaiming, decommissioning, and groundwater corrective action; license applications (LA) and renewals; license conditions changes; and annual surety updates.

NRC also provides technical assistance to Agreement States on uranium recovery issues and implements an active interface program including consultation with Federal agencies, states, Tribal governments, and other entities to promote understanding of uranium programs and resolving concerns in a timely manner.

E.2.1.2 HLW and Spent Fuel Regulation

Regulatory responsibility for disposal of HLW and spent fuel is described in the Energy Reorganization Act, the Nuclear Waste Policy Act of 1982, as amended (NWPA), and Energy Policy Act of 1992 (EPAct92). NRC has licensing authority for facilities for the disposal of spent fuel or HLW including:

- Conducting pre-licensing consultation;
- Certifying transportation packages; and
- Review of LA for construction authorization of a repository at Yucca Mountain.

[67] Specific information on NRC Regional Offices can be accessed at: http://www.nrc.gov/about-nrc/organization.html.

[68] DOE GM04-85AL26037 Memorandum of Understanding between the U.S. Department of Energy and the U.S. Nuclear Regulatory Commission. November 1990.

EPA has issued final standards for HLW disposal at Yucca Mountain (at 40 CFR Part 197), and NRC has published conforming licensing regulations for HLW disposal at Yucca Mountain (at 10 CFR Part 63). EPA has also issued final standards for HLW disposal for sites other than Yucca Mountain (at 40 CFR Part 191). Although EPA and NRC finalized regulations for HLW disposal for sites other than Yucca Mountain, these regulations have remained substantially the same since their development over 20 years ago. NRC is currently evaluating the need for revisions to these regulations to conform to EPA's final standards and to take advantage of regulatory enhancements that have occurred since 10 CFR Part 60 was developed. EPA standards and NRC regulations are generally consistent with national and international recommendations for radiation protection standards.

E.2.1.3 LLW Regulation

Commercial LLW disposal facilities are designed, constructed, and operated under licenses issued by either NRC or an Agreement State[69], pursuant to Section 274 of the Atomic Energy Act, based on NRC health and safety regulations governing waste disposal quantities, forms, and activity levels (10 CFR Part 61, *Licensing Requirements for Land Disposal of Radioactive Waste*). This regulation establishes the procedures, criteria, and terms and conditions for the issuance of licenses for the disposal of LLW. Four performance objectives, including protection of an inadvertent intruder into the waste disposal site, define the overall level of safety to be achieved by disposal.[70] Specifically, Section 61.55 addresses the classes of LLW. These classes are described in Table B-1 of this report. The process by which a state becomes an Agreement State regulating LLW is described in http://www.nrc.gov/about-nrc/state-tribal/become-agreement.html. The Low-Level Radioactive Waste Policy Amendments Act of 1985 (LLRWPAA) gave the states responsibility for the disposal of LLW generated within their borders (except for certain waste generated by the Federal government). The Act authorized the states to enter into compacts that would allow them to dispose of waste at a common disposal facility. See Section H.1.1. for additional information on commercially licensed LLW disposal facilities and disposal compacts.

E.2.1.4 Decommissioning Regulation

Decommissioning involves safely removing a facility from service and reducing residual radioactivity to a level permitting the property to be released for unrestricted or restricted use. This action is taken by a licensee before NRC terminates its license.

Title 10 CFR Part 20, Subpart E provides the main decommissioning requirements and regulations; however, the diversity and complexity of decommissioning dictates regulations focusing on specific features associated with the different types of sites and activities undergoing termination of licenses and decommissioning.[71] A unique consideration for decommissioning in the U.S. is a timeliness provision; i.e., specific time periods for decommissioning unused portions of operating nuclear materials facilities and for decommissioning the entire site upon termination of operations.

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[69] Under the provisions of the AEA, NRC can relinquish regulatory authority to individual states (Agreement State), including regulation of LLW sites in those states.

[70] The other performance objectives are protection of the general population from releases of radioactivity; protection of individuals during the operation of the facility (as opposed to after the facility is closed) and stability of the disposal site.

[71] The specific regulations are accessible at: http://www.nrc.gov/waste/decommissioning/reg-guides-comm/regulations.html.

NRC has developed a number of guidance documents to help licensees prepare decommissioning documents. The primary decommissioning guidance is documented in the *Consolidated Decommissioning Guidance* (NUREG-1757) and the *Standard Review Plan for Evaluating Nuclear Power Reactor License Termination Plans* (NUREG-1700, Rev. 1). These documents describe: (1) acceptable methods for implementing NRC's regulations; (2) techniques and criteria used by NRC in evaluating decommissioning actions; and (3) guidance to licensees responsible for decommissioning NRC-licensed sites.[72] *The Consolidated Decommissioning Guidance* documents are periodically revised and re-issued as a result of lessons learned, changes in regulations, and an ongoing continuous improvement activity. For additional information on these activities, please refer to past issues of the U.S. National Report and the Status of the Decommissioning Program Annual Report.[73]

To strengthen future decommissioning at existing operating facilities, 10 CFR 20.1501 requires surveys to identify contamination that would require remediation for license termination. Guidance implementing the rule was provided in RG 4.22, *Decommissioning Planning during Operations*, issued December 2012.

Additional information on NRC's decommissioning approach is provided in Section F.6.1 of this report. There are many opportunities for public involvement and information throughout the decommissioning process.[74, 75]

The decommissioning process for non-power reactor facilities can be initiated by any number of conditions.[76] These include expiration of the license and cessation of operations in all or part of the site for 24 months. NRC inspects the licensee's decommissioning operations to ensure compliance with the decommissioning plan (DP). These inspections will normally include in process and confirmatory radiological surveys.[77]

In the final steps of decommissioning of material sites, licensees are required to perform a number of actions including certification of the disposition of all licensed material and performance of a radiation survey of the premises.[78]

E.2.1.5 NRC's Integrated Materials Performance Evaluation Program

NRC, in coordination with the Agreement States, developed and piloted a review process in 1994 for Agreement State and NRC regional materials programs called the Integrated Materials Performance Evaluation Program (IMPEP). Common performance indicators were established to obtain comparable information on the performance of

[72] These are accessible from http://www.nrc.gov/waste/decommissioning/reg-guides-comm/guidance.html.
[73] http://www.nrc.gov/waste/decommissioning.html.
[74] http://www.nrc.gov/waste/decommissioning/public-involve.html.
[75] Additional information on the decommissioning process for reactors is accessible at: http://www.nrc.gov/waste/decommissioning/process.html.
[76] Major steps in the complex materials site decommissioning process are described at http://www.nrc.gov/waste/decommissioning/process.html.
[77] NRC's decommissioning oversight activities at http://www.nrc.gov/waste/decommissioning/oversight.html.
[78] Specific details for unrestricted versus restricted release, schedules for notification and completion of decommissioning milestones, as well as alternatives in the compliance with regulatory requirements for decommissioning are discussed in greater detail at http://www.nrc.gov/waste/decommissioning.html.

each program. NRC began full implementation of IMPEP in 1996 to ensure public health and safety are adequately protected from potential hazards of using radioactive materials, and Agreement State programs are compatible with NRC's program.[79]

IMPEP employs a team of NRC and Agreement State staff to assess both Agreement State and NRC radioactive materials licensing and inspection programs. All reviews use the following common indicators in the assessment and place primary emphasis on performance:

- Technical Staffing and Training;
- Status of Materials Inspection Program;
- Technical Quality of Inspections;
- Technical Quality of Licensing Actions; and
- Technical Quality of Incident and Allegation Activities.

Additional areas are identified as non-common performance indicators (Compatibility Requirements, Sealed Source and Device Evaluation Program, Low-Level Radioactive Waste Disposal Program, and Uranium Recovery Program) and may also be addressed in the assessment.

NRC Regional Offices are rated in a comparable manner but without additional compatibility finding. IMPEP reviews provide good practices, annual reports, and lessons learned which are made available to all regulatory programs.[80] Additional information on the IMPEP program can be found at the IMPEP Toolbox. Lessons learned reflect input and feedback from Agreement State officials and NRC regional staff.

E.2.2 U.S. Environmental Protection Agency

EPA has several radioactive waste regulatory functions which are described in more detail below. EPA is composed of a headquarters organization and 10 regional offices. Each EPA Regional Office is responsible for executing Agency's programs with states in its region. EPA also has 17 laboratories located across the nation.

E.2.2.1 Waste Isolation Pilot Plant Oversight

The Waste Isolation Pilot Plant Land Withdrawal Act (WIPP LWA), as amended, required EPA to issue final regulations for disposal of spent fuel, HLW, and transuranic (TRU) waste. The Act also gave EPA authority to develop criteria implementing final WIPP radioactive waste disposal standards. The Act specified, EPA must also determine every five years whether the WIPP facility is in compliance with final disposal regulations. The Act also requires EPA to determine whether WIPP complies with other Federal environmental and public health and safety regulations, such as the Clean Air Act (CAA) and the Solid Waste Disposal Act.

[79] The IMPEP program was selected in 2004 as among the top 50 programs for the "Innovations in American Government Awards," sponsored by the Ash Institute for Democratic Governance and Innovation at Harvard University's John F. Kennedy School of Government and administered in partnership with the Council for Excellence in Government.

[80] Additional information on IMPEP may be found at http://nrc-stp.ornl.gov/impeptools.html.

EPA issued final amendments to its radioactive waste disposal standards for spent fuel, HLW, and TRU radioactive waste on December 20, 1993, initially promulgated in 1985 (40 CFR Part 191). The final individual protection standards require disposal systems to limit the amount of radiation to which an individual can be exposed for 10000 years. The final groundwater protection standards require disposal systems to be designed so that for 10000 years after waste disposal, contamination in off-site underground sources of drinking water will not exceed the maximum contaminant level for radionuclides established by EPA under the Safe Drinking Water Act (SDWA). Containment requirements of Subpart C limit releases of radionuclides to specified levels for 10000 years after the facility accepts its final waste for disposal, while assurance requirements involve additional measures intended to provide confidence in the long-term containment of radioactive waste. EPA issued final compliance criteria on February 9, 1996 (40 CFR Part 194) for certification and recertification of WIPP compliance with the final radioactive waste disposal standards in 40 CFR Part 191.

DOE submitted a Compliance Certification Application to EPA on October 29, 1996, to demonstrate WIPP complies with the criteria at 40 CFR Part 194. EPA then conducted a very open certification review process, involving multiple opportunities for written public comments and public hearings. EPA issued a Final Rulemaking Notice on the certification decision on May 18, 1998. WIPP received its first TRU waste shipment on March 26, 1999.

The Office of Radiation and Indoor Air coordinates most EPA actions under the WIPP LWA. Other EPA offices also play important roles concerning WIPP. EPA's Region VI office, based in Dallas, Texas, is responsible for collecting and reviewing information related to WIPP compliance with all applicable environmental laws and regulations other than the radioactive waste disposal standards, and provides a recommendation to the EPA administrator. The Region VI office also coordinates with EPA's Office of Resource Conservation and Recovery on hazardous waste issues. Some TRU waste intended for disposal at the WIPP also contains hazardous components, subjecting it to the regulations developed under the Resource Conservation and Recovery Act of 1976 (RCRA), as amended.

EPA conducts inspections of both waste generators and WIPP operations. Separate inspections may be conducted for waste characterization activities, quality assurance (QA), or WIPP site activities (procedural or technical).

The State of New Mexico is authorized by EPA to carry out the base RCRA and mixed waste programs in lieu of equivalent Federal programs. The New Mexico Environment Department reviews permit applications for treatment, storage, and disposal facilities for hazardous waste, under Subtitle C of RCRA. WIPP's Hazardous Waste Facility Permit (HWFP) is renewed every 10 years. The updated HWFP was approved on November 30, 2010 and the permit's effective date was December 30, 2010.

E.2.2.2 EPA HLW and Spent Fuel Disposal Standards

In addition to EPA's generally applicable standards in 40 CFR Part 191, the EPAct92 required EPA to develop radiation protection standards specifically for the Yucca Mountain site to protect the public and the environment from exposure to radioactive wastes disposed in the repository (40 CFR Part 197). These standards were issued in 2001. As a result of a legal challenge to the regulatory compliance period, EPA amended the standard to extend the compliance period and incorporate other supporting

provisions. The amended standards were issued in 2008. Further legal challenge to the amended standards is stayed pending resolution of NRC's renewed license review.

E.2.2.3 Mixed Waste Regulation

A dual regulatory framework exists for mixed waste. EPA or authorized states regulate the hazardous waste component and NRC, NRC Agreement States, or DOE regulate the radioactive component. NRC and DOE regulate mixed waste radiation hazards using AEA authority. EPA regulates mixed waste chemical hazards under its RCRA authority. NRC is authorized by the AEA to issue licenses to commercial users of radioactive materials. RCRA gives EPA authority to control hazardous waste from "cradle-to-grave." Waste handlers must comply with both AEA and RCRA statutes and regulations once a waste is found to be a mixed waste. The requirements of RCRA and AEA are generally consistent and compatible. The provisions in Section 1006(a) of RCRA allow the AEA to take precedence if provisions of requirements of the two acts are inconsistent.

Land Disposal Restriction regulations, under the 1984 Amendments to RCRA, prohibit disposal of most mixed waste until it meets specific treatment standards for hazardous constituents, which may be based on a concentration or a specific treatment technology. Most commercial mixed waste (generated and stored) can be treated to meet Land Disposal Restriction regulations with commercially available treatment technology. No treatment or disposal capacity is available for a small percentage of commercial mixed waste. Commercial mixed waste volumes are very small (approximately two percent) compared to the total volume of mixed waste being generated or stored by DOE.

DOE has developed Site Treatment Plans to handle its mixed wastes under the Federal Facilities Compliance Act, signed into law on October 6, 1992. These plans are being implemented by orders issued by EPA or the state regulatory authority.

EPA issued regulations in 2001 allowing certain mixed waste to be exempted from RCRA hazardous waste requirements, as long as it meets NRC or Agreement State requirements. These regulations may be found at 40 CFR Part 266, Subpart N, and apply to:

- Storage at the generator site or another site operating under the same license;
- Treatment in a tank or container at the generator site or another site operating under the same license;
- Transportation to a licensed treatment facility or LLW disposal facility; and
- Disposal at a licensed LLW disposal facility, as long as the waste meets RCRA treatment standards for hazardous constituents.

E.2.2.4 Uranium Mining and Milling Standards

UMTRCA, which amended the AEA, directed EPA to establish standards for active and inactive uranium and thorium (U&Th) mill sites (see Section D.2.2.3). The standards for active sites were issued in 1983 as 40 CFR Part 192 (and amended in 1995), and establish limits on radon emanations from tailings as well as contamination limits for buildings, soil, and ground water. NRC incorporated these standards into its regulations in 10 CFR Part 40, Appendix A. A key aspect of UMTRCA is that it required EPA's standards to address non-radiological contaminants in a manner consistent with EPA's

requirements for managing chemically hazardous waste. The inactive site standards, 40 CFR Part 192, Subparts A, B and C are implemented by DOE at inactive sites.

The AEA does not identify uranium-mining overburden as radioactive material to be controlled, and NRC and DOE do not regulate the disposition of conventional mining wastes as part of the nuclear fuel cycle. Once uranium-mining product is beneficiated or is brought into the milling circuit, including production from in situ recovery (ISR) operations, then NRC and its Agreement States regulate its possession, use, transport, etc.

EPA has also established National Emission Standards for Hazardous Air Pollutants (NESHAPs) under the CAA for airborne radionuclide emissions from a variety of industrial sources (40 CFR Part 61). Subparts B, T, and W of the CAA apply to underground uranium mines, inactive uranium mill tailings piles, and active uranium mill tailings piles, respectively. See Section E.2.2.4 of the Third U.S. National Report for more information on these regulations.

EPA is currently reviewing 40 CFR Part 192 and Subpart W for the purpose of updating the standards to more directly address ISR facilities and reflect new risk assessments. EPA proposed revisions to the Subpart W standards on May 2, 2014 (79 FR 25388). The proposal specifies management practices to be used to control radon emanation from conventional tailings impoundments, non-conventional impoundments (e.g., evaporation ponds), and heap leach facilities.

E.2.2.5 Other EPA Radiation-Related Authorities

EPA has regulatory responsibilities for the following:

- Developing general radiation protection guidance to the Federal government. Section F contains additional information about radiation protection;
- Limiting airborne emissions of radionuclides. Subpart H of EPA's NESHAPs standards limit the airborne emissions of radionuclides (other than radon) from DOE sites managing defense-related spent fuel and radioactive waste. A limit of 0.1 mSv (10 mrem) per year effective dose equivalent is applied to any member of the public in the vicinity of such sites. Emission monitoring is specified, and DOE sites are required to submit an annual compliance report to EPA. Subpart I applied similar requirements to NRC-licensed facilities but was rescinded when NRC established comparable requirements – Subpart I now applies only to Federal facilities other than DOE that are not licensed by NRC;
- Setting drinking water regulations, under the SDWA, as amended, including standards for radionuclides in community water systems;
- The Clean Water Act authorizes the National Pollutant Discharge Elimination System (NPDES) permit program, which controls water pollution by regulating point sources that discharge pollutants into surface waters. Point sources are discrete conveyances such as pipes or man-made ditches. These permits apply to such activities as dewatering mines to allow resource recovery of minerals. In most cases, the NPDES permit program is administered by EPA authorized states;
- Remediating radiologically contaminated sites listed on the CERCLA National Priorities List (NPL). See Section D.3.4. The NPL includes sites licensed by NRC or Agreement States, as well as DOE sites. EPA and NRC entered into a

MOU in October 2002, to avoid future confusion about the potential for dual regulation at decommissioned sites. This MOU defines conditions where the two agencies would consult on the decommissioning of NRC-licensed facilities;[81]

- Coordinating with state radiation protection agencies to protect the environment, workers, and the public from naturally occurring radioactive materials (NORM) exposed or concentrated by mining or processing; and
- Coordinating with DOE, NRC and states on orphaned sources, recycled materials, and controlling imports and exports to prevent radioactively contaminated scrap from entering the U.S.[82] See further discussions in Sections I and J.

E.2.3 U.S. Department of Energy

DOE is responsible for regulating its spent fuel and radioactive waste management activities pursuant to the Atomic Energy Act (see Table E-1 in the Fourth U.S. National Report), except where Congress has specifically given NRC licensing and related regulatory authority over DOE activities or facilities. Radiation and environmental protection are ensured by a rigorous framework of Federal regulations, DOE Directives (e.g., DOE Orders (DOE O)), and external recommendations by the Defense Nuclear Facilities Safety Board (DNFSB). The major applicable Federal regulations include 10 CFR Part 820, *Procedural Rules for DOE Nuclear Activities*,[83] 10 CFR Part 830, *Nuclear Safety Management*,[84] and 10 CFR Part 835, *Occupational Radiation Protection.*[85] (See Section F.3)

DOE also regulates facility operations and radiation protection through standards and requirements established in DOE O. The major applicable Orders include DOE O 458.1, *Radiation Protection of the Public and the Environment*[86] (see Section F.3) and DOE O 435.1, *Radioactive Waste Management.*[87] Table E-1 provides a list of spent fuel and radioactive waste management Federal regulations, and DOE Orders.

The following sections describe the multiple independent oversight and regulatory layers governing DOE's spent fuel and radioactive waste management activities.

E.2.3.1 DOE Regulatory Requirements and Independent Oversight

DOE's former Office of Health, Safety and Security (HSS) which provided regulatory and independent oversight functions for DOE spent fuel and radioactive waste management activities designated under the Joint Convention was reorganized in 2014 into two

[81] See OSWER Directives 9295.8-06 and 9295.8-06a at http://www.epa.gov/superfund/health/contaminants/radiation/mou.html.
[82] The U.S. Coast Guard and the U.S. Department of Homeland Security Customs and Border Protection have the lead in detecting and taking steps to prevent the illegal entry of such materials. They have the authority to take enforcement actions and, depending on the circumstances, may seize or have a shipment returned to the point of origination.
[83] http://ecfr.gpoaccess.gov/cgi/t/text/text-.idx?c=ecfr&sid=878197d37c47d5d267017ca6fde249ba&rgn=div5&view=text&node=10:4.0.2.5.24&idno=10
[84] http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&tpl=/ecfrbrowse/Title10/10cfr830_main_02.tpl.
[85] http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&tpl=/ecfrbrowse/Title10/10cfr835_main_02.tpl.
[86] https://www.directives.doe.gov/directives-documents/0458.1-BOrder.
[87] https://www.directives.doe.gov/directives-documents/0435.1-BOrder.

offices, the Office of Environment, Health, Safety and Security (EHSS) and the Office of Independent Enterprise Assessment (IEA).[88]

EHSS provides corporate leadership and strategic approaches for protecting DOE's workers, the public, the environment and national security assets. This mission is accomplished through developing corporate policies and standards and providing guidance on their implementation; sharing operating experience, lessons learned, and best practices; and providing assistance and supporting services to line management with the goal of mission success as DOE's environment, health, safety and security advocate. Activities include:

- Developing effective, efficient, and state-of-the-art environmental, occupational safety and health, and medical policies and rules for operating DOE facilities; and
- Providing technical assistance to DOE programs to identify and resolve environment, safety, health, safeguards, and security issues.

EHSS develops, manages, and directs programs for health and safety policy to protect health and safety of workers and for facility and systems operations safety. It serves as the primary DOE liaison with the Department of Labor (DOL) Occupational Safety and Health Administration and NRC on health and safety regulation reviews and pending regulatory reform.

IEA provides an independent regulatory oversight function within DOE, reporting to the Office of the Secretary of Energy. The office serves as a check and balance that meets the Department's responsibilities as a self-regulating entity. The IEA is responsible for:

- Performing assessments in the areas of nuclear and industrial safety, cyber and physical security, and other functions;
- Implementing an investigative capability to conduct Congressionally-mandated enforcement functions in the areas of worker safety and health, nuclear safety, and security;
- Implementing the Enforcement Program to promote overall improvement in DOE's nuclear safety, worker safety and health, and security programs;
- Managing the Independent Oversight Program, providing an independent evaluation of the adequacy of DOE's policy and the effectiveness of line management performance in safeguards and security, cyber security, emergency management, environment, safety, and health;
- Conducting independent reviews of DOE sites, facilities, organizations, and operations in the areas of safety and emergency management; and
- Conducting special reviews of safety and emergency management topics at the request of line management, or as directed by senior DOE management.

DOE regulations in 10 CFR Parts 820, 830, and 835 make DOE nuclear safety requirements subject to enforcement, including the imposition of civil and criminal penalties. DOE's former Office of Price-Anderson Enforcement has been abolished and its functions transferred to IEA. Those functions are: maintaining the internal self-regulatory program; investigating potential violations; and, where warranted, initiating enforcement actions including imposing civil penalties. Those actions are performed according to processes and procedures in 10 CFR Part 820. Oversight activities are

[88] http://energy.gov/iea/services/enterprise-assessments.

further described in DOE O 227.1, *Independent Oversight Program*[89] and DOE O 226.1B, *Implementation of Department of Energy Oversight Policy*.[90]

In addition to the oversight functions of EHSS and IEA, DOE's Low-Level Waste Disposal Facility Federal Review Group (LFRG)[91] was established to fulfill the requirements contained in DOE O 435.1, as well as serve as a regulatory oversight function or body for compliance reviews of Performance Assessments (PA) for DOE LLW disposal facilities. Additionally, the LFRG assists senior managers in the review of documentation that supports the approval of LLW PA's, and composite analyses for a particular waste disposal facility or appropriate Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) documents. LFRG advises the senior managers at each site to start, continue or stop operations at that particular site.

DOE's Office of the General Counsel (and the National Nuclear Security Administration Office of the General Counsel, as appropriate) ensures programs and processes are conducted in accordance with applicable Federal statutes and regulations. In particular, it exercises approval authority for DOE National Environmental Policy Act (NEPA) analyses. It coordinates with and assists in preparing environmental impact statements for major DOE proposed actions. It also develops written orders, policies, regulations, and guidance documents for environmental review requirements and their implementation.

E.2.3.2 Defense Nuclear Facilities Safety Board

The Defense Nuclear Facilities Safety Board (DNFSB) is an independent Federal agency established by Congress in 1988. DNFSB's mandate under the AEA is to make nuclear safety recommendations concerning DOE defense nuclear facilities. DNFSB reviews and evaluates the content and implementation of DOE health and safety standards for design, construction, operation, and decommissioning of defense nuclear facilities. DNFSB is authorized to recommend to the Secretary of Energy any specific measures, such as changes in content and implementation of those standards, DNFSB believes should be adopted to ensure the public health and safety are adequately protected. DNFSB also reviews the design of new defense nuclear facilities before construction begins, as well as modifications to older facilities, and is authorized to recommend changes to protect public health and safety.

E.2.3.3 Other Federal Regulators

Certain DOE facilities and operations are subject to regulation and independent oversight by other agencies as described in Section E.2 above. Both NRC and EPA regulate certain DOE facilities; e.g., the Three Mile Island damaged fuel and core debris is in NRC-licensed dry storage at the DOE Idaho Site. EPA certifies the WIPP (Section D.2.2.1) through its WIPP LWA authority (Section E.2.2.1). Lists of spent fuel and radioactive waste management facilities and their licensing authority are in Annex D-1 and Annex D-2.

[89] https://www.directives.doe.gov/directives-documents/0227.1-BOrder.
[90] https://www.directives.doe.gov/directives-documents/0226.1-BOrder-b.
[91] http://energy.gov/em/low-level-waste-disposal-facility-federal-review-group-lfrg.

E.2.3.4 State Authorities

EPA authorized states play a significant role in regulation and independent oversight of DOE facilities (Section E.2.4.1). Most of DOE's cleanup is performed under CERCLA through Federal Facility Agreements (FFAs), and under RCRA through various consent and compliance orders. These enforceable regulatory agreements and orders with Federal and state agencies establish the scope of work to be performed at a given site and the dates by which specific cleanup milestones must be achieved. Failure to comply with these agreements and orders is subject to fines and penalties. Table E-2 describes the types of regulatory agreements. The status of cleanup projects can be found at http://www.em.doe.gov/pdfs/NDAApercent20Report-(01-15-09)a.pdf.

DOE has successfully developed a close working relationship with Tribal governments, state regulators, and local citizens. DOE's Office of Environmental Management has the largest Federal Advisory Committee Act chartered citizen advisory board in the Federal Government with boards at eight cleanup sites. DOE also supports working groups with the National Governors' Association, the National Conference of State Legislators, the Energy Communities Alliance (represents local communities at cleanup sites), and the State and Tribal Government Working Group.

E.2.3.5 Nuclear Waste Technical Review Board

The U.S. Nuclear Waste Technical Review Board (NWTRB) was created by Congressional legislation, in the 1987 amendments to the Nuclear Waste Policy Act (NWPAA). It advises both Congress and the Secretary of Energy on technical issues related to DOE's implementation of the Nuclear Waste Policy Act of 1982 (NWPA). The Board evaluates the technical validity of all activities undertaken by the Secretary of Energy related to DOE's obligation to manage and develop an approach to dispose of spent fuel and HLW. The NWTRB is a unique Federal agency and is completely independent, non-partisan and non-political. Its eleven members are appointed by the President from a list of nominees submitted by the National Academy of Sciences (NAS) which makes its nominations based solely on the expertise of the individual in relevant scientific and engineering disciplines. The independent technical peer review offered by the NWTRB contributes to the acceptance of different approaches to managing nuclear waste by the public and scientific communities. The NWTRB is an organization that performs an independent and integrated technical evaluation of DOE's implementation of the NWPA.

Table E-2 Regulatory and Agreement Order Descriptions	
Agreement/ Order	**Description**
Federal Facility Agreement (FFA)	A legal agreement among DOE, EPA, and sometimes the state. It sets forth schedules and processes for site cleanup under CERCLA, including enforcement provisions for non-compliance. FFAs that include the state as a party often incorporates RCRA compliance requirements, as well as state hazardous waste law requirements that flow from RCRA.
Consent Order Or Consent Agreement Or Settlement Agreement	A legal agreement between DOE and EPA or the state, documenting the settlement of a cleanup issue outside of court. Consent orders, consent agreements, and settlement agreements are legally binding, so compliance disputes may ultimately be taken to court. Most consent orders, consent agreements, and settlement agreements address RCRA issues or state hazardous waste issues that flow from RCRA, although they can also address CERCLA issues. A few also incorporate Toxic Substances Control Act requirements.
Consent Decree	A court-issued enforceable order, generally reflecting an agreement between DOE and EPA or the state. Consent decrees can cover CERCLA or RCRA, as well as state hazardous waste laws.
Site Treatment Plan and Compliance Order	A legal agreement and plan developed under the Federal Facility Compliance Act and RCRA for DOE facilities that generate or store mixed wastes, setting schedules to treat all of the facilities' mixed waste.

E.2.4 State Regulatory Authorities

Provisions of law allow Federal agencies to delegate or relinquish certain regulatory responsibilities to the states having radioactive materials or nuclear facilities. More complex facilities such as nuclear power plant (NPP) are regulated by Federal authorities. Regional arrangements allow closer coordination with licensees who often do not reside in the regulatory bodies Headquarters' location, such as using radioisotopes for medical uses. These arrangements are not necessarily mandatory, but, where the state can demonstrate adequate competencies, the appropriate Federal agency can transfer regulatory authority.

E.2.4.1 EPA Authorized States

EPA delegates authorities to states in two areas of radioactive waste management. NESHAPs regulations are based on the requirements of the CAA law, and the authority for delegating to states is described by law. A state must have emission limits at least as stringent as EPA's national standards. Most states have not pursued delegation of radionuclide NESHAPs. EPA's process for delegating RCRA hazardous waste requirements to states is similar (but would apply to the hazardous portion of mixed waste). The state must have a program at least as stringent as EPA's, and the application for authorization must address specific areas of compatibility. The statutory basis for specific rules, however, may differ. Some "base" requirements must be adopted by states, while states may choose not to adopt other rules. The rule issued by EPA in 2001, and described in Section E.2.2.3, allowing mixed radioactive and hazardous waste generators to remain exempt from the hazardous waste requirements,

for example, is not immediately effective in authorized states because it provides for a less stringent method of managing these wastes.

E.2.4.2 NRC Agreement States

The AEA, as amended, provides a statutory basis for NRC to relinquish to the states portions of its authority to license and regulate byproduct materials (radioisotopes); source materials (uranium and thorium (U&Th)); and certain quantities of special nuclear materials. NRC retains regulatory authority over NPPs, and conversion and enrichment facilities. As of December 2013, 37 of the 50 states have entered into Agreements with NRC.

Agreement States are those states having entered into an effective regulatory discontinuance agreement with NRC under subsection 274b. of the AEA. The role of the Agreement States is to regulate most types of radioactive material in accordance with the compatibility requirements of the AEA. These types of radioactive materials include source material (U&Th), reactor fission byproducts, byproduct materials as defined in Section 11e. of the AEA, and quantities of special nuclear materials not sufficient to form a critical mass. NRC, under its own internal practices, periodically reviews the performance of each Agreement State to assure compatibility with its regulatory standards. See Section E.2.1.5 on NRC's IMPEP.

Agreement States issue radioactive material licenses, promulgate regulations, and enforce those regulations under the authority of each individual state's laws. The Agreement States conduct their licensing and enforcement actions under direction of the governors in a manner compatible with the licensing and enforcement programs of NRC. However, NRC retains the authority to approve the final disposition of a uranium recovery site prior to its transfer to DOE, after closure activities are completed.

NRC assistance to states entering into agreements includes review of requests from states to become Agreement States, or amendments to existing agreements, meetings with states to discuss and resolve NRC review comments, and recommendations for NRC approval of proposed agreements. NRC also conducts training courses and workshops; evaluates technical licensing and inspection issues from Agreement States; evaluates state rule changes; participates in activities conducted by the Organization of Agreement States[92] and the Conference of Radiation Control Program Directors (CRCPD), Inc.; and provides early and substantive involvement of the Agreement States in NRC rulemaking and other regulatory efforts. NRC also coordinates with Agreement States on event reporting and information, reciprocity arrangements, and responses to allegations reported to NRC involving Agreement States.

[92] http://www.agreementstates.org for more information.

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F. GENERAL SAFETY PROVISIONS

Section F addresses general safety provisions in Articles 21-26 of the Joint Convention including:

- License holder responsibilities;
- Human and financial resources;
- Quality assurance;
- Operational radiation protection;
- Emergency preparedness; and
- Decommissioning.

This section also addresses Articles 4-9 and Articles 11-16. The following provisions are common for both spent fuel and radioactive waste management:

- General safety requirements;
- Existing facilities;
- Siting proposed facilities;
- Facility design and construction;
- Facility safety assessment; and
- Facility operation.

Sections G and H of the United States of America (U.S.) National report, address these same areas plus Articles 10 and 17 of the Joint Convention for Spent Fuel Disposal and Institutional Measures after Closure. These sections also and provide additional information specific to management of spent fuel or radioactive waste.

Section E presents the various regulations and directives, many of which are referenced in the following sections governing safety requirements in the U.S., including those for spent fuel management. Most of these regulations are available electronically on the internet. See Table A-2.

This report focuses on important issues and provisions mentioned above. For additional background and specific information, refer to Chapter F in the previous U.S. National Report.[93]

F.1 License Holder Responsibilities (Article 21)

The Joint Convention specifies each Contracting Party must ensure the prime responsibility for safety of spent fuel and radioactive waste management rests with the licensee, and each licensee takes the appropriate steps to meet its responsibility. The government has the responsibility only if there is no licensee. Nuclear Regulatory Commission (NRC) and Agreement State regulations ensure licensees are responsible for safe radioactive waste and spent fuel management. Commercial disposal facility licensees or operators will eventually transfer control of the site to Federal or state governmental agencies, which in turn will be responsible for protection of public safety and the environment.

[93] http://energy.gov/em/downloads/fourth-national-report-joint-convention-safety-spent-fuel-management-and-safety.

F.2 Human and Financial Resources (Article 22)

Both commercial (NRC-regulated) and Department of Energy (DOE) sectors have requirements to ensure human and financial resources are sustained for spent fuel and radioactive waste management activities. Table F-1 provides information from NRC on human resources in terms of full-time equivalent (FTE) staff dedicated to regulation in various programmatic areas. It should be noted that these numbers reflect the resources requested in NRC's FY 2015 budget.

Table F-1 Distribution of NRC FY 2015 Budget Request FTE

Budgeted Program	FTEs Requested for FY 2015
Nuclear Reactor Safety	2,958.4
Nuclear Materials and Waste Safety	860.3
Inspector General	63.0

Source: Nuclear Regulatory Commission

Table F-2 provides a breakdown for the human resources in FTEs needed to support Nuclear Materials and Waste Safety including radioactive waste, spent fuel and oversight (which includes enforcement). The programmatic categories of nuclear materials and waste safety consist of 860.3 FTEs. Approximately 307.2 FTEs or 36 percent of these FTEs are allocated to nuclear waste and spent fuel management.

Table F-2 NRC Staffing for Materials and Waste Management

Regulatory Program[94]	FTEs Requested for FY 2015
Fuel Facilities	237.9
Nuclear Materials Users	315.2
High-Level Waste Repository	0
Spent Fuel Storage and Transportation	163.0
Decommissioning and Low-Level Waste	144.2
Materials and Waste Safety Total	*860.3*
Oversight (includes Enforcement)	**FTEs Requested for FY 2015**
Spent Fuel Storage and Transportation	21.9
Decommissioning and Low-Level Waste	29.0
Materials Users	89.0
Oversight Total	*139.9*

The NRC has a report, *Performance and Accountability Report - Fiscal Year 2013 (NUREG-1542, Volume 19)*[95] which summarizes the performance of its mission to protect people and the environment through the regulation of nuclear power and use of nuclear material. It provides key financial and performance information for the U.S. Congress and the public to assess how well it has carried out its mission. This report also documents the finding of an independent auditor on NRC's condensed financial statements. This summary is part of a larger effort to implement openness and transparency in NRC's program performance and financial management information.[96]

[94] Source: http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1100/v27/.
[95] http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1542/v19/.
[96] Additional detailed information on NRC's approach to open government is accessible at: http://www.nrc.gov/public-involve/open.html.

F.2.1 Personnel Qualifications for NRC Licensees

NRC regulations require licensees to have qualified personnel. The requirements provide for an organizational structure of the licensee, both offsite and onsite, including lines of authority and assignments of responsibilities, whether in the form of administrative directives, contract provisions, or otherwise.

NRC establishes qualifications for licensees' employees responsible for operational safety and radiological health, including the radiation safety officer and health physics personnel. Technical qualifications include training and experience so the licensee's staff is competent to engage in the licensed activities. The licensee must additionally conduct a personnel training program and, within a plan, maintain an adequate complement of trained personnel to carry out licensed activities in a safe manner. See additional information in the Fourth U.S. National Report.

F.2.2 DOE Qualification Requirements

DOE places requirements on contractors for training, proficiency testing, certification, and qualification of operating and supervisory personnel. Training requirements for nuclear safety management are in 10 Code of Federal Regulations (CFR) Part 830 and radiation worker protection in 10 CFR Part 835.

DOE directives further impose additional personnel training and qualification requirements for its activities. Developing and maintaining a technically competent workforce to accomplish its missions in a safe and efficient manner is accomplished through the Federal Technical Capability Program (FTCP).[97] See additional information in the U.S. Fourth National Report.

F.2.3 Financial Surety

The U.S. is in the forefront of establishing financial surety mechanisms to guarantee resources for cleanup, decommissioning, emergency remediation, etc. Licensees in the commercial sector must meet NRC requirements for financial surety. Spent fuel and radioactive waste management activities in the government sector (DOE facilities) have the financial assurance of the U.S. Government. The U.S. Congress makes annual appropriations. For nuclear materials facilities and activities regulated in NRC Agreement States, commercial licensees must meet the Agreement State financial assurance provisions.

The treatment of the trust funds for decommissioning a commercial power reactor differs depending on whether the licensee is a public utility or not. A public utility trust fund relies on funds collected in electric rates, and can take credit for future authorized collections. In addition, the public utility trust fund can take credit for projected earnings on the trust fund balance. The state public service commission determines the rate of return that can be used to calculate the earnings credit. Licensees who are not public utilities do not have prices guaranteed by a state public utility commission. Therefore, they cannot take credit for future collections. However, they are allowed to take credit for future earnings on the balance of the trust fund, at a rate no greater than 2 percent real rate of return. The period for projecting the earnings credit can extend up to approximately 60 years after permanent shutdown. However, if the licensee plans to

[97] http://www.hss.doe.gov/deprep/ftcp/about.asp.

take more than seven years after permanent shutdown to complete decommissioning, it must provide additional financial assurance to cover the increased costs of a period of safe storage.

In addition to trust funds, a power reactor licensee may use several other methods to assure funding for decommissioning. These methods include guarantees, contractual obligations, and combinations thereof. If the power reactor licensee is a government entity, it may provide assurance by using a statement of intent to obtain funds for decommissioning from its governing legislative body. A power reactor licensee may propose other methods of assurance, but must show the method is equivalent to the methods listed in NRC's regulations in order to obtain approval. However, nearly all costs of power reactor decommissioning are assured using a trust fund.

F.2.3.1 Commercial Low-Level Waste Management Facilities

The financial information provided by commercial low-level waste (LLW) management facilities must be sufficient to demonstrate the financial qualifications of the applicant are adequate to carry out the activities for which the license is sought and other financial obligations. Each applicant must show it either possesses the necessary funds or has reasonable assurance of obtaining them to cover the estimated costs of conducting all licensed activities over the planned operating life of the project, including costs of construction and disposal.

Waste processors are subject to 10 CFR 20.1403 (or equivalent regulations in Agreement States). These regulations require sufficient financial assurance to enable an independent third party, including a governmental custodian, to implement responsibilities for control and maintenance of the site where the license is terminated with restrictions on future use. The financial assurance mechanism and amount are scrutinized by NRC before the license is terminated. No post-closure activities or institutional controls are needed for sites released free of future restrictions.

NRC financial assurance requirements for commercial LLW disposal facilities are contained in Subpart E of 10 CFR Part 61. Specific rules for funding of closure and stabilization are in 10 CFR 61.62 and for funding of institutional control in 10 CFR 61.63. A state has the responsibility to review and accept financial sureties in Agreement States in accordance with its regulations equivalent to Part 61.

The applicant must provide assurance that sufficient funds are available to carry out disposal site closure and stabilization (by an independent contractor, if necessary) including: (1) decontamination or dismantlement of structures; and (2) closure and stabilization of the disposal site so the need for active maintenance by the ultimate site owner is virtually eliminated and only minor custodial care, surveillance, and monitoring are required. The licensee's surety mechanism is reviewed annually by NRC (or Agreement State) to assure sufficient funds are available for completion of the closure plan.

F.2.3.2 Spent Fuel and High-Level Waste Management Facilities

The Nuclear Waste Policy Act of 1982 (NWPA) requires utilities having a contract with DOE for the disposal of spent fuel or high-level waste (HLW) to pay fees into the Nuclear Waste Fund sufficient to cover the costs associated with disposal activities for spent fuel and HLW. Following a November 2013 court ruling, the fee has been suspended. This

fee, evaluated annually for sufficiency, previously was $0.001 per kilowatt-hour of nuclear power generated and sold. Financial assurance for the storage of spent fuel is required under provisions at 10 CFR 72.22 and 72.30 for specifically licensed, non-DOE, independent spent fuel storage installations (ISFSIs) to ensure funds are available to store spent fuel in ISFSIs and for future decommissioning. ISFSI general licenses are covered by the financial assurance requirements in 10 CFR Part 50 for a reactor licensee. Financial mechanisms used include surety/insurance or other guarantee method, government statement of intent, or contractual obligations on the part of the firm's customers.

F.2.3.3 Uranium Recovery Waste Management Facilities

Financial surety arrangements must be established by each mill operator prior to the start of operations to assure sufficient funds will be available to carry out the Decontamination and Decommissioning (D&D) of the mill and site and for the reclamation of any tailings or waste disposal areas in the event the licensee is unable to do so. This process is similar for both conventional mills and in situ recovery (ISR) operations (ISRs); the main difference is that ISRs have no tailings piles.

The amount of funds to be guaranteed by such surety arrangements must account for costs of an independent contractor for performing the work and must be based on NRC-approved cost estimates, which address:

- D&D of buildings and the site;
- Long-term site surveillance and control (if applicable); and
- Reclamation of tailings and/or waste areas in accordance with Appendix A to 10 CFR Part 40.

Financial surety arrangements generally acceptable to NRC are surety bonds, trust funds, and letters of credit and combinations thereof or other arrangements approved by NRC. The surety must also cover payment of the charge for long-term surveillance and control at heap leach and conventional mill sites (long-term surveillance is not required at ISR facilities). A minimum charge of $250000 (indexed to 1978 U.S. dollars) to cover the costs of long-term surveillance is paid by each mill operator to the General Treasury of the U.S. or to an appropriate state agency prior to the termination of a uranium or thorium mill license.

A variance in funding requirements for the long-term care charge may be specified by NRC if site surveillance or control requirements at a particular site are determined, based on site-specific evaluation, to be significantly greater than annual site inspections.[98] Eventual ownership of the uranium mill disposal site will be transferred to either DOE or an appropriate state agency in perpetuity. The funding should be adequate and should not impose costs to the long-term custodian during the long-term care period.

The surety is reviewed annually by NRC to recognize any increases or decreases resulting from inflation, changes in engineering plans, activities performed, and any other conditions affecting costs. This process yields a surety at least sufficient at all times to

[98] Conducted by the government agency responsible for long-term care of the disposal site to confirm its integrity and to determine the need, if any, for maintenance and/or monitoring, e.g., if fencing is necessary.

cover the costs of decommissioning and reclamation of the areas expected to be disturbed before the next license renewal.

F.2.3.4 Complex Material Sites Decommissioning

Many of the existing NRC-regulated decommissioning sites are complex and difficult to decommission for a variety of financial, technical, or programmatic reasons. Certain sites can be thought of as NRC "legacy" sites; those sites where past financial or operational events have created the problems needing a cleanup solution, and ultimately complete decommissioning and license termination. NRC evaluated the lessons from these existing legacy sites and has issued a final rule on decommissioning planning to change its current financial assurance and licensee operational requirements to minimize or prevent future legacy sites.[99] See Section E.2.1.4 for more information regarding decommissioning planning. A detailed description of the decommissioning process for all materials sites is available at the NRC website.[100]

The cost to decommission these facilities ranges broadly, from a few thousand up to the hundred million dollar range. More specific information on financial assurance for decommissioning, such as the need for licensees to provide a decommissioning funding plan, is provided at http://www.nrc.gov/waste/decommissioning/finan-assur.html.

NRC regulations at 10 CFR 20.1406, *Minimization of Contamination*, specifically require that new applications describe how design and operations will minimize contamination and facilitate eventual decommissioning. As mentioned above, NRC published a final rule on decommissioning planning. One aspect of the rule focuses on ensuring that licensees have adequate financial assurance to complete decommissioning, while the other ensures that licensees have an adequate ground water monitoring program in place and will implement measures to minimize ground water contamination. NRC affirmed the final rule on November 30, 2010, which took effect in January 2012; except for some provisions which took effect in March 2013. Waste minimization is more fully discussed in Section F.7.2.

Additional details on financial assurance in decommissioning material sites can be found in Consolidated Decommissioning Guidance, Financial Assurance, Recordkeeping, and Timeliness (NUREG-1757, Vol. 3, Rev.1).[101]

F.3 Quality Assurance (Article 23)

The following subsections provide a summary of quality assurance (QA) requirements prescribed by NRC and DOE for spent fuel and waste management activities. QA requirements apply to licensees, licensed subcontractors, DOE contractors and subcontractors, and to suppliers. QA programs are applied to design, purchase, fabrication, handling, shipping, storing, cleaning, assembly, inspection, testing, operation, maintenance, and repair, and modification of structures, systems and components important to safety.

[99] Lessons learned from NRC's experiences in decommissioning can be accessed at http://www.nrc.gov/waste/decommissioning/lessons-learned.html.
[100] http://www.nrc.gov/waste/decommissioning/process.html.
[101] http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1757/v3/index.html.

F.3.1 NRC Quality Assurance

For commercial licensees, NRC generally inspects the facilities and activities regardless of organizational affiliation. NRC holds the organization specified in the license as the responsible party for enforcement purposes.

The applicant needs to demonstrate specific technical information for adequate performance objectives and the applicable technical requirements for a LLW disposal operation. Some of the information includes a description of the QA program, tailored to LLW disposal, developed and applied by the applicant for the determination of natural disposal site characteristics, and for QA during the design, construction, operation, and closure of the land disposal facility and the receipt, handling, and emplacement of waste.[102]

Guidance to applicants on how to meet the QA regulatory requirements in Part 61 is also provided in NUREG-1293, Revision 1, *Quality Assurance Guidance for a Low-Level Radioactive Waste Disposal Facility (April 1991)*.[103] The criteria in NUREG-1293 are similar to the criteria contained in 10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants*. Although Appendix B to 10 CFR Part 50 is not applicable (N/A) to the NRC's LLW disposal regulation, the criteria it contains are basic to any nuclear regulatory QA program. For example, QA includes quality control and is implemented by inspections, audits, calibration testing, as well as review of design and operational protocols. Other sources of guidance include: NUREG-1383, *Guidance on the Application of Quality Assurance for Characterizing a Low-Level Radioactive Waste Disposal Site: Final Report* (1990),[104] which provides QA guidance related to site characterization activities. Chapter 9 of both *Standard Format and Content of a License Application for a Low-Level Radioactive Waste Disposal Facility* (NUREG-1199) and *Standard Review Plan for the Review of a License Application for a Low-Level Radioactive Waste Disposal Facility* (NUREG-1200) provide additional QA guidance for potential 10 CFR Part 61 applicants, *QA Guidance for Low-level Waste Disposal Facilities*.

The QA program for storage of spent fuel, HLW, and reactor-generated Greater-than-Class C low-level waste (GTCC LLW) is described in 10 CFR Part 72, Subpart G. An additional useful document is NUREG/CR-6314, *Quality Assurance Inspections for Shipping and Storage Containers*.[105] The QA requirements for packaging and transportation of licensed radioactive material are provided in Subpart H of 10 CFR Part 71. This would include packaging and transport of radioactive sources – disused or otherwise – unless handled under an exemption provision. NRC Regulatory Guide 7.10 describes QA programs for packaging for transport of radioactive material.[106]

QA is generally addressed as part of the license requirements for uranium recovery operations. Areas where QA is particularly important includes: disposal cell performance; monitoring, injection, and recovery well construction; and final cover system construction. Typically, technical specifications are developed to provide

[102] See 10 CFR 61.12(j).
[103] Available from the NRC Web-based ADAMS at http://www.nrc.gov/reading-rm/adams.html.- ADAMS Accession Number ML11242A180.
[104] http://www.osti.gov/bridge/servlets/purl/6503151-A8yRkR/6503151.pdf.
[105] http://pbadupws.nrc.gov/docs/ML0126/ML012600315.pdf.
[106] Quality Assurance guidance for Part 71 is provided in the Regulatory Guide 7.10, *Establishing Quality Assurance Programs for Packaging Used in Transport of Radioactive Material,* Revision Number 2.

requirements for materials and construction techniques. A QA testing program for the operational phases, including supervision by a qualified engineer or scientist, is established to assure the specifications are met. In some cases, onsite pilot projects on a smaller scale can provide a demonstration that reclamation and restoration strategies are achievable.

QA plays a significant role in decommissioning of nuclear facilities. Decommissioning plans (DP) include a QA program to determine if the licensee has adequate controls in place to support the decommissioning. The QA program should address document control, control of measuring and test equipment, corrective action, QA records, audits, environmental monitoring, instrumentation and surveillances. Requirements are specified in 10 CFR 72 Subpart G, 10 CFR 50.82, and guidance are available from NUREG-1757 *Consolidated Decommissioning Guidance: Decommissioning Process for Materials Licensees*.

F.3.2 DOE Quality Assurance

Most DOE activities are subject to QA requirements found in DOE Orders and Guidance. DOE QA requirements are specified at 10 CFR 830.120. DOE programs must implement the QA criteria to achieve adequate protection of the workers, the public, and the environment, taking into account the work to be performed and its hazards. They must develop their QA programs by applying ten QA criteria using a graded approach. The ten QA criteria fall within three areas: management, performance, and assessment. The management criteria are QA program, personnel training and qualification, quality improvement, documents and records. The performance criteria are work processes, design, procurement and inspection, and acceptance testing. The assessment criteria are management assessment and independent assessment. DOE performs internal audits and assesses whether its contractors have satisfactorily implemented the DOE QA program.

F.4 Operational Radiation Protection (Article 24)

The following sections describe radiation protection responsibilities at Environmental Protection Agency (EPA), NRC, and DOE. The U.S. Government also has access to leading experts in radiation protection through institutions such as the National Academy of Sciences (NAS)/National Research Council, the NWTRB[107] (See Section E.2.3.5) and the National Council on Radiation Protection and Measurements (NCRP). The NAS is a private, nonprofit institution providing science, technology and health policy advice under a Congressional charter. The NAS established a Board on Radioactive Waste Management (now part of the new Nuclear and Radiation Studies Board) focusing on waste management and disposal.

F.4.1 U.S. Environmental Protection Agency

EPA is responsible for issuing guidance to Federal agencies on radiation protection matters. EPA provides emergency response training and analytical support to state, local, and Tribal governments and works closely with other national and international radiation protection organizations to further our scientific understanding of radiation risks.

[107] www.nwtrb.gov.

Primary radiation protection regulations for spent fuel management include 40 CFR Part 190, *Environmental Radiation Protection Standards for Nuclear Power Operations*, and 40 CFR Part 191, *Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-level and Transuranic Radioactive Wastes*.

Another radiation protection regulation related to 40 CFR Part 191, pertaining to transuranic (TRU) waste (not spent fuel) management at DOE's Waste Isolation Pilot Plants (WIPP) geologic repository, is found in 40 CFR Part 194, *Criteria for the Certification and Re-certification of the Waste Isolation Pilot Plant's Compliance with 40 CFR Part 191 Disposal Regulations*. See Section E.2.2.1 for additional information.

EPA's statutory role includes developing guidance for use by Federal agencies responsible for protecting the public from the harmful effects of radiation. EPA's Federal guidance is often applied by state agencies and the private sector to ensure consistency of practice. Guidance documents produced by EPA are available on the internet.[108] Specific dose limits are provided in Table F-3. For key radiation protection guidance documents see http://www.epa.gov/radiation/federal/index.html.

F.4.2 NRC General Radiological Protection Limits

The provisions for general safety for workers and protection of the public during the operational phase of commercial radioactive waste management facilities are addressed in NRC regulations contained in 10 CFR Part 20, *Standards for Protection Against Radiation*. 10 CFR Part 20 includes agency requirements for:

- Dose limits for radiation workers and members of the public;
- Monitoring and labeling radioactive materials;
- Posting radiation areas; and
- Reporting the theft or loss of radioactive material.

The provisions in 10 CFR Part 20 also includes:

- Penalties for not complying with NRC regulations; and
- Tables of individual radionuclide exposure limits.

NRC regulates commercial nuclear power generation as well as medical, academic, and industrial uses of radioactive material.[109] NRC promulgates safety regulations expressed in annual total effective dose equivalent (TEDEs),[110] as well as air and liquid effluent release concentrations. See Table F-3 for occupational and public health protection standards.

F.4.2.1 Occupational Dose Limits

Operations are conducted so the occupational dose to individual adults complies with the appropriate annual limit; refer to Table F-3. Annual occupational dose limits are established at 10 CFR 20.1201 for adults and Section 20.1207 for minors. There are other specific conditions, such as for planned special exposures and specific organ

[108] EPA Radiation Protection Program, http://www.epa.gov/radiation/programs.html.

[109] NRC can relinquish regulatory authority for nuclear materials to Agreement States under the provisions of the Atomic Energy Act, as amended. Refer Section E.2.4.2. for more specific information.

[110] Dose is defined here as the total effective dose equivalent, which is defined as the sum of the deep-dose equivalent for external exposures and the committed effective dose equivalent for internal exposures.

limits, as well as considerations for a soluble uranium chemical toxicity intake limit of 10 milligrams in a week. For more specific constraints refer to 10 CFR Part 20, Subpart B.

NRC maintains the Radiation Exposure Information and Reporting System (REIRS) for radiation workers, which provides the latest available information on radiation exposure to the workforce at certain NRC-licensed facilities. It also contains information concerning the recording and reporting requirements of NRC licensees. This information and other details on occupational exposure are available on the internet and updated annually.[111] An example of this information is provided in Figure F-1 that provides historical TEDEs for ISFSIs.[112]

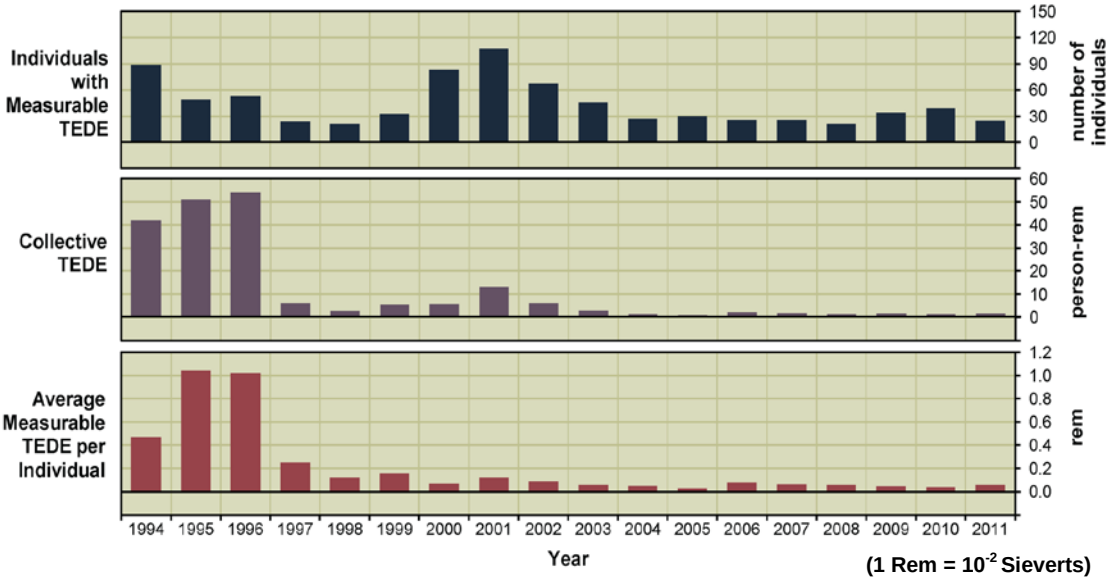

Figure F-1 Average Annual Values at Independent Spent Fuel Storage Facilities, 1994-2011

F.4.2.2 Public Dose Limits

Public individual dose limits are provided in Table F-3. These dose limits are exclusive of the contributions from background radiation, any medical administration to individuals, and other contributions not attributable to other regulated operations.

Exposure limits for specific situations are provided in 10 CFR Part 20.

[111] NRC's Radiation Exposure Information and Reporting System (REIRS) for Radiation Workers are accessible at http://www.reirs.com.

[112] This document is published as NUREG-0713, *Occupational Radiation Exposure at Commercial Nuclear Power Reactors and Other Facilities* 2009, Vol. 33, NRC, April 2013, available at: http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr0713/.

F.4.2.3 Radiological Criteria for License Termination (Decommissioning)

For protection of the public, dose-based requirements for licensees seeking license termination are found in 10 CFR Part 20, Subpart E (see Table F-3). These regulations establish two final states for licensee termination: unrestricted use and restricted use. In addition to the specific limits for each state, NRC requires licensees to maintain doses as low as reasonably achievable (ALARA). This means the licensee must make every reasonable effort to reduce the doses as far below the specified limits as is practical, taking into account the state of technology and economics. See 10 CFR 20.1003.

F.4.2.4 LLW Disposal Sites

Protection of the general population from releases of radioactivity from a LLW disposal facility is also dose-based. Reasonable efforts should be made to maintain releases of radioactivity in effluents to the general environment ALARA. See Table F-3 for specific applications of dose.

F.4.2.5 Uranium Mill Tailings Disposal Sites

Reclaimed uranium mills are required to meet a radon release constraint in 10 CFR Part 40, Appendix A in addition to the annual public and occupational dose limits described in the previous section. See Table F-3 for public dose limits. The 0.7 Bq/m2-s radon release from uranium mill tailings was based on the cost-effectiveness of control for a thick earthen cover design, taking into consideration individual and population doses. There are also groundwater concentration limits for radionuclides and certain hazardous constituents, as well as a design control requirement.

F.4.3 DOE Radiation Protection Regulations

DOE requires radiation protection for workers and the public in its regulations and directives. 10 CFR Part 835 governs radiation protection of workers at DOE facilities and activities not licensed by NRC. DOE regulations in 10 CFR Part 835 are similar to NRC regulations in 10 CFR Part 20, but there are some differences resulting from the types of radiological activities regulated by DOE and NRC, respectively.

DOE implements applicable radiation protection standards considering and adopting, as appropriate, recommendations of authoritative organizations such as the NCRP and the International Commission on Radiological Protection (ICRP). It is also DOE policy to adopt and implement standards generally consistent with those of NRC.

DOE occupational radiation protection requirements emphasize contamination control and internal dose monitoring because DOE operates facilities involved in weapons production. 10 CFR Part 835 specifies warning signs specifically for contamination areas, contains a table of surface contamination values, and requires the use of bioassay data instead of air sampling data for internal dose estimation in most cases. DOE-STD-1196-2011, *Derived Concentration Technical Standards*,[113] is a new DOE Standard that supports implementing DOE O 458.1. The Standard provides both Derived Concentration Standards (DCS) and dose coefficients developed using the latest state of knowledge and practice in radiation protection (i.e., ICRP 60, 68, 72, 89, 103, 107).

[113] http://energy.gov/sites/prod/files/2013/06/f1/DOE-STD-1196-2011.pdf.

There is no time limit on the applicability of DOE's radiation protection criteria. DOE considers whether risks may eventually be low enough so continued protection would not be needed. DOE, or successor agencies, may be required in some cases, to maintain control because of the nature of the hazard and statutory requirements. Compliance with these regulations is generally determined by inspectors using survey equipment to measure radionuclide airborne or liquid concentrations within and at control boundaries.

Safety assessment computer models (i.e., RESidual RADiation (RESRAD))[114] are used to forecast exposures, prior to operating a nuclear facility, including spent fuel storage and radioactive waste disposal on a predictive basis. The concentrations and doses predicted by modeling a range of potential scenarios are then compared to dose and concentration limits in the applicable Federal regulations and DOE Orders and Manuals.

F.4.3.1 Collective Dose to the Public

DOE estimates radiation doses to the public around its many sites through extensive continuous radiological monitoring and surveillance programs as part of its commitment to communities where its facilities are located. The offsite individual doses remain well below DOE and EPA NESHAPs[115] compliance limits. Figure F-2 shows the historical trend. To put the estimated DOE-wide annual collective dose in perspective, background radiation dose to the population in a large metropolitan area would be more than 20000 person-Sv (two million person-rem) annually, from natural and man-made sources.

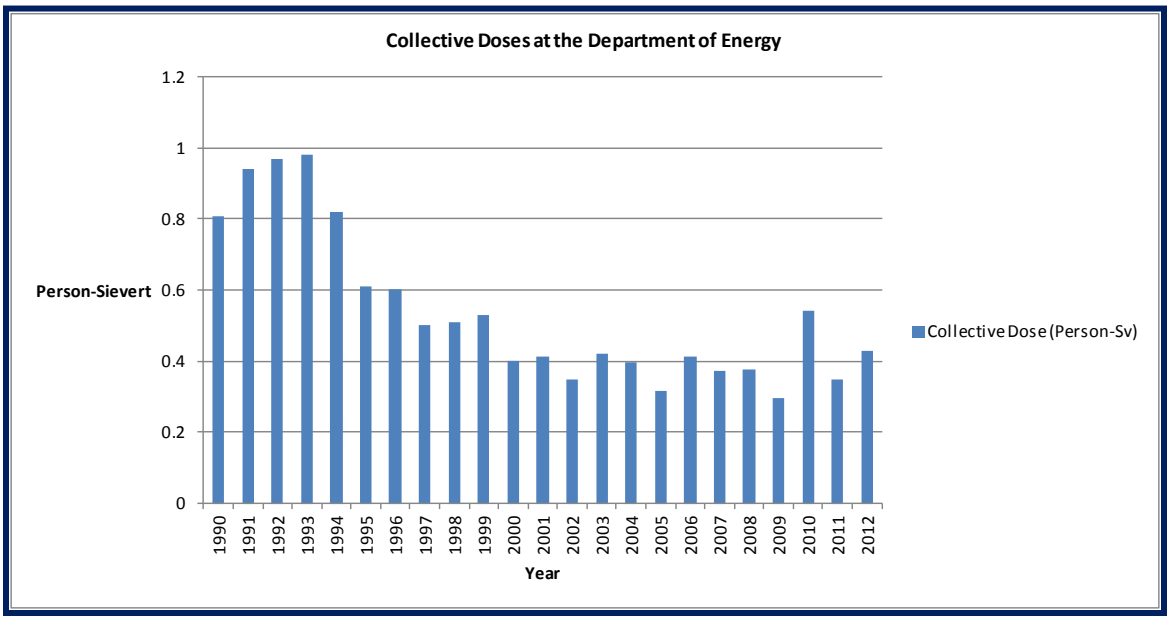

Figure F-2 Estimated Off-Site Radiation Dose to the Public around DOE Sites

[114] http://web.ead.anl.gov/resrad/home2/.
[115] National Emission Standards for Hazardous Air Pollutants.

F.4.3.2 Dose to DOE Workers

DOE keeps radiation exposures to workers ALARA within the constraints imposed by work, equipment, and technical conditions. Only 14 percent (11906 out of 87377) of DOE workers monitored for radiation dose received a measurable dose between 2008 and 2012. In 2010, the average annual TED,[116] measurable dose to a worker was 0.73 mSv (73 mrem), and the collective dose was 9.74 person-Sv (947 person-rem). Within the five-year period from 2008 to 2012, one individual in 2010 exceeded the 50 mSv (5 rem) annual limit receiving 316.18 mSv (31.16 rem). In 2008, one individual exceeded the 20 mSv (2 rem) administrative limit.

To place DOE worker dose in perspective, the average American receives approximately 6.2 mSv/a (620 mrem/yr) from natural- and man-made sources.[117] The majority of DOE workers with a measurable dose between 2008 and 2012, received less than 1 mSv (100 mrem) TED equivalent. Thousands of people work in radiation areas every day without receiving significant radiation exposure, which may be attributable to the effectiveness of ALARA controls.

[116] Total Effective Dose, *E* (TED): DOE uses the term TED that is equivalent to NRC's TEDE. Total Effective Dose, *E* or TED replaced the term from TEDE to TED within ICRP 60 and ICRP 103.
[117] Source: *Ionizing Radiation Exposure of the Population of the U.S.*, National Council on Radiation Protection and Measurements Report No. 160, 2009.

Table F-3 Major Radiation Protection Standards			
Summary Table Regulation	Agency	U.S. Standard Limit	SI Equivalent
General Public (10 CFR 20.1301 & DOE O 458.1)	DOE & NRC	Total Effective Dose Equivalent (TEDE[118]): 100 mrem/year	TEDE 1 mSv/a Ambient Air 1 mSv/a[119]
Uranium mill tailings (40 CFR Part 61 and 192 & 10 CFR Part 40 App. A)	DOE, EPA & NRC	$^{226/228}$Ra: 5 pCi/g (surface) 15 pCi/g (subsurface) ^{222}Rn: 20 pCi/m^2-sec. NRC standard includes benchmark dose for other radionuclides Public dose per 40 CFR Part 190	$^{226/228}$Ra: 0.19 Bq/g (surface) 0.56 Bq/g(subsurface) ^{222}Rn: 0.74 Bqi/m^2-sec NRC standard includes benchmark dose for other radionuclides
Residual radioactive material UMTRCA Title I Facilities (40 CFR Part 192)	DOE & EPA	$^{226/228}$Ra: 5 pCi/g (surface) 15 pCi/g (subsurface) ^{222}Rn: 20 pCi/m^2-sec. Alternatively, a limit of 0.5 pCi/l in air at the boundary of the facility Gamma emissions in buildings not to exceed 20 micro roentgen/hr above background	$^{226/228}$Ra: 0.19 Bq/g (surface) 0.56 Bq/g(subsurface) ^{222}Rn: 0.74 Bqi/m^2-sec. Alternatively, a limit of 0.0185 Bq/l in air at the boundary of the facility. Gamma emissions in buildings not to exceed 5.16 mC/kg-hr above background.
HLW operations (10 CFR Part 60)	DOE & NRC	100 mrem/year	1 mSv/a
Commercial LLW disposal (10 CFR Part 61)	NRC	Annual dose equivalent to public 25 mrem to the whole body 75 mrem to the thyroid, and 25 mrem to any other organ	Annual dose equivalent to public 0.25 mSv to the whole body 0.75 mSv to the thyroid, and 0.25 mSv to any other organ

[118] Dose is defined here as the total effective dose equivalent, which is defined as the sum of the deep-dose equivalent for external exposures and the committed effective dose equivalent for internal exposures. DOE uses the term Total Effective Dose (TED) which is equivalent to TEDE in other Federal agencies.
[119] Limit is exclusive of radiation from background, medical administrations, and contributions from non-licensed sources

Table F-3 Major Radiation Protection Standards			
Summary Table Regulation	Agency	U.S. Standard Limit	SI Equivalent
DOE LLW disposal (DOE O 435.1)	DOE	TEDE to public: 25 mrem/year from all exposure pathways, excluding the dose from radon and its progeny in air. TEDE to public via the air pathway does not exceed 10 mrem/year, excluding the dose from radon and its progeny. Release of radon is less than an average flux 20 pCi/mP^{2}P/s at the surface of the disposal facility; alternatively, a limit of 0.5 pCi/l in air at the boundary of the facility.	TEDE to public: 0.25 mSv/a from all exposure pathways, excluding the dose from radon and its progeny in air. TEDE to public via the air pathway does not exceed 0.10 mSv/a, excluding the dose from radon and its progeny. Release of radon is less than an average flux of 0.74 Bq/m^2/s at the surface; alternatively, a limit of 0.0185 Bq/l in air at the boundary of the facility.
Effluent emissions (10 CFR Part 20) Appendix B, Table 2	NRC	Radionuclide specific activities ≥ 50 mrem/year (100 mrem/year for radionuclides limited by submersion dose)	Radionuclide specific activities ≥ 0.5 mSv/a (1 mSv/a for radionuclides limited by submersion dose)
Drinking water (40 CFR Part 141)	DOE, EPA & NRC	Maximum contaminant levels, Radium: 5 pCi/L Gross Alpha 15 pCi/L (excludes Rn & U) Beta/photon: 4 mrem/year Uranium: 30 µg/L	Maximum contaminant levels, Radium: 0.19 Bq/L Gross Alpha 0.56 Bq/L (excludes Rn & U) Beta/photon: 0.04 mSv/a Uranium: 30 µg/L
Uranium fuel cycle (40 CFR Part 190)	DOE, EPA & NRC	Annual dose equivalent to public 25 mrem to the whole body 75 mrem to the thyroid, and 25 mrem to any other organ	Annual dose equivalent to public 0.25 mSv to the whole body 0.75 mSv to the thyroid, and 0.25 mSv to any other organ
Air emissions (National Emission Standards for Hazardous Air Pollutants) (40 CFR Part 61, H) and Radiation Protection Programs (10 CFR 20.1101)	DOE, EPA & NRC	10 mrem/year to nearest off-site receptor	0.1 mSv/a to nearest off-site receptor

Table F-3 Major Radiation Protection Standards			
Summary Table Regulation	Agency	U.S. Standard Limit	SI Equivalent
Superfund (CERCLA) cleanup (40 Part CFR 300)	DOE, EPA & NRC	Protective of human health & environment (lifetime risk), Complies with Applicable or Relevant and Appropriate Requirements (ARARs)	Not Applicable
Decommissioning (10 CFR Part 20, Subpart E)	NRC	Unrestricted Use: 25 mrem/yr TEDE plus ALARA Restricted Use: If institutional controls fail, not to exceed 100 mrem/yr or 500 mrem/yr.	Unrestricted Use: 0.25 mSv/a TEDE plus ALARA Restricted Use: If institutional controls fail, not to exceed 1 mSv/a or 5 mSv/a.
Occupational standards (DOE 10 CFR Part 835 OSHA 29 CFR 1910.1096 NRC 10 CFR Part 20.1201)	DOE, OSHA & NRC	5 rem/year & TEDE (TED)[120] 15 rem/year eye (lens) dose equivalent 50 rem/year Deep Dose + any other organ (other than lens of the eye)	50 mSv/a TEDE (TED) 150 mSv/a eye (lens) dose equivalent 500 mSv/a Deep Dose + any organ (other than lens of the eye)
Spent Fuel, HLW, TRU management and disposal (40 CFR Part 191)	DOE, EPA & NRC	Annual Dose to Any Member of the Public from Management and Storage: *NRC-licensed sites* 25 mrem whole body 75 mrem thyroid 25 mrem other organ *DOE disposal sites (non-NRC licensed)* 25 mrem whole body 75 mrem thyroid Disposal Standards Applicable for 10,000 Years After Disposal: 15 mrem/year committed effective dose to any member of the public; Radionuclide-specific release limits to the accessible environment; Ground-water concentrations not to exceed drinking water limits	Annual Dose to Any Member of the Public from Management and Storage: *NRC-licensed sites* 0.25 mSv whole body 0.75 mSv thyroid 0.25 mSv other organ *DOE disposal sites (non-NRC licensed)* 0.25 mSv whole body 0.75 mSv thyroid Disposal Standards Applicable for 10,000 Years After Disposal: 0.15 mSv/a committed effective dose to any member of the public; Radionuclide-specific release limits to the accessible environment; Ground-water concentrations not to exceed drinking water limits

[120] TED means Total Effective Dose – used by DOE.

Table F-3 Major Radiation Protection Standards			
Summary Table Regulation	Agency	U.S. Standard Limit	SI Equivalent
Spent Fuel and HLW at Yucca Mountain (40 CFR Part 197 & 10 CFR Part 63)	DOE, EPA & NRC	15 mrem/year to any member of the public from management and storage; 15 mrem/year to the Reasonably Maximally Exposed Individual (RMEI) for 10000 years after disposal for undisturbed performance and from human intrusion; 100 mrem/year to the RMEI between 10000 years and the period of geologic stability after disposal for undisturbed performance and from human intrusion; Ground-water concentrations not to exceed drinking water limits for 10000 years after disposal	0.15 mSv/a to any member of the public from management and storage; 0.15 mSv/a to the Reasonably Maximally Exposed Individual (RMEI) for 10000 years after disposal for undisturbed performance and from human intrusion; 1 mSv/a to the RMEI between 10000 years and the period of geologic stability after disposal for undisturbed performance and from human intrusion; Ground-water concentrations not to exceed drinking water limits for 10000 years after disposal
Independent Spent Fuel Storage Installations (ISFSIs) (10 CFR Part 72)	NRC	Annual dose equivalent to a real individual member of the public 25 mrem to the whole body 75 mrem to the thyroid, and 25 mrem to any other critical organ	Annual dose equivalent to a real individual member of the public 0.25 mSv to the whole body 0.75 mSv to the thyroid, and 0.25 mSv to any other critical organ

Note: U.S. Standards for off-site transportation are excluded from the scope of the Joint Convention, and therefore not listed.

F.4.4 Other Radiation Protection Regulations

EPA has the prime role in setting U.S. radiation protection standards that are implemented by NRC, DOE, and other Federal agencies, although other agencies may also regulate certain aspects of radiation protection standards:

- The Occupational Health & Safety Administration of the Department of Labor (DOL) has regulations dealing with worker protection from ionizing radiation found in 29 CFR; and
- The Mine Safety and Health Administration of the DOL has safety and health regulations related to underground mining in 30 CFR Part 57, subparts 4037 to 5047.

Limits for air and water discharges from spent fuel/radioactive waste facilities are established through rulemaking by the responsible agency. EPA has issued rules for spent fuel, HLW, TRU waste, commercial nuclear fuel cycle, and uranium/thorium mill tailings facilities. See EPA's responsibilities detailed throughout Section E.

NRC implements these rules and has established rules for commercially generated low-level radioactive waste facilities. NRC collects data from all nuclear power plant (NPP) licensees and reports are submitted twice each year in accordance with Regulatory Guide 1.21 Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste. Similarly, fuel cycle facility licensees are required to submit semi-annual reports in accordance with Regulatory Guide 4.16, *Monitoring and Reporting Radioactivity in Releases of Radioactive Materials in Liquid and Gaseous Effluents from Nuclear Fuel Processing and Fabrication Plants and Uranium Hexafluoride Production Plants*. Commercial NPP licensees produce annual reports of their discharges; information on environmental monitoring is summarized on NRC's website.[121]

Information on radiological discharges from DOE facilities engaged in waste management, environmental cleanup and spent fuel activities are available through DOE Annual Site Environmental Reports (ASERs).[122]

DOE regulates air and water discharges from its radioactive waste facilities through its internal orders (DOE O 458.1), while airborne emissions from DOE facilities are regulated by EPA's NESHAPS.[123]
Many states have comprehensive radiation control programs. These programs, for example, may regulate the use of diagnostic and therapeutic x-ray equipment and certain radioactive materials or conduct environmental monitoring.

[121] Information on operating reactor experience, including releases to the environment, is located at http://www.nrc.gov/reactors/operating/ops-experience.html. In addition, 10 CFR 72.44(d)(3) requires the annual submittal of a summary of effluents from the independent spent fuel storage facility. All reports can also be found in ADAMS at the NRC public website: http://www.NRC.gov.
[122] ASERs are available at: http://www.energy.gov/ehss/policy-guidance-reports/environment-policy-guidance-reports/annual-site-environmental-reports.
[123] http://www.epa.gov/compliance/monitoring/programs/caa/neshaps.html.

F.5 Emergency Preparedness (Article 25)

Article 25 specifies spent fuel and radioactive waste management facilities must have appropriate onsite and, if necessary, off-site emergency plans, and should be tested at an appropriate frequency. Additionally, Article 25 requires each Contracting Party to prepare and test emergency plans on its territory in the event of a radiological emergency at a spent fuel or radioactive waste management facility in the vicinity of its territory. The following subsections describe the extensive emergency preparedness and emergency management programs in place at NRC-licensed and DOE facilities.

As part of the U.S. National Response Framework (NRF),[124] the Federal Radiological Monitoring and Assessment Center (FRMAC) is a Federal asset available on request by the Department of Homeland Security (DHS) and state and local agencies to respond to a nuclear or radiological incident. The FRMAC is an interagency organization with representation from DOE/Nuclear National Security Agency (DOE/NNSA), EPA, NRC, Department of Defense (DOD), Department of Health and Human Services (HHS), Federal Bureau of Investigations (FBI), and other Federal agencies. DOE/NNSA has the responsibility to maintain the operational readiness and to deploy FRMAC upon request. The mission of FRMAC is to coordinate and manage all Federal radiological environmental monitoring and assessment activities during the response of any of the three phases; immediate, intermediate and delayed (recovery, cleanup) phases of any nuclear, radiological incident or accident, within the U.S. in support of state, local, Tribal governments, DHS, and any other Federal coordinating agency. For the management of an event, related to the immediate and intermediate phase of FRMACs response, DOE/NNSA has the lead. The lead will then transition over to EPA for the cleanup and recovery phases of an incident/accident.

In addition, the following subsections describe the extensive emergency preparedness and emergency management programs in place at NRC-licensed and DOE facilities.

F.5.1 NRC Emergency Preparedness

F.5.1.1 Nuclear Facility Response Plans

NRC regulations require comprehensive emergency plans be prepared and periodically exercised to assure actions are taken to notify and protect citizens in the vicinity of a nuclear facility during an emergency. Although NPPs, as well as fuel fabrication and uranium conversion and enrichment facilities, have active components potentially requiring immediate protective response to mitigate the effects of an accident or a terrorist attack, radioactive waste disposal systems are passive. For radioactive waste management and spent fuel management at a NPP or other significant nuclear fuel cycle facility, the emergency preparedness program is modified by license condition upon the facility's entry into the decommissioning phase. The revised provisions for emergency preparedness and response will be modified commensurate with the hazard of the materials remaining within the former controlled areas.
The vast majority of events reported to NRC are routine and do not require activation of its incident response program. See NRC's site *About Emergency Response*[125] for information on how NRC responds to potential public health and safety emergencies.

[124] http://www.fema.gov/national-response-framework.
[125] http://www.nrc.gov/about-nrc/emerg-preparedness/respond-to-emergency.html.

NRC Regulatory Guide 3.67[126] provides information on the classification of emergencies as either "alerts" or "site area emergencies" for nuclear material and fuel cycle facility licensees. Some nuclear materials licensees may also use the "Unusual Event" classification to notify officials of events of lower safety significance, although not required by NRC regulations.[127] DOE also has published classification guidance in DOE G151.1-1, *Categorization and Classification of Operational Emergencies*.[128]

Although the severity and extent of hazards associated with spent fuel or radioactive waste management facilities are different than those associated with a NPP, many of the elements for emergency response are still applicable. An Emergency Plan is required by NRC regulations in any license application (LA) for a spent fuel storage facility not located on the site of an operating nuclear reactor. There must be semiannual communications checks with Offsite Response Organizations (OROs) and biennial onsite exercises to test response to simulated emergencies. Other radiological/health physics, medical, and fire drills are conducted annually. There are similar requirements to have an Emergency Plan for materials licenses using large quantities of radioactive materials in unsealed form, on foils or plated sources, or sealed in glass.

The emergency plans for spent fuel and radioactive waste as held at reactor or fuel cycle facilities are reviewed on an ongoing basis as a result of activities of the resident inspector program. More specifically for these licensees, the plans are evaluated as part of annual certifications from licensees based upon local emergency exercises and by Federal Emergency Management Agency (FEMA) biennially.[129] Emergency plans, if required for radioactive waste not located at an operating reactor or nuclear fuel cycle facility, are evaluated as part of standard inspection activities. Inspection frequency is based upon the inspection schedule (annual, biennial, triennial, etc.) for the type of facility.

The Emergency Planning and Community Right-to-Know Act requires off-site "general emergency" planning for facilities possessing hazardous chemicals (including uranium) onsite. NRC simply requires certification that these requirements have been met. It should also be noted that "General Emergency" planning (for off-site areas) is much broader in scope, detail, complexity and politics than "Site Area" emergency planning.

F.5.1.2 Emergency Response

NRC activates its incident response program at its Headquarters Operations Center and one of its four Regional Incident Response Centers (Region I in King of Prussia, Pennsylvania; Region II in Atlanta, Georgia; Region III, in Lisle, Illinois; or Region IV in Arlington, Texas), in response to an event at an NRC-licensed facility that potentially threatens public health and safety, or the environment. NRC will immediately dispatch a team of experts from the respective Regional Office to the site if event conditions warrant. NRC's highest priority is to provide expert consultation, support, and assistance to state and local public safety officials responding to the event. Additional

[126] http://pbadupws.nrc.gov/docs/ML1033/ML103360487.pdf.
[127] Further information on the NRC's emergency event classification is available at: http://www.nrc.gov/about-nrc/emerg-preparedness/about-emerg-preparedness/emerg-classification.html
[128] http://www.directives.doe.gov/.
[129] For more on the inspection activities see http://www.nrc.gov/reactors/operating/oversight/inspection-basics.html.

details on emergency response are accessible from the Third U.S. National Report and from the NRC website.[130]

Communications with the media is the responsibility of NRC Office of Public Affairs. This office will communicate frequently with the media via press releases, Web postings (and a special emergency event Web page), press conferences, if needed, and an open media-bridge telephone line. NRC regional public affairs officers normally interact with media personnel during an event that does not result in a change to NRC's response mode or if the agency is in the Monitoring Mode. See additional information on effective risk communication by NRC at http://www.nrc.gov/reading-rm/doc-collections/nuregs/brochures/br0308.

NRC's role, as well as the roles of other Federal agencies in the coordinated emergency response to a nuclear accident, is described in the Nuclear/Radiological Incident Annex of the NRF.[131]

F.5.1.3 Emergency Response Exercises

NRC Headquarters and Regional staff members typically participate in several emergency response exercises each year for materials facilities. This is in addition to participation in four full-scale emergency exercises for NPPs, as well as participation in several multi-agency exercises. The previous U.S. National Report discusses in more detail the emergency measures, requirements, and additional references addressing emergency response. Final After Action Reports are developed following Emergency Exercises where OROs are scheduled to participate with associated Licensees. Past reports are available at: http://www.nrc.gov/about-nrc/emerg-preparedness/related-information/fema-after-action-reports.html. These are mostly related to NPPs.

Each regional office typically participates in four emergency response drills or exercises each year, selected from among the list of hostile action-based drills, fuel fabrication facility exercises, or full-scale Federal Emergency Management Agency-evaluated (FEMA-evaluated) exercises required of U.S. nuclear facilities. The Final After Action Reports are prepared by FEMA. Additionally, NRC headquarters participates with each of the four regional offices annually in a drill or exercise. Each regional office is expected to participate in a drill or exercise with each reactor or fuel facility site in its region, once every six years. On-scene participants during these drills and exercises include the NRC licensee, state, Tribal government, county, and local emergency response agencies. The scope and goals of these drills and exercises may vary to some degree, but the principal NRC objective is to demonstrate readiness to recognize and evaluate the event and to support the NRF, state and local authorities, and the nuclear facility, in response to the emergency.

F.5.1.4 Incident Investigation and Event Reporting

Incident investigation is a formal process conducted to help prevent subsequent issues, which could adversely impact public health and safety, or the environment. NRC's Incident Investigation program provides a formal, structured, and appropriately measured NRC investigative response to significant operational events based on their safety significance. This process includes gathering and analyzing information;

[130] http://www.nrc.gov/about-nrc/emerg-preparedness/respond-to-emergency.html.
[131] http://www.fema.gov/emergency/nrf for more detail.

determining findings and conclusions, including the causes of a significant operational event; and publishing the investigation results for NRC, industry, and public review.

NRC's Incident Investigation program, outlined in Management Directive 8.3, *NRC Incident Investigation Program*,[132] ensures the investigation of significant events is performed in a timely, objective, systematic, technically sound, and independent way by NRC. Factual information about the event and probable cause(s) must also be documented.

A senior NRC manager reporting directly to NRC Executive Director for Operations leads the Incident Investigation Team. The team is technically and administratively supported by the Office of Nuclear Security and Incident Response. See additional information on investigation in the previous U.S. National Report.

Whether or not an emergency plan is called for, NRC regulations require the timely reporting of any event that may have caused, or threatens to cause, release of radioactive material inside or outside of a restricted area or any event involving loss of control of licensed material (events may include fires, explosions, toxic gas releases, etc.).

F.5.1.5 Emergency Preparedness at Radioactive Materials Facilities

NRC regulations in 10 CFR Part 30, *Rules of General Applicability to Domestic Licensing of Byproduct Material*; 10 CFR Part 40, *Domestic Licensing of Source Material*; *and 10 CFR Part 70, Domestic Licensing of Special Nuclear Material*, require some fuel cycle and materials licensees to prepare emergency plans. These emergency plans are required to comply with the requirements of 10 CFR 30.32(i)(3), 10 CFR 40.31(j)(3), or 10 CFR 70.22(i)(3). Generally, the types of information to be submitted in these emergency plans include: facility description, types of accidents, classification and notification of accidents, detection of accidents, mitigation of consequences, assessment of releases, responsibilities, notification and coordination, information to be communicated, training, safe shutdown, exercises, and hazardous chemicals on site.

NRC performed a regulatory analysis on emergency preparedness for nuclear fuel cycle facilities and other radioactive material licensees in 1988.[133] Specific thematic information on emergency preparedness and planning for specific waste management facility types is summarized in the previous U.S. National Report for geologic and near-surface disposal sites, uranium mills, and decommissioning.

NRC and Agreement States issued enhanced security orders[134] that require materials licensees to have a pre-arranged plan with the local law enforcement agency (LLEA) for assistance in response to an actual or attempted theft, sabotage, or diversion of International Atomic Energy Agency (IAEA) Code of Conduct Category 1 and 2 quantities of radioactive material. The LLEA response is needed for offsite coordination, the protection of the public health and safety, and to mitigate potential consequences of malevolent use of radioactive material. DOE/NNSA assists licensees and LLEA in the

[132] http://pbadupws.nrc.gov/docs/ML0312/ML031250592.pdf.
[133] The findings for this analysis were published in NUREG-1140, A Regulatory Analysis on Emergency Preparedness for Fuel Cycle and Other Radioactive Material Licensees.
[134] http://www.nrc.gov/security/byproduct/orders.html.

development of their response to the potential theft of radioactive material at the Alarm Response Training course at Y-12 National Security Site in Oak Ridge, TN.

It should also be noted that NRC is evaluating the applicability of lessons-learned from the Fukushima event to non-operating reactor and non-reactor facilities. As this evaluation proceeds, these lessons will be reflected in such areas as emergency preparedness and response for other types of regulated facilities, where appropriate. See sections K.2 and A.3.4 of this document for additional information on the U.S. government's assessment of lessons learned from Fukushima.

F.5.2 DOE Emergency Preparedness and Management

DOE has implemented an emergency management system for all its sites and facilities. DOE O151.1C, *Comprehensive Emergency Management System*,[135] describes DOE's emergency management system, by establishing policy; assigning roles and responsibilities; and providing the framework for development, coordination, control, and direction. This order establishes requirements for emergency planning, preparedness, response, recovery, and readiness assurance activities and describes the approach (including a graded approach) for effectively integrating these activities under a comprehensive, all-emergency concept.

Additional emergency management details are found in DOE Guide 151.1-1A, *Emergency Management Fundamentals and the Operational Emergency Base Program*.[136] This Guide provides information about the emergency management fundamentals embedded in the requirements of DOE O 151.1C, as well as acceptable methods of meeting the requirements for the Operational Emergency Base Program, ensuring all DOE facilities have effective capabilities for all-emergency preparedness and response. Additional details on DOE's emergency management activities and its independent oversight are in the Third U.S. National Report, Section F.5.2.[137]

F.5.3 EPA Emergency Preparedness and Response

EPA's primary responsibilities in a radiological emergency are to perform environmental monitoring and cleanup activities (designated as Emergency Support Function 10 in NRF).[138] EPA's specific role will vary depending on the nature of the incident. Per the Nuclear/Radiological Incident Annex (NRIA) of the NRF, EPA is the coordinating agency for the Federal environmental response to incidents where the radioactive material involved is not licensed, owned, or operated by a Federal agency or an NRC Agreement State. This includes incidents involving foreign, unknown, or unlicensed radiological sources that have actual, potential, or perceived radiological consequences in the U.S. or its territories (most recently, EPA provided domestic environmental monitoring for the Fukushima accident). Through its RadNet monitoring system (see Section H.4), Radiological Emergency Response Team, laboratory capabilities, and other assets, EPA works with other Federal agencies, state and local governments and first responders, and international organizations to monitor, contain, and cleanup any radiological materials released to the environment. As an example, EPA's monitoring capabilities

[135] https://www.directives.doe.gov/directives-documents/100-series/0151.1-BOrder-c.
[136] https://www.directives.doe.gov/directives-documents/0151.1-EGuide-1a.
[137] http://www.em.doe.gov/pdfs/3rdpercent20USpercent20Rptpercent20onpercent20SNFpercent20JC--percent20COMPLETEpercent20REPORTpercent20-percent2010percent2013percent2008.pdf.
[138] http://www.epa.gov/radiation/emergency-response-overview.html.

have been deployed to support responses to wildfires threatening DOE installations in New Mexico and Washington. At times, EPA's extensive assets for responding to chemical emergencies will also be involved.

EPA is also responsible for supporting state and local authorities in planning for radiological emergencies. A key aspect of this planning is the development of protective action guides (PAGs) to help emergency managers and public officials make decisions about evacuation or other actions to protect the public.[139] EPA also conducts training[140] for first responders and participates in a wide variety of exercises.

F.6 Decommissioning Practices (Article 26)

Both NRC and DOE have active decommissioning programs as discussed in Section D.3. Their approaches are discussed in the following subsections.

F.6.1 NRC Decommissioning Approach

NRC regulates nuclear facility D&D with the ultimate goal of license termination. NRC regulations assign responsibility for decommissioning licensed and unlicensed[141] facilities to the licensee or other responsible parties. NRC evaluates the authorized party's proposed DP, including the licensee's justification for using a particular remediation methodology, to determine if it is appropriate. The decommissioning process consists of a series of integrated activities ending with license termination and site release. Decommissioning may be relatively simple and straightforward, or complex. Specific details on decommissioning activities at NRC authorized facilities are detailed in annual reports on the status of the decommissioning program. Information is provided on specific provisions such as timing, the review process, financial assurance, public participation and other programmatic considerations.[142]

NRC does not identify a reference scenario for a critical radiological accident during decommissioning. Licensees are required to analyze their particular facility and determine the appropriate health and safety measures necessary to maintain worker and public doses within NRC limits. The health and safety plan is provided to NRC as part of the Decommissioning or License Termination Plan (DP or LTP). NRC reviews the plan as part of its review and approval of the DP or LTP.

This comprehensive decommissioning program[143] uses a dose-based approach for regulating decommissioning activities, and includes routine decommissioning sites, formerly licensed sites, non-routine/complex sites, fuel cycle sites, and test/research and power reactors. Remediating these sites is now managed more effectively as part of this larger program.

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[139] http://www.epa.gov/radiation/rert/pags.html. EPA is in the process of updating the PAG manual (See Sections A.3.4 and K.2).

[140] http://www.epa.gov/radiation/pubs.html.

[141] Some facilities are not licensed, but NRC and the Agreement States have regulatory authority to deal with safety-related issues for non-operational sites. Some of the complex sites discussed in Section D.3.3 of this report do not have active licenses, because they are either legacy sites or previously terminated sites, which are deemed no longer in compliance with safety standards. See http://www.nrc.gov/info-finder/decommissioning/complex/.

[142] NRC Annual Status of Decommissioning Program is available from http://www.nrc.gov/about-nrc.html.

[143] http://pbadupws.nrc.gov/docs/ML1331/ML13311A566.pdf.

F.6.1.1 Nuclear Reactor Facilities

After a nuclear power reactor licensee decides to permanently cease operations (See Figure F-3, Step 1), the licensee must submit written certification to NRC within 30 days of a decision (Step 2). Once the licensee removes the fuel permanently from the reactor vessel, the licensee is required to submit written certification to NRC, stating the date the fuel was permanently removed from the reactor vessel and stating the disposition of the fuel (Step 3). Licensees must also submit a Post-Shutdown Decommissioning Activity Report (PSDAR) (Step 4), and NRC will make the PSDAR publicly available and will also schedule a public meeting in the vicinity of the licensee's facility within 90 days of NRC's receipt of the licensee's PSDAR submittal (Step 5). Normally, NRC will hold the meeting at least 30 days before the 90-day period ends.

Once the licensee certifies that the facility has permanently ceased operation and the fuel has been permanently removed from the reactor vessel, and the 90-day period has passed, decontamination and dismantlement under the provisions of 10 CFR 50.59 and 10 CFR 50.82 may commence (Step 6).

Licensees should submit the LTP as a supplement to the final safety analysis report (FSAR) or as an equivalent document. By regulation (10 CFR 50.82(a)(9)(i)), the licensee must submit an LTP at least two years before the planned license termination date (Step 7). NRC must issue a notice of receipt of the LTP and publish an opportunity for a hearing. A public meeting is held near the facility before NRC approves the plan.

NUREG-1700, Revision 1, *Standard Review Plan for Evaluating Nuclear Power Reactor License Termination Plans,* describes the information requirements for an LTP. Licensees, as of 2007, must make provisions to facilitate decontamination of structures and equipment, to minimize the quantity of radioactive wastes and contaminated equipment, and to facilitate removal of radioactive wastes and contaminated materials when the facility is permanently decommissioned.

NRC shall terminate the license if it determines that the remaining dismantlement has been performed in accordance with the approved LTP, and the final radiation survey and associated documentation, including an assessment of dose contributions associated with parts released for use before approval of the LTP, demonstrate that the facility and site have met the criteria for decommissioning in 10 CFR part 20, subpart E (Step 8).

Reactor licensees may choose immediate dismantlement (DECON) or monitored deferred status (SAFSTOR) options. The choice of decommissioning method (SAFSTOR vs. DECON) is left entirely to the licensee. Licensees are not restricted to solely a SAFSTOR or DECON approach and can combine the SAFSTOR and DECON options. Current regulations require decommissioning be completed within 60 years. Additional time will be considered only when necessary to protect public health and safety. Spent fuel can remain stored in the Spent Fuel Pool (SFP) or in dry cask storage facilities until a disposal option becomes available.

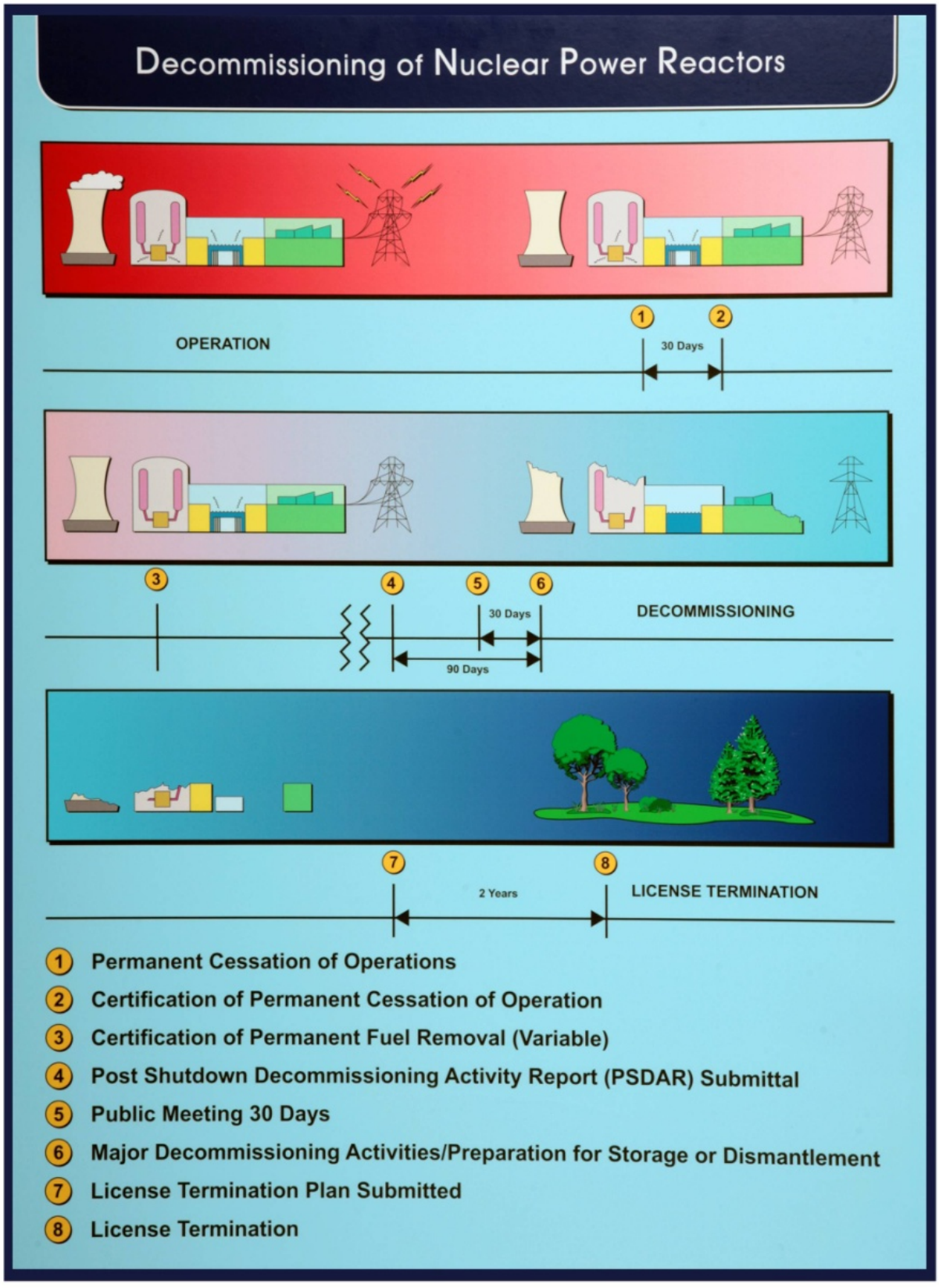

Figure F-3 Decommissioning Process for Nuclear Power Reactors

F.6.1.2 Materials Facilities and Activities

Material facilities decommissioning activities include maintaining regulatory oversight of complex decommissioning sites, conducting inspections, interacting with the affected public, undertaking financial assurance reviews, and coordinating with other partner Federal agencies.

The initiating conditions for decommissioning a materials facility, as well as the major steps and timing for decommissioning, are documented in annual reports on the status of the decommissioning program, which were mentioned previously. There are occasions in which the licensee requests restricted release of the site. In those cases, where the authorized party proposes restricted release of the site, NRC first evaluates the compliance with the financial assurance and institutional control provisions of the DP, before considering the remainder of the DP.

NRC's staff review is guided by NUREG-1757, *Consolidated Decommissioning Guidance*[144], where NRC has consolidated its decommissioning guidance for materials sites into a more risk-informed and performance-based document.

NRC inspects the facility during decommissioning operations to ensure compliance with the DP. These inspections will normally include in-process and confirmatory radiological surveys. LLW from decommissioning is disposed at a licensed LLW disposal facility (pending availability) after components and materials are dismantled and decontaminated. Other waste with sufficiently low concentrations of radionuclides, e.g., building rubble, can be disposed by alternate methods. See Section H.1.4.

F.6.1.3 Decommissioning License Termination Criteria

NRC's dose constraint for decommissioned facility unrestricted release is detailed in 10 CFR Part 20 Subpart E. Table F-3 provides the dose limit for decommissioning. License termination under restricted conditions (restricted release) is permissible when achieving the unrestricted levels would result in net public or environmental harm. This requires relying on institutional controls (10 CFR 20.1403 for specific provisions). However, during the period of performance of the institutional controls, the decommissioned facility would be expected to comply with the unrestricted release constraint.

F.6.2 DOE Decommissioning Approach

DOE's management approach for disposing excess facilities is described in DOE O 413.3B, *Program and Project Management for the Acquisition of Capital Assets*,[145] with the technical approaches described in DOE O 430.1B, *Real Property Asset Management*.[146] Further guidance is provided in DOE Guide 430.1-4, *Decommissioning Implementation Guide.*[147] Additional Orders and Guides for decommissioning and cleanup related activities are found in the DOE Directives system.[148]

[144] http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1757/.
[145] https://www.directives.doe.gov/directives-documents/0413.3-BOrder-b.
[146] https://www.directives.doe.gov/directives-documents/0430.1-BOrder-bc2.
[147] https://www.directives.doe.gov/directives-documents/0430.1-EGuide-4.
[148] https://www.directives.doe.gov/.

Most decommissioning projects are conducted under a variety of regulatory processes – most commonly the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) – and site-specific cleanup agreements, which are legally binding and specify the process, end states, decision points, and required approvals. Regulatory requirements and independent oversight for these projects, as well as for spent fuel and radioactive waste management activities are described in Section E.2.3. Additional details on DOE decommissioning projects are described in the Third U.S. National Report.[149]

F.7 General Safety Requirements (Articles 4 and 11)

General safety requirements addressed in the subsections below were called out specifically in the Joint Convention report preparation guidance.[150]

F.7.1 Criticality Control and Residual Heat Removal

F.7.1.1 Criticality Control

The American Nuclear Society Standards Subcommittee 8 (ANS-8), Operations with Fissionable Materials Outside Reactors has developed national standards for the prevention and mitigation of criticality accidents during handling, processing, storing, and transporting special nuclear materials at fuels and material facilities. These national standards have been approved by the American Nuclear Society Committee N16 on Nuclear Criticality Safety and by the American National Standards Institute (ANSI). ANSI/ANS-8 nuclear criticality safety standards provide guidance and criteria on good practices for nuclear criticality safety generally acceptable to NRC for the prevention and mitigation of nuclear criticality accidents. NRC has incorporated recommendations from these sources into Regulatory Guide 3.71 *Nuclear Criticality Safety Standards for Fuels and Material Facilities.*[151]

Interim Staff Guidance on the safety of spent fuel management, including criticality and sub criticality safety are provided at: http://www.nrc.gov/reading-rm/doc-collections/isg/spent-fuel.html. Specifically:

- SFST-ISG-8, Revision 3 – Burnup Credit in the Criticality Safety Analyses of PWR Spent Fuel in Transport and Storage Casks,
- SFST-ISG-19 – Moderator Exclusion under Hypothetical Accident Conditions and Demonstrating Subcriticality of Spent Fuel under the Requirements of 10 CFR 71.55(e).

Criteria for criticality safety for the independent storage of spent fuel, HLW, and GTCC LLW are defined in NRC regulations in 10 CFR Part 72, *Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-level Radioactive Waste*, and *Reactor-related Greater Than Class C Waste, Subpart F, Criteria for Nuclear Criticality Safety*. Section 72.124 establishes criteria for nuclear criticality safety, including design for criticality safety, methods of criticality control, and criticality monitoring.

[149] http://energy.gov/em/downloads/third-national-report-joint-convention-safety-spent-fuel-management-and-safety.
[150] International Atomic Energy Agency, Guidelines Regarding the Form and Structure of National Reports: *Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management* (INFCIRC/604/Rev. 1), Vienna, Austria, 19 July 2006.
[151] Available at: http://www.nrc.gov/reading-rm/doc-collections/reg-guides/fuels-materials/rg/.

F.7.1.2 Residual Heat Removal

Dry storage cask systems (for both HLW and spent fuel) are required to have reliable passive heat removal capability. NRC regulations and DOE Orders require the decay heat removal for storage facilities be capable of reliable operation so the temperatures of materials used for systems, structures, and components important to safety, e.g., fuel assembly cladding material, and solidified HLW packages, remain within the allowable limits under normal, off-normal, and accident conditions.[152] Additionally, wet and dry fuel assembly transfer systems must also have adequate decay heat removal under normal, off normal, and accident conditions. Technical specifications for heat removal capability for a storage system are proposed by the applicant or may result from the review and evaluation of submittals relating to those areas.

F.7.2 Waste Minimization

Waste minimization programs in the U.S. are mandated by law, regulations, and a Presidential Executive Order.[153] The Pollution Prevention Act of 1990[154] focused industry, government, and public attention on reducing the amount of pollution through cost-effective changes in production, operation, and raw materials use. Opportunities for source reduction are often not realized because existing regulations and the industrial resources required for compliance focus mainly on treatment and disposal. Source reduction, however, is fundamentally different and more desirable than waste management or pollution control.

EPA's Waste Minimization Program seeks to reduce or eliminate waste in manufacturing by promoting the concept of sustainability.[155] EPA works with industry, government agencies, and communities to voluntarily find ways to help them reduce the amount of waste they generate, particularly if the wastes contain one or more waste minimization priority chemicals.

Federal agencies, such as DOE, are subject to Executive Orders mandating waste minimization and pollution prevention programs, particularly Executive Order 12780, *Federal Agency Recycling and the Council on Federal Recycling and Procurement Policy*, and Executive Order 12856, *Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements*. DOE has programs designed to reduce environmental releases and the amount of waste eventually requiring treatment, storage, and disposal at DOE sites. Such reduction activities include site-wide coordination, planning, reporting, employee awareness, assessments, incentives, cost-savings initiatives, recycling, and affirmative procurement programs.
NRC regulations (10 CFR 20.1406) require applicants for licenses to "minimize, to the extent practicable, the generation of radioactive waste." These regulations combined with the cost and availability of disposal of radioactive waste in the U.S. provides strong incentives to waste generators to practice waste minimization.

Licensees, as a practical matter, take steps to reduce the volume of radioactive waste after it was produced due to the cost of disposal at licensed commercial burial sites.

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[152] See 10 CFR Part 72, subsections 72.122(h)(1) and (l) also 72.236(b),(f),(g), and (h).
[153] Greening the Government through Leadership in Environmental Management Executive Order 13148. Available at http://energy.gov/nepa/downloads/executive-order-13148-greening-government-through-leadership-environmental-management.
[154] United States Code, Title 42, Sections 13101 and 13102.
[155] http://www.epa.gov/wastes/hazard/wastemin/index.htm.

Common means are compaction and incineration. Although a number of NRC licensees are authorized to incinerate certain LLW, most incineration is performed by a small number of commercial incinerators.

Additional information on minimization of waste throughout all stages of the nuclear fuel cycle, including disposal, can be found in Regulatory Guide 4.21, *Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning*, June 2008.[156] This guidance provides examples of measures, which can be combined to support a contaminant management philosophy. This philosophy includes prevention of unintended release, early detection of potential releases, and aggressive cleanup when releases happen.

F.7.3 Interdependencies within Spent Fuel and Waste Management

Successful management of spent fuel and radioactive waste requires careful integration among power or research reactors, waste generators, storage facilities, treatment facilities, disposal sites and their transportation interfaces (Articles 4(iii) and 11(iii)). Integration is achieved through interface management, such as specified waste acceptance criteria, so generators and disposers have a common understanding of the waste characteristics, packaging requirements, transportation specifications, etc. Acceptance requirements constrain the management of interfaces between the various steps in spent fuel and waste management. The U.S. recognizes the importance of this integration and manages the interfaces between various steps, e.g., storage, transportation, and disposal.

The U.S. Government uses a system composed of inspections, enforcement, QA, testing and record keeping, thereby ensuring interdependencies among these steps remain relatively seamless. Manifests are used for transportation of radioactive waste and spent fuel. Portal monitors and other monitors located at specific check points are used to confirm the characteristics of radioactive materials as they are transferred within a site, as well as in shipments between facilities. Disposal facility operators use the monitoring results to review and verify the validity of assumptions made and to update the assessments as specified in Article 15 for the period after closure. The U.S. has regulations governing cradle-to-grave management of radioactive waste, and waste managers are responsible for the safety of their inventories under the terms of their licenses or safety bases.

F.7.4 National Laws/Regulations and International Criteria and Standards

The U.S. has an extensive and comprehensive set of laws and regulations for radiation protection, meeting the intent of Article 4 and Article 11 of the Joint Convention. EPA (Section E) is responsible for developing national environmental standards and guidance for Federal and state agencies containing recommendations for their use in developing radiation protection requirements. The U.S. Government works with international organizations, such as the IAEA and the ICRP, to ensure U.S. standards are in general harmony with recommendations from these organizations. NRC, DOE, and EPA are involved in the process of revising and drafting IAEA Safety Standards relating to nuclear, radiation, waste, and transport safety. Because transportation is excluded from the definitions of radioactive waste and spent fuel management (see Article 2, items (i)

[156] Regulatory Guide 4.21 is available at http://www.nrc.gov.

and (n)), the activities supporting the revision of Safety Standard TS-R-1 are not discussed in this report. However, the U.S. Government has a very active role in the radiation safety standards committee, the waste safety standards committee, the nuclear safety standards committee, and the Commission on Safety Standards. These committees meet biannually to review and approve safety standards for publication by the IAEA. The U.S also supports IAEA efforts to encourage nations to follow the guidance in the Code of Conduct on the Safety and Security of Radioactive Sources.

The U.S. believes these standards are a valuable source of guidance that a country can use to establish or enhance its national programs. These standards, however, do not prescribe the only approach to establishing strong national programs and are not binding on any country, except to the extent an individual country, acting in accordance with its national framework, incorporates all or parts of them into its national law or regulations.

Several agencies are now using or allowing the use of the updated dose coefficients found in ICRP Publications 60, 68 and 72. New recommendations have been issued by the ICRP and most U.S. agencies are studying those changes before considering any revisions to current public and worker dose limits. Any change from effective dose equivalent to effective dose as the basis for human dosimetry has not yet occurred on a broad scale, although new regulations may incorporate the newer dose methods.

F.7.5 Biological, Chemical, and Other Hazards

The U.S. has major environmental laws taking into account the potential effects of biological, chemical, and other hazards; facility operators must abide by these laws to protect workers, the public, and the environment. EPA issues and enforces regulations to implement these environmental laws. EPA in turn delegates some regulatory authority to states meeting the minimum Federal requirements.

One law that addresses biological, chemical and other hazards is the Resource Conservation and Recovery Act (RCRA), which grants EPA the authority to control hazardous waste from “cradle-to-grave.” This includes the generation, transportation, treatment, storage, and disposal of hazardous waste. RCRA also sets forth a framework for the management of non-hazardous solid wastes. The 1986 amendments to RCRA enabled EPA to address environmental problems resulting from underground tanks storing petroleum and other hazardous substances. RCRA focuses only on active and future facilities and does not address abandoned or historical sites covered by CERCLA (Superfund).[157] The 1984 Federal Hazardous and Solid Waste Amendments to RCRA required phasing out land disposal of untreated hazardous waste. Some of the other mandates of this law include increased enforcement authority for EPA, more stringent hazardous waste management standards, and a comprehensive underground storage tank program. Impacts from chemical hazards are assessed as part of the environmental assessment (EA) process. These assessments are required prior to constructing spent fuel and radioactive waste management facilities.

F.7.6 Avoiding Undue Burden/Impacts on Future Generations

Avoiding undue burdens on future generations is one important goal of U.S. policy to manage, store, and dispose of spent fuel and radioactive waste. Progress made toward timely decommissioning of inactive nuclear facilities and storage and permanent

[157] 42 U.S.C. 9601, et. seq.

disposal of spent fuel and radioactive waste is a strong component of a strategy to achieve this policy. The WIPP geologic repository is an example of the U.S. addressing the burden/impacts on future generations as national policy.

F.8 Existing Facilities (Articles 5 and 12)

The U.S. conducts safety reviews of both commercial and governmental spent fuel and radioactive waste management facilities under its existing regulations.[158] No additional reviews of existing facilities are required to comply with the Joint Convention because existing facilities are already subject to periodic safety reviews. The frequency and type of assessments and inspections depend on the type of facility and results of previous safety reviews. For example, for ISFSIs or a Monitored Retrievable Storage Facility (MRS), regulations in 10 CFR 72.70 specify licensees shall update periodically the FSAR to ensure the information included in the report contains the latest information developed.[159]

F.9 Siting Proposed Facilities (Articles 6 and 13)

The U.S. has a legal and regulatory framework to site proposed new facilities. The process provides for evaluation of all relevant site related factors, safety impacts to workers, the public, the environment, and socio-economic impacts. See Section E.

F.9.1 Assessing Environmental Impacts (NEPA Process)

The National Environmental Policy Act of 1969 (NEPA) is the basic National charter for protection of the environment. It establishes policy, sets goals, and provides means for carrying out the policy. Federal agencies have implementing regulations to integrate environmental values into their decision-making processes by considering the environmental impacts of their proposed actions and reasonable alternatives. The NEPA process provides the option to the public to attend NEPA-related hearings or public meetings and to submit comments directly to the lead agency. The Third U.S. National Report provides more specific information on NEPA.

F.9.2 Site Selection

NRC regulations prescribe site characterization activities and pre-license application reviews by NRC, as well as the application requirements for licensing and construction authorization. Although technical siting specifications are generally dictated by operations or activities being licensed, the procedural criteria for scoping and public involvement are fairly uniform and are documented in 10 CFR Part 51. The regulations also provide for participation in the pre-licensing (site) review and licensing review by states, affected Tribal governments, and interested stakeholders. Information is made publicly available.

Site selection for a new spent fuel or waste management facility is embodied in the EA process (implementation of NEPA). Licensees select a site based on consideration of many factors, including geography, demography, meteorology, hydrology, seismology, and the geology characteristics of the site and the surrounding area. Nearby industrial

[158] See 10 CFR Part 72; Section 72.70.
[159] http://www.nrc.gov/reading-rm/doc-collections/cfr/part072/part072-0070.html.

parks, transportation, sensitive areas, parklands, historical sites, and military facilities are also a consideration in the selection process.

From the information supplied in response to the regulations, NRC can determine if the applicant has properly addressed environmental, socioeconomic, and other site considerations, which could be adversely affected by the proposed operation or facility.

F.9.3 Public and Stakeholder Involvement

The U.S. recognizes the many benefits derived from public participation in its program activities, including spent fuel and radioactive waste management. Public participation in the U.S. regulatory program is open and ongoing, and consists of both formal and informal communication between government officials and stakeholders. Regular communication with the public allows the government to gather the most diverse collection of opinions, perspectives, and values from the broadest spectrum of the public, enabling the government to make better, more informed decisions and providing the public with the opportunity to influence decisions that affect their communities. Information is available to members of the public about different topics, including decommissioning, spent fuel, and radioactive waste.[160]

Congress enacted the WIPP Land Withdrawal Act (WIPP LWA) in October 1992, giving EPA significant new responsibilities for certifying DOE's determination of compliance at WIPP. EPA, in implementing its responsibilities, committed to conducting an open public process including interaction with all interested parties. This increased the public's understanding of EPA's role and responsibilities for the WIPP project, enabled the public to have informed opinions about the project by increasing their knowledge about radiation and its risks, and enhanced the overall decision-making process.[161]

The *Administration's Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste*[162] embraced the core findings of the BRC and affirmed that any workable solution for the final disposition of used fuel and nuclear waste must be based not only on sound science, but also on achieving public acceptance at the local, state and Tribal levels.

The Administration supports working with the U.S. Congress to develop a consent-based process that is transparent, adaptive and technically sound. The BRC emphasized that flexibility, patience, responsiveness and a heavy emphasis on consultation and cooperation with all parties are necessary in the siting process and in all aspects of implementation. The BRC and the Administration strategy emphasize the importance of pursuing consolidated interim storage in parallel with looking at alternative sites for geologic disposal.

Officials at many DOE sites have formed formal panels made up of interested citizens to advise the government on planned ongoing activities under the Federal Advisory Committee Act. Site-Specific Advisory Boards (SSABs) provide consensus advice and

[160] http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/.
[161] Additional information on the WIPP outreach program was provided in the Second U.S. National Report in Annex F-8. http://www.epa.gov/radiation/wipp.
[162] See Section A.4.1.3.

recommendations to DOE spent fuel and waste management activities at most locations where spent fuel and radioactive waste is stored.[163]

DOE, EPA and NRC conduct public hearings and public meetings, accept written and electronic comments on proposed actions, participate in stakeholder meetings, and provide and maintain internet sites.[164] NRC's internet website provides a full description of the agency's public information process and meeting calendar.

F.10 Facility Design and Construction (Articles 7 and 14)

Articles 7 and 14 of the Joint Convention require that spent fuel and radioactive waste management facilities are designed and constructed to limit possible radiological impacts and discharges throughout their life cycle. This is accomplished by performing reviews of the proposed operations against well-established design and construction criteria in the standards, regulations and orders. Subsequent monitoring and inspection during the construction process provides confidence that the operation will operate safely. Examples include DOE O 420.1B, which requires all facilities to be designed for protection from natural phenomena and to facilitate safe decommissioning at end of their operating life. NRC, EPA and Agreement and Authorized States have similar provisions concerning limiting radiological impacts and discharges at spent fuel and waste management facilities.

F.11 Assessing Facility Safety (Articles 8 and 15)

The Joint Convention requires that a systematic safety assessment and an EA appropriate to the hazards present at the facility are prepared to cover the entire life cycle. Updated and detailed assessments are required before operations commence. Although a safety assessment is generally a stand-alone process, it is also addressed as part of the NEPA process (see Section F.9.1). NRC employs a risk-informed and performance based approach to decision-making where risk insights are considered along with other factors such as engineering judgment, safety limits, redundancy, and diversity. Risk insights are gathered by asking three questions: "What can go wrong?" "How likely is it?" and "What are the consequences?" A risk assessment is a systematic method for addressing these three questions to understand likely outcomes, sensitivities, areas of importance, system interactions, and areas of uncertainty. This is applied agency-wide in the decision making process.

F.12 Facility Operation (Articles 9 and 16)

The U.S. uses results of inspection, monitoring, and testing to verify and review safety assessment assumptions (per Article 16(iii) of the Joint Convention).

F.12.1 NRC Facility Safety

NRC regulations for issuing site-specific licenses for the operation of ISFSI are in 10 CFR Part 72. These regulations incorporate a graded approach and require the licensee to demonstrate via safety assessment that the facility is operated safely. NRC regulations require licensees to update safety assessments whenever significant new information becomes available; possibly reducing a margin of safety or requiring a

[163] Information on SSABs may be found at http://www.em.doe.gov/Pages/ssab.aspx.
[164] http://www.epa.gov/radiation/index.html and http://www.nrc.gov.

change to license conditions. Part 72 also requires the operator of an ISFSI to update its safety analysis every 24 months and update its DP to reflect current inventories and conditions of the site and structures at the time of decommissioning.

NRC has regulations (10 CFR Part 61) and internally developed licensing and inspection programs governing the authorization to operate low-level radioactive waste disposal facilities. Part 61 requires the licensee to prepare a performance assessment of the disposal facility demonstrating that the performance objectives of Part 61 were fulfilled. The performance assessment must be updated whenever significant changes are made to the disposal facility and at time of closure.

Operations safety data are reported to or identified by NRC in event reports, inspection reports, component failure reports, industry reports, safeguard and security events, reports of defects and noncompliance (10 CFR Part 21), and reports of operation experience at foreign facilities. NRC screens operations safety data for safety significance, trends and generic implications, and the need for further regulatory action. NRC also develops, coordinates, and issues generic communications to alert industry to safety concerns and recommends the need for special inspections or event investigations.[165] Examples were included in previous U.S. National Reports.

F.12.1.1 Inspecting NRC-Licensed Commercial Facilities and Activities

NRC inspects licensed commercial NPPs, research reactors, fuel cycle facilities, and radioactive materials activities and operations, including their management of radioactive waste and discharge of radioactive effluents. If an inspection identifies that a licensee is not in compliance with regulatory and/or license requirements, NRC informs the licensee of the problems found and provides the licensee an opportunity to address the problems. NRC conducts follow-up inspections to ensure problems are corrected.

NRC's safety oversight program is designed to limit exposures to acceptable limits and maintain them ALARA, protect the environment, and safeguard radioactive material from terrorist threats. The oversight program includes inspections and assessments of licensee and vendor activities with a focus on minimizing risk to public health and safety. NRC issues reports to document inspection findings. These inspection reports may contain enforcement actions and follow-up inspection items. NRC makes inspection reports electronically available for public review in its Agency-wide Documents Access and Management System (ADAMS) by searching for a site name or docket number.

NRC also conducts routine safety inspections of ISFSIs and of vendors and fabricators of dry cask storage systems. The inspectors examine whether licensees and vendors are performing activities in accordance with radiation safety requirements, licensing and certificate of compliance (CoC) requirements, and QA program commitments. Announced or unannounced NRC inspections are conducted during pre-operational testing, and periodically between one and three years afterward, to determine if the licensee is in full compliance. Licenses and the technical specifications included in CoCs for cask designs contain additional inspection/review requirements. Inspectors follow guidance in NRC's Inspection Manual.[166]

[165] http://www.nrc.gov/reading-rm/doc-collections/gen-comm/.
[166] http://www.nrc.gov/reading-rm/doc-collections/insp-manual/.

For an ISFSI that has routine operations with loaded dry-cask disposal systems, an inspection is expected every two to three years. Inspections may occur more frequently, depending upon prior inspection history, licensee performance, lessons learned, emergent issues or scheduling issues. In addition, any cask unloading occurrences should be inspected.

NRC and Agreement States conduct approximately 2000 inspections of its nuclear material licensees per year. These inspections review areas such as training, radiation protection programs, patient dose records, and security, as well as radioactive waste and/or spent fuel management. Details in the conduct and documentation of an inspection are addressed in operational inspection manual chapters.[167]

F.12.1.2 NRC Enforcement and Civil Penalties

If licensees violate regulatory or license requirements, NRC initiates action based on its Enforcement Policy, taking into account investigation of results from inspection, testing or other violation identification mechanisms, including allegations. The NRC Enforcement Policy, including its revisions, is available to NRC licensees and members of the public on NRC's website.[168]

CALENDAR YEAR 2013 NRC ENFORCEMENT SUMMARY HIGHLIGHTS

NRC issued 75 escalated enforcement actions, including:

- 54 escalated Notices of Violation without civil penalties
- 11 actions involving civil penalties totaling $212,400
- 10 enforcement orders

Only one civil penalty associated with an Alternative Dispute Resolution (ADR) was issued totaling $1000

The Office of Enforcement exercises oversight of NRC enforcement programs, provides programmatic and implementation direction to regional and Headquarters offices conducting or involved in enforcement activities, and ensures regional enforcement programs are adequately carried out. NRC uses three primary enforcement actions: Notices of Violations (NOVs), Civil Penalties, and Orders.[169] Details of these actions and NRC enforcement process can be found in previous U.S. National Reports and at the NRC Office of Enforcement website.[170]

NRC authority to issue orders is detailed in Section 161 of the AEA and extends to any area of licensed activity affecting the public health and safety. NOVs and civil penalties are issued based on the significance of the violations. Orders may be issued for violations, or in the absence of a violation, to address a public health or safety issue. A graphical representation of the NRC graded approach for dispositioning violations is included on NRC's website.[171] Civil penalties are normally assessed for severe violations, as well as for deliberate violations of the reporting requirements. Additional

[167] A full list is presented at http://www.nrc.gov/reading-rm/doc-collections/insp-manual/manual-chapter/.
[168] http://www.nrc.gov/about-nrc/regulatory/enforcement/enforce-pol.html.
[169] The term *order* within this context is distinguished from a DOE Order.
[170] http://www.nrc.gov/about-nrc/regulatory/enforcement/program-overview.html.
[171] Ibid.

details on severity levels and recent enforcement actions for materials facilities are available from NRC's website.[172]

All orders and Alternative Dispute Resolutions (ADRs) are made available to the public.[173] Significant enforcement actions (including actions to individuals) are included in the Enforcement Document Collection in the Electronic Reading Room of NRC's web site. Enforcement annual reports are also publicly available.[174]

F.12.2 DOE Facility Safety

DOE exercises regulatory authority over spent fuel and radioactive waste management operations conducted by DOE or on its behalf pursuant to the AEA, except in cases where Congress has specifically provided NRC authority over DOE facilities or activities (see Section E.2.3). The major applicable Federal regulations include 10 CFR Part 820 *Procedural Rules for DOE Nuclear Activities,*[175] 10 CFR Part 830 *Nuclear Safety Management,*[176] 10 CFR 835 *Occupational Radiation Protection*[177] and 10 CFR Part 851, *Worker Safety and Health Program*.[178] DOE's nuclear safety regulations are similar to those of NRC's.

In addition to the regulations referenced above, facility operations and radiation protection programs fall under standards and requirements established in DOE Orders and Directives. The major applicable orders include DOE O 420.1C, *Facility Safety,* DOE O 458.1, *Radiation Protection of the Public and the Environment*[179] and DOE O 435.1, *Radioactive Waste Management.*

Other requirements for implementing 10 CFR Part 830 are found in DOE O 422.1, *Conduct of Operations.*[180] Implementation guidance is found in DOE G 421.1-2, *Implementation Guide For Use in Developing Documented Safety Analyses To Meet Subpart B of 10 CFR 830*[181] and DOE G 423.1-1A, *Implementation Guide For Use In Developing Technical Safety Requirements.*[182] Table E-1 provides a list of spent fuel and radioactive waste management Federal regulations as well as DOE Orders and other Directives. Further details are found in previous U.S. National Reports.

Oversight responsibility for DOE facility safety is assigned to EHSS[183] and the Office of Independent Enterprise Assessments (IEA). In carrying out this responsibility, EHSS is focused on providing effective and consistent safety-related policy development, technical assistance, education and training, and complex-wide independent oversight and enforcement. Key safety functions include:

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172 http://www.nrc.gov/reading-rm/doc-collections/enforcement/actions/materials/.
173 http://www.nrc.gov/about-nrc/regulatory/enforcement/adr.html.
174 http://www.nrc.gov/reading-rm/doc-collections/enforcement/annual-rpts/.
175 http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&sid=878197d37c47d5d267017ca6fde249ba&rgn=div5&view=text&node=10:4.0.2.5.24&idno=10.
176 http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&tpl=/ecfrbrowse/Title10/10cfr830_main_02.tpl.
177 http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&tpl=/ecfrbrowse/Title10/10cfr835_main_02.tpl.
178 http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&tpl=/ecfrbrowse/Title10/10cfr851_main_02.tpl.
179 https://www.directives.doe.gov/directives-documents/0458.1-BOrder.
180 https://www.directives.doe.gov/directives-documents/0422.1-BOrder.
181 https://www.directives.doe.gov/directives-documents/0421.1-EGuide-2.
182 https://www.directives.doe.gov/directives-documents/0423.1-EGuide-1a.
183 Detailed information about the EHSS mission, functions, and programs may be found at http://energy.gov/ehss/environment-health-safety-security.

- **Corporate Safety Analysis** providing analysis and certification of DOE-wide performance in protecting the public, the workers, and the environment while performing the missions of DOE. This analysis supports corporate decision-making and synthesizes operational information to support continuous environmental, safety, and health improvement across the DOE complex. Such analysis is a means of communicating experiences to potentially reduce risk, improve efficiency, and enhance the cost-effectiveness of DOE processes and operations.
- **Corporate Safety Programs** including safety program topics such as Accident Investigation, Accident/Incident Reporting System, Analytical Services Program, Behavior-Based Safety/Human Performance, Corrective Action Management Program, Federal Occupational Safety and Health, and Laboratory Accreditation Program.

Under IEA,[184] the Office of Enforcement promotes overall improvement in DOE's safety and security programs through management and implementation of DOE enforcement programs for safety and classified information security authorized by the AEA. The office is independent of DOE offices that develop and implement policy and programs. The office conducts enforcement investigations using systematic enforcement practices to evaluate operational events and conditions representing potentially serious violations of DOE's nuclear safety, worker safety and health, and classified information security regulations. These investigations can result in civil penalties against DOE contractors that violate the regulations.

- **Worker Safety and Health Enforcement** implementing 10 CFR Part 851, which is DOE's congressionally mandated requirement for a worker safety and health program that reduces or prevents occupational injuries, illnesses, and accidental losses by providing DOE contractors and their workers with safe and healthful workplaces at DOE sites; and procedures for investigating whether a violation of a requirement of this regulation has occurred, determining the nature and extent of any such violation, and imposing an appropriate remedy.
- **Nuclear Safety Enforcement** implementing DOE's nuclear safety enforcement program in accordance with 10 CFR Part 820, *Procedural Rules for DOE Nuclear Activities*, as authorized by AEA. Title 10 CFR Part 820 provides procedures which govern the conduct of DOE personnel in nuclear activities and ensure that all personnel attain compliance with DOE's nuclear safety requirements.

[184] Detailed information about the IEA enforcement mission and functions may be found at http://energy.gov/iea/services/enforcement.

G. SAFETY OF SPENT FUEL MANAGEMENT

Section F described aspects common to spent fuel and radioactive waste safety per Articles 4-9 and 11-16 of the Joint Convention, respectively. This section provides additional information relative to the same Articles pertaining solely to spent fuel. This section also addresses Article 10 of the Joint Convention.

G.1 General Safety Requirements (Article 4)

The need for general safety requirements is found in the Atomic Energy Act (AEA) and the Nuclear Waste Policy Act, as amended. The licensing requirements for storage of spent fuel, high-level waste (HLW), and reactor related Greater-than-Class C (GTCC) low-level waste (LLW) at an independent spent fuel storage installation (ISFSI) are contained in 10 Code of Federal Regulations (CFR) Part 72. Additional applicable regulations include 10 CFR Part 71, *Packaging and Transportation of Radioactive Material*; Part 73, *Physical Protection of Plants and Materials*; Part 75, *Safeguards on Nuclear Material-Implementation of US/IAEA Agreement*. Table E-1 lists key NRC regulations.

Although both pool storage and dry storage are safe methods for spent fuel management, there are significant differences in the operation and safety practices of these facilities. Pool storage requires consistent operational vigilance by utilities or other licensees and relies on the satisfactory performance of mechanical systems using pumps, piping and instrumentation, whereas dry cask storage systems rely on passive measures to ensure safety.

Nuclear Regulatory Commission (NRC) authorizes storage of spent fuel at independent spent fuel storage installations (ISFSIs) under two licensing options: site-specific and general licenses. To obtain a site-specific license, an applicant submits an application to NRC and NRC performs a technical review of all aspects of the proposed ISFSI. The application must contain general and financial information; the applicant's technical qualifications to be able to safely operate the ISFSI; a safety analysis report; quality assurance (QA) program; an operator-training program; physical protection, decommissioning, and emergency plans; an environmental report; and specific license conditions.

Upon approval, NRC issues a license for up to a 40–year term. NRC recently completed a rulemaking to extend the license and certificate of compliance (CoC) from 20-year to 40-year terms. The licensee has an option for renewal at the end of the license term.[185]

A general license to store spent fuel at an ISFSI is automatically granted, via 10 CFR 72.210, to any nuclear power plant (NPP) licensee that has a license under 10 CFR Part 50 or 10 CFR Part 52. The general license is valid for 40 years from the loading date of each storage cask, as long as the as the licensee maintains its 10 CFR Part 50 or 10 CFR Part 52 license and continues to meet the other requirements of the general license.

[185] More specific information about the licensing process for both wet and dry storage facilities can be found at http://www.nrc.gov/waste/spent-fuel-storage.html.

The prospective general licensee must also review its security program, emergency plan, QA program, training program and radiation protection program, and make any necessary changes to incorporate the ISFSI at its reactor site.

NRC has approved 36 dry spent fuel storage design models, which general licensees may consider for use at their site. Each NRC-approved storage cask design has been technically reviewed for its safety aspects and found adequate to meet spent fuel storage requirements in 10 CFR Part 72. The CoC is issued for a term of up to 40 years and can be renewed. The CoC designations and models are listed in NRC regulations (10 CFR 72.214).

NRC approves dry cask storage systems by evaluating each design for resistance to normal and off-normal conditions of use and hypothetical accident conditions such as floods, earthquakes, tornados, and temperature extremes. The maximum allowable heat generation from the fuel assemblies stored in each cask may be different for each design. The temperature of the fuel in the casks continuously decreases over time. There have been no releases of spent fuel storage cask contents or other significant safety problems from the dry cask storage systems in use today.

G.2 Existing Facilities (Article 5)

ISFSIs in the United States of America (U.S.) use different dry storage system designs (some of which are licensed for a specific site). The designs encompass dual-purpose canisters, vault storage systems, and metal and concrete storage casks. These storage casks are made by several vendors and have been licensed or certified by NRC. Almost all ISFSIs are owned and operated by 10 CFR Part 50 power reactor license holders. ISFSI facilities are identified in Annex D-1D.

Typical examinations for renewal of a storage license or CoC evaluate aging of components through corrosion, chemical attack, and other mechanisms for reduction in the efficacy of important storage cask components. Current guidance on renewing site-specific storage licenses or CoCs is contained in NUREG-1927, *Standard Review Plan for Renewal of Spent Fuel Dry Cask Storage System Licenses and Certificates of Compliance*.[186]

G.3 Siting Proposed Facilities (Article 6)

Siting of ISFSIs at operating NPP is addressed as part of the overall safety evaluation for the operating facility. For the case of siting ISFSIs at an away-from-reactor facility, 10 CFR Part 72 Subpart E, *Siting Evaluation Factors*, addresses factors such as the radiological criteria, design basis events, geologic considerations, and controlled areas.[187]

In the Fourth U.S. National Report, a private initiative, Private Fuel Storage, LLC (PFS), was discussed. NRC issued a license to PFS on February 21, 2006, but progress in developing the facility was delayed indefinitely because PFS was unable to gain use of public lands for an intermodal transfer facility. PFS submitted an annual fee exemption request, which is under review by the Commission.

[186] Publicly available from NRC, http://www.nrc.gov/reading-rm/adams.html – ADAMS Accession Number ML111020115.
[187] For more detailed information on spent fuel storage, http://www.nrc.gov/waste/spent-fuel-storage.html.

G.4 Spent Fuel Management Facility Design and Construction (Article 7)

General design criteria contained in 10 CFR Part 72 Subpart F establish the design, fabrication, construction, testing, maintenance, and performance requirements for structures, systems, and components important to safety, as defined at 10 CFR 72.3. These are minimum requirements for the design criteria for an ISFSI or monitored retrievable storage installation.

Subpart L in 10 CFR Part 72 establishes requirements for spent fuel storage cask design approval and fabrication for use by general licensees. This subpart also contains requirements and conditions for renewal of designs having an NRC CoC; record keeping and reporting requirements; procedures for amending a CoC; and periodic updating of safety analysis reports. QA requirements, which apply to both the facility and certificate holder, are located in 10 CFR Part 72, Subpart G.

NRC reviews safety analysis reports using guidance to the staff in NUREG-1536, *Standard Review Plan for Dry Cask Storage Systems*, and NUREG-1567, *Standard Review Plan for Spent Fuel Dry Storage Facilities*. These plans ensure the quality and uniformity of NRC reviews.

G.5 Assessing Facility Safety (Article 8)

Technical evaluations of ISFSI safety are performed in six major areas: (1) siting; (2) operating systems; (3) criteria and technical design; (4) radiation safety programs supporting protection of both worker and public health and safety; (5) accidents; and (6) proposed technical specifications. Additional details and specific requirements are contained in NUREG-1567, *Standard Review Plan for Spent Fuel Dry Storage Facilities*.[188]

Demonstrating compliance with long-term performance requirements, by necessity, will involve the use of complex predictive models supported by data from field and laboratory tests, site-specific monitoring, and natural analog studies supplemented with prevalent expert judgment.

G.6 Facility Operation (Article 9)

NRC's regulations and its licensing and inspection programs, affect numerous aspect of spent fuel and radioactive waste storage activities, including the storage of spent fuel or reactor related GTCC LLW at an ISFSI; approval of the storage cask design; and the safe operation of the ISFSI. There have been no releases of spent fuel storage cask contents or other significant safety problems from the dry cask storage systems in use today.

Inspections ensure safe operation and continued integrity of the fuel in the storage cask. Other than a review of indirect parameters, there are no periodic inspections required to determine damage to the contents as part of the facility license conditions. It is important to note that studies have been performed on dry storage system canisters and their contents, which show no degradation that would warrant changing the storage

[188] NUREG-1567 can be accessed at http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/.

systems licensing bases. The results of these studies are located in NUREG/CR-6831, *Examination of Spent PWR Fuel Rods after 15 Years in Dry Storage*.[189]

NRC issued guidance on the standard format and content of technical specifications and recommendations on the most important fuel parameters in NUREG-1745, *Standard Format and Content for Technical Specifications* for 10 CFR Part 72 Cask Certificates of Compliance, and NUREG/CR-6716, *Recommendations on Fuel Parameters for Standard Technical Specifications for Spent Fuel Storage Casks*.[190] The important parameters are those with a large influence on criticality safety and radiation shielding doses. The ultimate determination of parameters is based on those the applicant uses in its modeling to demonstrate safety of the storage cask and facility design.

Requirements for incident reporting are located in 10 CFR 72.74, 72.75, and 72.80. The rules require reporting significant events where NRC may need to act to maintain or improve safety or to respond to public concerns. All events are considered against the International Nuclear Event Scale (INES). A report is generated per INES requirements if the event is classified a Level 2 or above. Section F.12 provides additional information on facility operations.

G.7 Spent Fuel Disposal (Article 10)

The Blue Ribbon Commission (BRC) on America's Nuclear Future evaluated alternative approaches concerning the back end of the fuel cycle and developed recommendations for management and disposal of spent fuel and HLW. The Administration's response to the BRC report was released in January 2013. The Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste is a "framework for moving toward a sustainable program to deploy an integrated system capable of transporting, storing, and disposing of used nuclear fuel and high-level radioactive waste from civilian nuclear power generation, defense, national security and other activities." Legislation will be necessary to fully implement this Strategy. DOE is conducting planning activities necessary to lay the groundwork for implementing the Strategy. See Section A.4.1.3. The BRC report provides a starting point for this Strategy, and the key principles of the recommendations are endorsed by the Administration. DOE has developed and is executing a research and development (R&D) program that will address critical scientific and technical issues associated with the long-term management of used nuclear fuel. DOE is identifying alternatives and conducting scientific research and technology development to enable long-term storage, transportation, and geologic disposal of used nuclear fuel and radioactive wastes generated by existing and future nuclear fuel cycles. The research focuses on sustainable fuel cycle options and technologies that minimize waste generation, improve safety, and complement institutional measures in limiting proliferation risk. The main objective in this R&D is to develop a suite of options that will enable future decision makers to make informed choices about how best to manage the used fuel from reactors. This R&D will be performed on functions in storage, transportation, and disposal in a variety of geologic environments, as well as work to better understand the potential degradation mechanisms involved in long-term dry cask storage.

[189] Publicly available from NRC, http://www.nrc.gov/reading-rm/adams.html – ADAMS Accession Number ML032731021.
[190] Publicly available from NRC, http://www.nrc.gov/reading-rm/adams.html – ADAMS Accession Numbers ML011940387 and ML010820352; respectively.

H. SAFETY OF RADIOACTIVE WASTE MANAGEMENT

Section F described common elements of spent fuel and radioactive waste safety per Articles 4-9 and 11-16 of the Joint Convention, respectively. This section addresses Articles11-16, which focus exclusively on radioactive waste management. This section also addresses Article 17 of the Joint Convention.

Primary legal basis and agency responsibilities for management of radioactive waste are discussed in detail in Section E. The Nuclear Regulatory Commission (NRC) regulates commercial radioactive waste including high-level waste (HLW), low-level waste (LLW), and uranium mill tailings. NRC's regulatory framework for disposing and managing commercial spent fuel is described in Sections F and G. This section addresses NRC's safety requirements for LLW and uranium recovery programs. See Section B.2.3.2 for additional information on waste types.

DOE's waste management practices are described in DOE Order (O) 435.1, *Radioactive Waste Management*. This order and its implementing manual require that all DOE radioactive waste be managed to protect worker and public health and safety, and the environment. DOE O 435.1 applies to all DOE radioactive waste classes, including HLW, transuranic (TRU) waste, and LLW. The requirements span the life cycle of waste management facilities from planning through decommissioning and post closure.

H.1 Existing Commercial LLW Management Facilities and Past Practices (Article 12)

H.1.1 Currently-Licensed LLW Facilities

The commercial sector's LLW is typically stored on site by licensees or by third party waste processors, either until it has decayed away (can be disposed of as ordinary trash) or until amounts are large enough for shipment to a LLW disposal site. LLW disposal occurs at commercially operated LLW disposal facilities and could be licensed by either NRC pursuant to 10 CFR Part 61 or Agreement States pursuant to their regulations which are compatible with 10 CFR Part 61.[191] All currently operating sites are licensed by Agreement States. Facilities must be designed, constructed, operated, and closed to meet rigorous safety standards. The operator of the facility must also extensively characterize the facility site and analyze how the facility will be protective of public health, safety and the environment for thousands of years.

NRC regulations (10 CFR 61.12(k)) for land disposal of LLW require license applicants submit a description of their radiation safety program for control and monitoring of radioactive effluents to ensure compliance with the radiation dose limits for the general population. Also, as required by 10 CFR 61.53(c), the licensee must maintain a monitoring program during the construction and operation of a LLW disposal facility. The monitoring system must be capable of providing early warning of releases of radionuclides from the disposal site before they leave the site boundary. Similarly, per 10 CFR 61.53(d), the licensee responsible for post-operational surveillance of the disposal site must maintain a monitoring system capable of providing early warning of releases after the site is closed. Siting requirements for land disposal of commercial LLW are contained in Subpart D of 10 CFR Part 61. NRC is currently working to revise

[191] There are no disposal facilities currently licensed by NRC for disposal of GTCC LLW. GTCC LLW is stored until a disposal facility is established in accordance with the LLRWPAA.

certain portions of 10 CFR Part 61. Refer to Section K.6, item 2, for more information on the rulemaking.

The Low-Level Radioactive Waste Policy Act of 1980 (LLRWPA) gave states responsibility for providing disposal capacity for LLW generated within their borders (except for certain waste generated by the Federal government). The LLRWPA authorized states to enter into compacts allowing them to dispose of waste at a common disposal facility and exclude waste from states outside the compact. Most states have entered into compacts. The LLRWPA was amended in 1985 to add a series of milestones and penalties in order to encourage compliance. Figure H-1 shows the makeup of U.S. regional compacts for LLW disposal. There are now 10 compacts, comprising 42 states, and 10 unaffiliated states (the District of Columbia and Puerto Rico are considered states by the AEA and LLRWPA). Three compacts have sited disposal facilities and a fourth facility is not affiliated with a compact. Existing U.S. commercial LLW disposal sites are discussed in Section D.2.2.2. All of these disposal sites are in Agreement States.

H.1.2 Past Practices and Formerly Licensed Facilities

NRC reviewed sites with terminated licenses to assure these facilities were properly decontaminated and posed no threat to public health and safety. Sites needing further attention were included as part of ongoing decommissioning programs or transferred to an Agreement State or other Federal agency. Past U.S. National Reports provide detailed information.

H.1.3 Management Strategies for Low-Activity Waste Sites

Although the U.S. does not have an official legal definition in place for the low activity waste (LAW) term, licensees do have the ability to manage and dispose of materials that fall into that category of waste. LAW is also a term frequently used by other nations and organizations involved in radioactive waste management.[192] One of the primary reasons LAW has become a focus of attention is the unusually large volumes to be managed in comparison to conventional LLW from the ongoing operations of nuclear facilities. Decommissioning or cleanup of contaminated sites in particular can generate large volumes of LAW.

Several Federal agencies implement or oversee cleanup programs producing substantial amounts of LAW (see Fourth U.S. National Report for details). For example, NRC established the complex sites decommissioning program in the early 1990s and continues to oversee the cleanup of sites contaminated with radioactive materials and licensees who implement the cleanup as discussed in Section D.3.3.

Estimating future needs for storage or disposal capacities for LAW, LLW, or mixed waste is the waste generator's responsibility. Hazardous waste facilities and municipal or industrial solid waste landfills are now used by U.S. generators for some LAW disposal. Both types of facilities are regulated under Resource Conservation and Recovery Act of 1976 (RCRA), which is implemented by the Environmental Protection Agency (EPA) and, in the case of hazardous waste, by states authorized by EPA, and, for non-hazardous solid waste, by states alone. See Section E.2.2.3 on mixed waste regulation.

[192] IAEA Symposium on Low-Activity Radioactive Waste Disposal; Cordoba, Spain. December 13-17, 2004.

Licensees in non-Agreement States are required to get NRC approval for alternate disposal of such very low activity waste (10 CFR 20.2002). The approval request must identify amounts, concentrations, and specific radionuclides and include a performance assessment demonstrating exposures will be no more than a few tens of μSv (few millirem). NRC approval exempts such waste from further regulatory control with regard to the waste's radioactive content. Agreement States have regulations similar to 10 CFR 20.2002 covering the disposal of very low activity wastes.

A number of DOE sites, on a case-by-case basis and in coordination with state regulators, have limited approval for waste disposal at specific solid waste landfills. The authorized limits are established to ensure no special regulatory requirements beyond those already in place for the landfill are necessary.

Low levels of residual radioactivity may remain at many DOE sites. If necessary, long-term management (e.g., institutional controls) will be implemented to ensure future use of the land is safe and barriers to prevent access are functioning as intended. Several DOE sites have waste disposal on site in Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) disposal cells requiring long-term stewardship. See Section H.2.5 for DOE's regulations on long-term management of legacy sites.

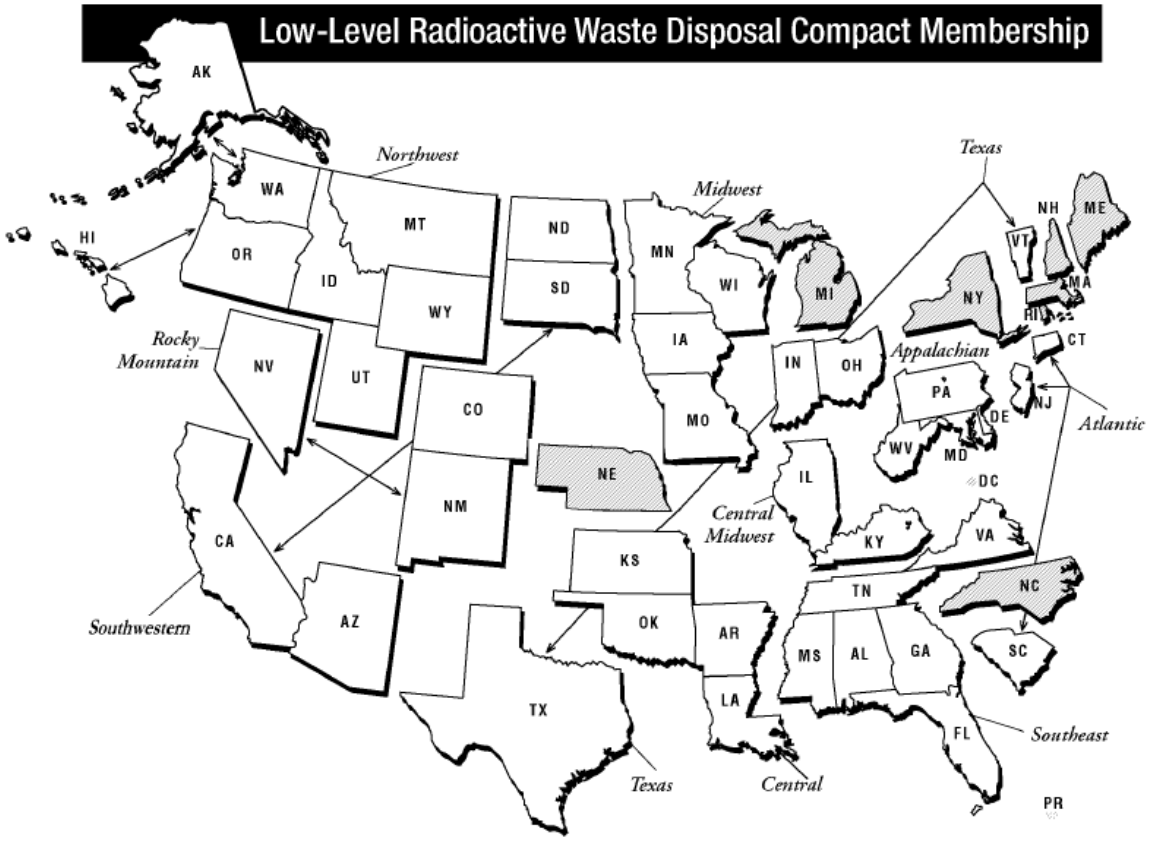
The CERCLA (Superfund) program administered by EPA has a long history of permitting residual materials, both chemicals and radioactive materials, to remain on site provided a reliable system of institutional controls is established. CERCLA requires a review every five years to ensure the controls are continuing to function.

H.1.4 Controlling Solid Materials Disposition

In the international context, Controlling Solid Materials Disposition is referred to as *clearance*. NRC generally addresses the release of solid material on a case-by-case basis using license conditions and existing regulatory guidance. In each case, material may be released from a licensed operation with the understanding and specific acknowledgment that the material may contain very low amounts of radioactivity, but the concentration of radioactive material is so small that its control through licensing is no longer necessary. Some materials are only contaminated on or near the surface; others are contaminated throughout their volume. The regulatory processes for release of these materials are different.

Land disposal is another option for disposition of low activity radioactive material from licensed facilities (Section H.1.3). NRC can consider specific licensing actions, as well as generic requests, concerning the disposition of solid materials. NRC regulations do not contain generally applicable standards for the disposition of solid materials with relatively small amounts of radioactivity in, or on, materials and equipment.[193] The offsite disposition of solid materials prior to license termination will continue to be evaluated on a case-by-case basis using existing guidance.

[193] American National Standard ANSI/HPS N13.12-2013, *Surface and Volume Radioactivity Standards for Clearance* was updated in May 2013. However, it has not yet been incorporated into the U.S. regulatory infrastructure.



Appalachian Compact
Delaware
Maryland
Pennsylvania
West Virginia

Atlantic Compact
Connecticut
New Jersey
South Carolina

Central Compact
Arkansas
Kansas
Louisiana
Oklahoma

Central Midwest Compact
Illinois
Kentucky

Northwest Compact
Alaska
Hawaii
Idaho
Montana
Oregon
Utah
Washington
Wyoming

Midwest Compact
Indiana
Iowa
Minnesota
Missouri
Ohio
Wisconsin

Rocky Mountain Compact
Colorado
Nevada
New Mexico

Northwest accepts Rocky Mountain waste as agreed between compacts

Southeast Compact
Alabama
Florida
Georgia
Mississippi
Tennessee
Virginia

Southwestern Compact
Arizona
California
North Dakota
South Dakota

Texas Compact
Texas
Vermont

Unaffiliated States
District of Columbia
Maine
Massachusetts
Michigan
Nebraska
New Hampshire
New York
North Carolina
Puerto Rico
Rhode Island

Unaffiliated States are shaded

Figure H-1 U.S. Low-Level Waste Compacts[194]

[194] http://www.nrc.gov/waste/llw-disposal/licensing/compacts.html

H.1.4.1 Surface Contaminated Radioactive Material Release

Criteria used by licensees to determine whether the material may be released are approved during the initial licensing or license renewal of a facility, as part of the facility's license conditions or radiation safety program. The licensees' actions must be consistent with the requirements of 10 CFR Part 20 (e.g., 10 CFR 20.1501). Thus, the licensee performs a survey of the material prior to its release. However, there are differences in the way reactor licensees and materials licensees apply the criteria for release of this material.

Nuclear reactor licensees historically follow a policy that was established and documented in NRC Office of Inspection and Enforcement Circular 81-07 and Information Notice 85-92.[195] The reactor licensees survey equipment and material before its release to identify the presence of controlled radioactive material above natural background levels; if this "presence" is detected, then no release may occur.[196] Otherwise, the solid material in question can be released for unrestricted use.

For materials licensees, NRC usually authorizes the release of solid material through specific license conditions. Criteria used to evaluate solid materials before they are released are contained in Regulatory Guide 1.86, *Termination of Operating Licenses for Nuclear Reactors*[197] and NUREG-1757.[198] Both documents contain a table of surface contamination criteria which may be applied by licensees for use in demonstrating that solid material with surface contamination can be safely released with no further regulatory control. These surface contamination criteria have been used in many contexts for all types of licensees for many years.

H.1.4.2 Volumetrically Contaminated Radioactive Material Release

NRC guidance documented in the series of three volumes of NUREG-1757[199] describes acceptable procedures and types of equipment for use in clearance of contaminated areas or items. Clearance levels are determined based on two methods, namely through the use of existing NRC guidance or through the development of alternative approaches, which are reviewed by NRC on a case-by-case basis.

NRC guidance on clearance levels is summarized in an NRC report (NUREG-1757, Vol. 1, Rev. 2, Section 15.11). NRC's guidance has not changed significantly since the previous U.S. National Report and is also available from NRC website.[200] Controlled releases of volumetrically contaminated concrete may be approved, pursuant to 10 CFR 20.2002, under an annual dose criterion of a "few mrem" (few 10s of μSv).

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[195] These documents are available from NRC's website: Information Notice No. 85-92: *Surveys of Wastes Before Disposal From Nuclear Reactor Facilities* (December 2, 1985) http://www.nrc.gov/reading-rm/doc-collections/gen-comm/info-notices/1985/in85092.html, and IE Circular No. 81-07: *Control Of Radioactively Contaminated Material* (May 14, 1981) http://www.nrc.gov/reading-rm/doc-collections/gen-comm/circulars/1981/cr81007.html.

[196] The fact that no radioactive material above background is detected does not mean that none is present; there are limitations on detection capability. In practice, the actual detection capability of survey instruments is typically consistent with the criteria in NRC Regulatory Guide 1.86.

[197] Available at http://pbadupws.nrc.gov/docs/ML0037/ML003740243.pdf.

[198] http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1757/.

[199] http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1757/.

[200] http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1757/v1/.

Reactor facilities release volumetrically contaminated materials under the provisions of Information Notice No. 88-22, *Disposal of Sludge from Onsite Sewage Treatment Facilities at Nuclear Power Stations*.[201] The provision permits release of materials if no licensed radioactive material above natural background levels is detected, provided the radiation survey used a detection level that is consistent with the lower limit of detection (LLD) values used to evaluate environmental samples.[202]

Radioactive waste management of materials resulting from decommissioning (decontamination, dismantlement, demolition, etc.) is addressed in NUREG-1757, Section 17.5.

H.2 DOE Waste Management Facilities

General safety requirements for DOE facilities were discussed in Section F. The following subsections contain additional information on the safety of radioactive waste management at DOE facilities. DOE manages radioactive waste owned or generated by DOE, including waste from atomic energy defense activities and waste resulting from DOE cleanup activities. Requirements for waste management are provided in DOE O 435.1, *Radioactive Waste Management.*

H.2.1 Past Practices (Article 12)

Some past radioactive waste management practices require additional environmental restoration activities or interventions as new technology and additional characterization information become available. Examples of these past practices include waste disposal techniques, such as soil columns or crib trenches, as well as sites where remaining residual radioactivity does not meet today's standards for unrestricted release. Environmental restoration activities resulting in off-site management and disposal of radioactive waste must meet the applicable requirements of DOE O 435.1. Cleanup decisions are reached through a formal regulatory process under CERCLA or RCRA regulations (for mixed waste). See Section E.2.2.3 on mixed waste regulation.

H.2.2 Siting Proposed Facilities (Article 13)

In addition to the requirements in DOE O 435.1, DOE radioactive waste management facilities, operations, and activities are designed and sited in accordance with DOE O 420.1A, *Facility Safety,*[203] and DOE O 430.1B, *Real Property Asset Management*.[204] Proposed locations for radioactive waste management facilities are evaluated to identify features to be avoided or must be considered in facility design and analyses. Criteria for siting a proposed new facility or expansion of an existing facility must consider:

- Environmental and geotechnical suitability;
- Human activity prohibiting site use;
- Suitability for the volume of proposed waste disposal;
- Presence of flood plain, tectonic, or water table fluctuation characteristics; and
- Ability to control radionuclide migration pathways, surface erosion and run-off.

201 http://www.nrc.gov/reading-rm/doc-collections/gen-comm/info-notices/1988/in88022.html.
202 NRC Regulatory Guide 4.8, *Environmental Technical Specifications for Nuclear Power Plants*.
203 https://www.directives.doe.gov/directives-documents/0420.1-BOrder-a.
204 https://www.directives.doe.gov/directives-documents/0430.1-BOrder-bc2.

H.2.3 Design and Construction (Article 14)

Design and construction was briefly discussed in Section F.10 of this report. Generally applicable requirements and procedures for nuclear facility design, construction and operation are in 10 CFR Part 830, *Nuclear Safety Management*; DOE O 420.1C, *Facility* Safety, DOE O 414.1D, *Quality Assurance*, DOE Policy P 450.4, *Safety Management System Policy*;[205] and DOE Acquisition Regulation clauses at 48 CFR 970.5223-1, 48 CFR 970.5204-2, and 48 CFR 970.1100-1. DOE's *Radioactive Waste Management Manual* requires new or modified waste management facilities subject to contamination with radioactive or other hazardous materials be designed to facilitate decontamination. A proposed decommissioning method must be included in the design.

H.2.4 Assessing Facility Safety (Article 15)

Radioactive waste facilities, operations, and activities must have a radioactive waste management basis consisting of physical and administrative controls to ensure protection of workers, the public, and the environment. Safety is ensured through specific waste management controls (waste acceptance criteria and waste certification programs), and based on regulatory requirements.

DOE LLW disposal facilities are sited, designed, operated, maintained, and closed so there is a reasonable expectation to comply with the performance objectives for DOE LLW disposed of after September 26, 1988. Site-specific radiological performance assessments (PA) are prepared and maintained for DOE LLW disposal facilities. More details on PAs, composite analyses, and compliance demonstration are discussed in the Fourth U.S. National Report.

In addition to PAs, site-specific radiological composite analyses are prepared and maintained for LLW disposal facilities receiving waste after September 26, 1988. The composite analysis accounts for all sources of radioactive material left at DOE sites potentially interacting with the LLW disposal facility, contributing to the dose projected to a hypothetical member of the public from existing or future disposal facilities. The composite analysis results are used for planning, radiation protection activities, and future use commitments to minimize the likelihood current LLW disposal activities will result in the need for future corrective or remedial actions. See additional information in the implementation guidance for DOE O 435.1 (DOE G 435-1).[206] The PA and composite analysis are maintained to evaluate changes affecting the performance, design, and operating bases for the facility. Additional iterations of the PA and composite analysis are conducted as necessary during the post-closure period.

A disposal authorization is a part of the radioactive waste management basis for a disposal facility and is obtained from DOE management prior to construction of a new LLW disposal facility. The disposal authorization statement is issued based on a review of the facility's PA, composite analysis, preliminary closure plan, and preliminary monitoring plan. It specifies the limits and conditions on construction, design, operations, and closure of the LLW facility based on these reviews.

Disposal Facility Closure Plans are developed for DOE LLW disposal sites. A preliminary closure plan is developed and reviewed with the PA and composite analysis.

[205] https://www.directives.doe.gov/directives-documents/0450.4-APolicy.
[206] http://www.directives.doe.gov/.

The closure plan is updated following the disposal authorization statement to incorporate conditions specified in the disposal authorization statement. Closure plans are updated as required during the operational life of the facility. Closure plans also include the total expected inventory of wastes to be disposed of at the facility over the operational life.

H.2.5 Institutional Measures after Closure (Article 17)

Institutional control measures are integrated into land use and stewardship plans and programs, and continue until the facility can be released pursuant to DOE O 458.1, *Radiation Protection of the Public and the Environment*. Most radioactive waste disposal sites will not meet DOE criteria for unrestricted release at any time in the foreseeable future. The location and use of the facility are filed with the local authorities responsible for land use and zoning.

DOE Policy 454.1, *Use of Institutional Controls*[207] requires the maintenance of active and passive controls for as long as the hazard exists. The active control period is determined by public risk, and some sites may indeed be released for either controlled or uncontrolled use. DOE anticipates many of its facilities may never be released from active institutional control.

DOE will use active institutional controls for at least 100 years following closure. Active controls, such as fences, roadways, signs, and periodic surveillance, prevent human intrusion during this period. More details on institutional controls including those applicable to TRU waste disposal at WIPP are available in the Fourth U.S. National Report.

H.3 Uranium Recovery Facilities

Uranium milling waste is designated as AEA Section 11e.(2), “byproduct material” as described in Section D.2.2.3.

H.3.1 General Safety Requirements (Article 11)

The general radiological waste safety provisions, as well as for siting and closure, for uranium milling activities are addressed in 10 CFR Part 40, with specific criteria described in Appendix A.[208] The criteria in Appendix A cover provisions such as siting and design of tailings impoundments and disposal of tailings or wastes. These provisions also address a number of non-radiological constituents (e.g., ammonia) contained in tailings. See Table F-3 for radiation safety criteria. See the Fourth U.S. National Report for more information.

H.3.2 Existing Facilities and Past Practices (Article 12)

The existing facilities are designated Uranium Mill Tailings Radiation Control Act (UMTRCA) Title I (closed or abandoned by 1978) or Title II (under license in 1978 or later). Reclamation at Title I facilities is largely complete with the exception of the former Atlas site near Moab, Utah; however, groundwater issues remain unresolved at a few

[207] https://www.directives.doe.gov/directives/0454.1-APolicy/view.

[208] Criteria Relating to the Operation of Uranium Mills and the Disposition of Tailings or Wastes Produced by the Extraction or Concentration of Source Material from Ores Processed Primarily for Their Source Material Content.

sites. Many Title II conventional mills in the U.S. are being decommissioned, and either have completed or are completing reclamation activities. The goal of the reclamation activities is to provide long-term stabilization and closure of the tailings impoundments and the sites. See Section D.2.2.3 for additional information.

NRC or the Agreement State inspects these sites at various intervals depending on the operational (or stand-by) and reclamation status. The inspection frequency can range from multiple times per year at an operating facility to once every three years at a facility in standby or reclamation status. Annex D-3 provides status of uranium recovery facilities.

H.3.3 Siting, Design, and Construction (Articles 13 and 14)

Appendix A to 10 CFR Part 40 has 13 criteria for the siting, design, construction, operation, termination and post-closure provisions.[209] Technical Criterion 1 sets broad objectives for siting and design. The intent is to provide permanent isolation of tailings and associated contaminants by minimizing disturbance and dispersion by natural forces, and to do so without ongoing maintenance. Additional criteria specify the period of performance (longevity) and other design considerations such as the presence of a liner system and dewatering method. Construction considerations include the preference for below grade disposal and reliance on a full self-sustaining vegetative cover or rock cover to reduce wind and water erosion to negligible levels.

H.3.4 Safety Assessment (Article 15)

A safety assessment is performed as part of the application review process for a uranium recovery operation. The application must provide detailed information on facilities, procedures, and equipment. The licensee must provide an environmental report with sufficient information for NRC to prepare an environmental assessment (EA) (under the provisions of the National Environmental Policy Act (NEPA)) as significant changes occur during the life of the facility, e.g., expansion of the tailings pile or increasing the number of in situ recovery (ISR) well fields. This information is used by NRC to determine whether the proposed activities are protective of public health and the environment. An EA is prepared as part of this process. A more complete EIS is prepared by NRC if the EA identifies potential significant environmental impacts. The licensee may, as a result of the EIS, have to revise the design and/or increase the financial assurance mechanism, guaranteeing adequate funding for closure and disposal.

H.3.5 Institutional Measures after Closure (Article 17)

Uranium recovery licensees are required by license conditions to complete site decontamination, decommissioning, and surface and groundwater remedial actions consistent with decommissioning, reclamation, and groundwater corrective action plans before license termination.[210] Licensees must document the completion of these remedial actions in accordance with NRC procedures. This information includes a report documenting completion of tailings disposal cell construction, as well as radiation

[209] These criteria can be accessed at http://www.nrc.gov/reading-rm/doc-collections/cfr/part040/part040-appa.html.

[210] See *Status of the Decommissioning Program Annual Report*, available at: http://www.nrc.gov/waste/decommissioning/reg-guides-comm.html.

surveys and other information required by 10 CFR 40.42. Other institutional measures are discussed in more detail in the Fourth U.S. National Report, such as a Long-Term Surveillance Plan (LTSP) implemented by the custodial agency.

H.4 Monitoring Releases to the Environment

RadNet, formerly known as the Environmental Radiation Ambient Monitoring System, is a national network of more than 200 monitoring stations distributed across all 50 states and the American Territories. Each station regularly samples the nation's air, precipitation, drinking water, or pasteurized milk for a variety of radionuclides (e.g., ^{131}I) and radiation types (e.g., gross beta).[211] RadNet includes:

- 132 fixed air monitors that can deliver real-time data using various telemetry methods;
- 2 older non-real-time fixed air monitors;
- 40 portable (or "deployable") real-time air monitors;
- 36 milk sampling locations;
- 31 precipitation sampling locations; and
- 65 drinking water sampling locations.

Over the past several years, EPA has been expanding the fixed network of air monitors to include near real-time capability; when completed, this capability will be available at 140 locations nationwide. EPA's strategy for siting these new fixed station monitors is to place them in locations ensuring improved national coverage from both a population and geographic standpoint. The monitors continue to be operated by volunteers. The 40 deployable air monitors are maintained at EPA's radiation laboratories in Montgomery, Alabama, and Las Vegas, Nevada.

The expanded RadNet system is designed to provide information to help evaluate the degree and extent of contamination caused by an accidental release or a terrorist incident. The upgrades include:

- Air monitors automatically transmitting near-real-time data;
- The additional placement of monitors to improve national coverage; and
- Air monitors with the capability of being deployed after an accident or terrorist event involving radioactive materials, to allow earlier and more comprehensive coverage of the affected areas to assist in response activities and decision-making.

RadNet normally operates in a "routine" mode, sampling radiation in all media on a regularly defined schedule. RadNet operates in an "emergency" (or alert) mode in a threat of a significant radiation release, accelerating the frequency of sampling and generating many more data records for a given period of time compared to the RadNet routine mode. In response to the incident at Fukushima in March 2011, EPA increased sampling and analysis and stationed deployable monitors in several western states, as well as Guam and Saipan. In addition to real-time measurements, more than 1700 samples were collected in the first month following the incident.

[211] RadNet data and instructions for viewing reports are available through the RadNet home page at http://www.epa.gov/radnet.

EPA also has developed RadMap, which is an interactive desktop tool to provide government at all levels with information about long-term radiation monitoring stations across the country. RadMap employs a stand-alone Geographic Information System (GIS) platform to allow users to view information about the network of more than 1700 Federal, state, local and industrial/commercial monitors. Information provided includes points of contact, available data, data collection parameters and frequency, demographics, and geographic points of interest, as well as links to the monitoring station owner's web site, if available. RadMap is a particularly useful tool for emergency responders and decision-makers to help assess the need for and appropriate location of additional monitoring resources. As a preloaded GIS program, RadMap ensures access to critical information even if computer network capabilities are unavailable.[212]

[212] http://www.epa.gov/radiation/radmap/index.html.

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I. TRANSBOUNDARY MOVEMENT

I.1 U.S. Legal and Policy Framework for Transboundary Movement

The Atomic Energy Act of 1954 (AEA) assigns regulatory oversight responsibility to the Nuclear Regulatory Commission (NRC) for commercial imports and exports of source, special nuclear and byproduct materials to and from the United States of America (U.S.).[213] NRC regulations governing commercial imports/exports are set forth in 10 Code of Federal Regulations (CFR) Part 110. The Fourth U.S. National Report provides more historical context.

Department of Energy (DOE) has independent authority for imports and certain exports under the AEA. Thus, DOE imports and certain exports are not subject to NRC export/import licensing regulations. For example, NRC's regulatory authority does not apply to DOE import of recovered disused sealed sources.

A specific license is required under 10 CFR Part 110 for imports or exports of radioactive waste as defined in 10 CFR 110.2. Such radioactive waste may also contain or be contaminated with hazardous waste.[214]

Exports of irradiated or spent fuel are addressed in other provisions governing exports of special nuclear material. A specific NRC license for imports of spent fuel is required if the shipment exceeds 100 kilograms. This requirement does not apply to DOE. Because DOE has separate statutory authority to import nuclear material and equipment, it is not subject to NRC import licensing.

I.2 Regulatory Requirements for Export or Import of Radioactive Waste

After an applicant has provided the required information for a license to import or export radioactive waste, NRC forwards the application to the U.S. Department of State (DoS). DoS is responsible for coordinating review by interested U.S. Federal Government agencies and contacting the involved foreign governments (material origin, intermediate, and/or ultimate consignee) to either provide notice or obtain consent.

It must be determined that the proposed transaction will not be inimical to the common defense and security of the U.S. and will not result in unreasonable risks to the public health and safety before an export or import license is issued. A brief description of the export and import review process for each is provided below since the reviews involve different considerations.

I.2.1 Exports

To issue a license for an export of radioactive waste, NRC must determine the action will not be inimical to the common defense and security interests of the U.S. NRC will not act on an application until receiving a recommendation from interested U.S. Federal agencies including the recipient nation's consent. Export-licensing criteria are specified

[213] Although not within the scope of the Joint Convention, NRC is also responsible for imports and exports of nuclear production and utilization facilities and any equipment or components, which are especially designed or prepared for use in such facilities.

[214] Defined in Section 1004(5) of the Solid Waste Disposal Act, 42 U.S.C. 6903(5). EPA regulates imports and exports of hazardous waste.

at 10 CFR 110.42. For proposed exports of radioactive waste, NRC requests DoS to contact the government of the recipient nation to ask if it will accept such an import from the U.S. and requests confirmation the designated consignee is authorized to receive the radioactive waste. DoS will ask the government to provide assurances that the material will be maintained in accordance with terms and conditions of the agreement if the material is subject to a peaceful nuclear cooperation agreement between the U.S. and the recipient nation. The U.S. accepts responses and assurances received from the nation of destination as confirmation that it has the administrative and technical capacity and regulatory structure to manage and dispose of the waste. NRC regulations do not require specific assessments and findings about the adequacy of the receiving nation's administrative and technical capacity and regulatory structure. NRC considers any circumstances under which it would issue a license authorizing the export of radioactive waste to a nation without a regulated waste disposal program.

Nations importing enriched uranium from the U.S. for use as reactor fuel, whether it is in the form of fresh fuel or spent fuel must obtain U.S. consent prior to retransferring it to a third party and for reprocessing, enrichment, or other alterations in form or content under the terms and conditions of U.S. peaceful nuclear cooperation agreements. Requests for U.S. approvals of such retransfers and alterations are submitted to and processed by DOE's National Nuclear Security Administration (DOE/NNSA), which coordinates U.S. interagency review of the proposed transaction. The U.S. is also consulted about the return of materials resulting from reprocessing if a nation obtains U.S. approval to transfer spent fuel to a third nation for reprocessing.

I.2.2 Imports

For proposed imports of radioactive waste, DoS contacts the government of the exporting nation, and seeks acknowledgement that they are aware of the proposed transaction and solicits any comments they might wish to provide. NRC has exclusive jurisdiction within the U.S. (the states and U.S. territories) to grant or deny specific licenses for non-DOE imports of radioactive waste. As part of the review of an application for a license to import radioactive waste, NRC consults with, as applicable, the Agreement State in which the facility is located and the associated low-level waste (LLW) compact commission(s) to confirm that an appropriate facility has agreed to accept and is authorized to possess the waste for management or disposal. NRC will not grant an import license for waste intended for disposal unless it is clear the waste will be accepted by a disposal facility, the host state, and the compact commission (where applicable). These are among the factors considered in determining the appropriateness of the facility agreeing to accept the waste for management. U.S. origin sources being returned to a manufacturer, distributor or other entity, which is authorized to receive and possess the sealed source or the device containing the sealed source, may be imported under the general import license. In August 2013, NRC published guidance on the import of non-U.S. origin radioactive sources[215].

I.3 Implementation Experience to Date

NRC ensures that exports and non-DOE imports of nuclear materials facilities and equipment under the Agency's jurisdiction are licensed in accordance with applicable U.S. statutory and regulatory requirements, as well as U.S. Government commitments to

[215] NRC published a Branch Technical Position (BTP) on the Import of Non-U.S. Origin Radioactive Sources on August 28, 2013 (78 FR 53020).

legally binding international treaties and multilateral and bilateral agreements. In addition, NRC and DOE continue to exercise global leadership by adhering to and promoting the adoption of international guidance such as the Code of Conduct on the Safety and Security of Radioactive Sources. Table I-1 provides the total number of licensing actions and Table I-2 provides the number of specific licenses issued for import or export of Category 1 and 2 radioactive materials. Appendix P to 10 CFR Part 110 provides import and export threshold limits for specific radionuclides. This includes discrete sources of ^{226}Ra. There are no specific license requirement for imports of Category 1 and 2 sources unless they are in the form of radioactive waste not excluded from the revised definition in 10 CFR 110.2.

Table I-1 Completed Export/Import NRC Licensing Actions for January 2000 – April 2014																
Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Total
Byproducts	1	0	0	2	6	7	2	3	1	1	7	3	6	5	3	47
Components	13	19	5	7	15	10	11	16	5	9	13	16	14	25	2	180
Moderator Material	4	2	3	3	6	3	1	2	1	2	1	4	16	7	1	56
Reactors & Major Reactor Components	4	5	2	0	1	3	1	4	1	3	0	0	2	1	1	28
Special Nuclear Material	50	86	68	53	56	51	64	52	43	69	41	37	38	29	4	741
Source Material	10	17	2	14	11	4	5	8	12	5	5	8	8	3	1	113
Waste Exports	2	3	1	4	1	5	2	5	3	0	6	4	1	6	0	43
Waste Imports	3	4	0	2	2	3	3	9	2	1	5	4	2	5	0	45
Total	**87**	**136**	**81**	**85**	**98**	**86**	**89**	**99**	**68**	**90**	**78**	**76**	**87**	**81**	**12**	**1253**

Source: NRC, Office of International Programs.

Table I-2 Appendix P Licenses Issued December 2005 – April 2014				
Year	Combination License	Export License	Import License	Total
2005	15	0	0	15
2006	49	15	19	83
2007	54	12	7	73
2008	21	12	6	39
2009	26	13	5	44
2010	26	12	5	43
2011	0	14	0	14
2012	0	35	0	35
2013	0	20	0	20
2014*	0	11	0	11
Total	**191**	**144**	**42**	**377**

Source: NRC, Office of International Programs

* Includes Appendix P Licenses Issued from January 1, 2014 through April 30, 2014

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J. DISUSED SEALED SOURCES

J.1 General Safety for Sealed Sources

Radiation safety programs for use and storage of byproduct material as a sealed source or device are based on robust containment of radioactive material. Sealed sources or devices are designed to withstand stresses imposed by the environment in which they are possessed and used. Regulations in 10 Code of Federal Regulations (CFR) Parts 30 and 39 provide requirements for both vendors and users of sealed sources and devices. Agreement States issue adequate and compatible regulations for the control of sealed sources and devices within their borders.

Certain regulations require radioactive sources in products used under a specific license issued in accordance with 10 CFR Parts 30-39 to be registered with Nuclear Regulatory Commission (NRC) or an Agreement State. In addition, for products using byproduct material in the form of a sealed source or in a device that contains the sealed source, 10 CFR 30.32(g) requires a license applicant to either make reference to a registered sealed source or device or provide the information necessary to perform a safety evaluation of the sealed source or device. NRC's safety evaluation and registration criteria are outlined in 10 CFR 32.210; furthermore, the regulations clarify the regulatory responsibility of those who hold product registration certificates. Regulations in 10 CFR Parts 30, 31, and 32 also allow for use of equipment requiring registration but not requiring a license for use, and for sources and devices requiring neither registration nor licensing if they meet certain requirements.

NRC and the Agreement States perform safety evaluations of the ability of sealed sources and devices to contain licensed material for use under the conditions requested. These evaluations are summarized in registrations, which are maintained by NRC in the National Sealed Source and Device Registry. Although full access to and functionality with the registry is currently unavailable to the public, the general public can still download reports on current and former vendors and products from the National Registry from the NRC public website.[216] Information on the regulatory process for evaluating and licensing sealed sources and devices is available to the public through NRC's website.[217] Agreement States also provide information on their radiation safety evaluations to NRC for the registry. A vendor only needs to provide detailed information about its sealed source or device to the regulatory agency that has jurisdiction. NRC estimates there are approximately two million of these devices and sources in existence.

Licensees possessing, using, packaging, handling, transferring, and disposing licensed material are required to comply with the general occupational and public radiation protection regulations, listed in Table E-1. This includes licensing, financial assurance and record keeping for decommissioning, and expiration and termination of licenses and decommissioning.

[216] http://www.nrc.gov/materials/miau/ssd/obtain-reports.html.

[217] http://www.nrc.gov/materials/miau/sealed-source.html.

J.2 Sealed Sources Security and Accountability

NRC's Integrated Source Management Portfolio (ISMP) is a set of information technology tools that supports the Radioactive Material Security Program, contained in the security Orders and in 10 CFR Part 37[218] and NRC's related radioactive materials licensing and tracking activities. The key systems that comprise the ISMP include the National Source Tracking System (NSTS), the Web-Based Licensing (WBL) System, and the License Verification System (LVS). These systems form a comprehensive program to augment the security and control of radioactive material by tracking information on all NRC and Agreement State licensees and more than 75000 high-risk radioactive sources possessed by approximately 1300 licensees.

NRC implemented the NSTS to enhance controls for certain radioactive materials considered to be of the greatest concern from a safety and security standpoint. The NSTS involves other Federal and state agencies and international partners and requires NRC licensees and Agreement States to report all Category 1 and 2 sealed sources throughout the lifecycle, from manufacture to disposal.

DOE also contributes information to the NSTS. This system enhances the ability of NRC and Agreement States to conduct inspections and investigations, communicate information to other government agencies, and verify legitimate ownership and use of nationally tracked sources.

The LVS serves as a "national verification system" that ensures only authorized licensees obtain radioactive materials in authorized amounts. The LVS was deployed in May 2013 and provides access to license information maintained by NRC and Agreement States. Specifically, the system will help authorities to confirm that (1) a license is valid and accurate, (2) a licensee is authorized to acquire quantities and types of radioactive materials, and (3) the licensee's Category 1 or 2 inventories do not exceed the possession limits.

NRC amended domestic licensing requirements to be consistent with the revised International Atomic Energy Agency (IAEA) Code of Conduct on the Safety and Security of Radioactive Sources and associated Guidance for imports and exports of IAEA Category 1 and 2 radioactive sources and material. NRC must approve these transfers of radioactive sources out of the U.S. in a specific export license as noted in Section I-2. A specific license is not needed for the import of this material; the activity can be performed under a general license although prior shipment notifications are still required.

DOE O 462.1, *Import and Export of Category 1 and 2 Radioactive Sources and Aggregated Quantities,* outlines responsibilities and procedures for DOE to conduct imports and exports of radioactive sources consistent with the IAEA Code of Conduct and Import/Export Guidance. The U.S. continues to promote greater harmonization for strengthening controls over international transfers of radioactive sources.[219]

[218] The security requirements for byproduct radioactive material are available on the NRC's website at http://www.nrc.gov/security/byproduct.html.
[219] Key objectives of the G-8 Evian, Sea Island and Glen Eagle Summits.

J.3 Management of Disused Sealed Sources

Licensees possessing disused sealed sources, that currently do not have a disposition path (such as Greater than Class C (GTCC) low-level waste (LLW)) or certain high activity sources), are responsible for properly storing the sources in accordance with NRC or Agreement State regulatory and/or license requirements until a disposal facility or alternative disposition path (such as recycling) is available. These sources must be stored at the owners' facilities or at commercial facilities in accordance with NRC or Agreement State licensing requirements (10 CFR Parts 30 and 39). These regulations require licensees to secure the material in accordance with regulatory requirements to prevent unauthorized removal or access to licensed materials stored in controlled or unrestricted areas.

DOE/National Nuclear Security Administration (DOE/NNSA) Global Threat Reduction Initiative (GTRI) Off-Site Source Recovery Project (OSRP) recovers sealed sources from the commercial sector representing threats to national security, and/or public health, and safety for safe storage and, if appropriate, eventual disposal. DOE/NNSA prioritizes recovery of disused radioactive sealed sources, registered with DOE/NNSA/GTRI/OSRP based on threat reduction criteria developed in coordination with NRC.

The Conference of Radiation Control Program Directors (CRCPD) Source Collection and Threat Reduction (SCATR) program, through a financial grant by DOE/NNSA, organizes (and in some cases subsidizes) the collection of disused radioactive sealed sources through private waste brokers for disposal at commercial facilities. In addition, EPA has the authority and capability to recover orphan sources. Recovered sources are managed in accordance with the objectives of the Joint Convention found in Article 1. Disused sources are not radioactive waste until accepted for disposal at commercial or governmental facilities.

Since September 2011, DOE/NNSA and CRCPD have recovered 7680 sources consisting of over 3.77E+15 Bq of radioactive material. In the lifetime of these programs, more than 36000 radioactive sealed sources consisting of over 3.4E+16 Bq from more than 1000 sites in the U.S. have been recovered, and over 2000 U.S. origin legacy sources have been repatriated from abroad.

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K. GENERAL EFFORTS TO IMPROVE SAFETY

This report describes ongoing United States of America (U.S.) efforts ensuring safe management of spent fuel, radioactive waste, and disused sealed sources. There are several key areas important to safety continuing to receive much attention.

K.1 Spent Fuel Management

The Blue Ribbon Commission (BRC) on America's Nuclear Future provided recommendations for developing a safe, long-term solution to managing the Nation's used nuclear fuel and nuclear waste.[220] Following the release of the final report in January 2012, the Administration's response to the BRC was released in January 2013.[221] Legislation is needed for full implementation of the Administration's strategy.

With the appropriate authorizations from Congress, and passage of enabling legislation, the Administration currently plans to implement a program over the next 10 years that:

- Sites, designs and licenses, constructs and begins operations of a pilot interim storage facility by 2021 with an initial focus on accepting used nuclear fuel from shut-down reactor sites;
- Advances toward the siting and licensing of a larger interim storage facility to be available by 2025 that will have sufficient capacity to provide flexibility in the waste management system and allows for acceptance of enough used nuclear fuel to reduce expected government liabilities; and
- Makes demonstrable progress on the siting and characterization of repository sites to facilitate the availability of a geologic repository by 2048.

The U.S. Department of Energy (DOE) continues to support research and technology development for long-term solutions and for storage, transportation, and disposal of spent fuel and wastes generated by existing and future nuclear fuel cycles. See Section G.7. In the meantime, commercial reactor sites will continue to store spent fuel in reactor pools and dry casks using Nuclear Regulatory Commission (NRC) approved designs.

K.2 Future Actions Based on Lessons Learned from the Fukushima Accident

The U.S. based on the lessons learned from this accident and has incorporated a number of lessons learned in its regulatory infrastructure. The nuclear industry in the U.S. has also been progressing in those areas in which the Japanese experience has great relevance to the safety at U.S. commercial reactors. To review NRC's progress in implementing the many different lessons-learned activities in greater detail visit http://www.nrc.gov/reactors/operating/ops-experience/japan-dashboard.html

Although many of the lessons learned from Fukushima relate to safety at operating nuclear power plants (NPP), within the context of the Joint Convention there are some areas of significance to radioactive waste and spent fuel storage safety. For example, as

[220] http://www.brc.gov/.
[221] http://www.energy.gov/downloads/strategy-management-and-disposal-used-nuclear-fuel-and-high-level-radioactive-waste.

mentioned in Section A.4.8, the recent *International Regulatory Review Service Follow-up Report* suggested consideration of regulatory actions and guidance to facilitate the orderly transition from operation to decommissioning for commercial NPPs. NRC began in October 2012 to review the existing process for transitioning such responsibilities; and is in the process of identifying possible rulemakings to clarify and expedite the process of transitioning NPPs from operational to decommissioning.

Furthermore, NRC and industry (namely, the Nuclear Energy Institute) began to cooperatively evaluate the transitioning process and have established decommissioning transition working group committees to further examine the facility transition process. The major focus after the accident has been on following the recommendations of a special task force of NRC experts assembled by the agency; specifically NRC ordered plants to adopt strategies to mitigate the potential effects of a prolonged loss of offsite power by any natural force – hurricane, flood, tornado, etc. In addition, NRC directed affected NPPs in the U.S. to have pressure-relieving vents that can be operated under any accident condition, and ordered additional measures to provide backup cooling water and instrumentation for spent fuel pools (SFP).

The U.S. efforts to deal with the legacy of the accident will be more explicitly addressed within the context of the Convention on Nuclear Safety, but the regulatory and functional enhancements resulting from the incorporation of the Fukushima lessons and experiences will be reviewed for their applicability within the context of the Joint Convention, as well. The U.S. is also examining how to address those lessons learned relevant to radioactive waste storage and management.

K.3 Greater-Than-Class C LLW Disposal

DOE is analyzing alternatives for the disposal of Greater-than-Class C low-level waste (GTCC LLW) and DOE GTCC-like waste. DOE continues to work on the Final Environmental Impact Statement (EIS). As required by Energy Policy Act 2005 (EPAct05), DOE will submit a report to the U.S. Congress and await Congressional action before making a final decision on a disposal option(s) for GTCC LLW.

K.4 Waste Disposition for Commercial Medical Isotope Production

DOE/National Nuclear Security Administration (DOE/NNSA) is working to accelerate the establishment of reliable commercial production of the medical isotope molybdenum-99 (^{99}Mo) in the U.S. without the use of highly-enriched uranium (HEU) as described in Section A.4.6. The objective of these projects is to produce significant quantities of non-HEU-based ^{99}Mo by 2016. The projects are currently under development and production has not yet commenced at the time this report was written.

The American Medical Isotopes Production Act of 2012 directs DOE to make low-enriched uranium (LEU) available, through lease contracts, for the production of ^{99}Mo for medical uses. It specifies that DOE will retain responsibility for the final disposition of spent fuel created by the irradiation, processing or purification of the leased LEU, and will take title to and be responsible for the final disposition of radioactive waste created by the irradiation, processing, or purification of the leased LEU for which DOE determines the producer does not have access to a disposal path. The program is currently under development and will be implemented using full cost recovery principles, consistent with the legislation.

K.5 International Collaboration

Establishing and maintaining an international program is an important part of the U.S. vision of safe and secure disposal of spent fuel, because working with other countries expands the technical depth of individual programs, offering knowledge in optimizing disposal systems. International activities link the U.S. to the world's evolving spent fuel and HLW management practices, and provide a forum for exchanging strategies and technologies with other nations. Through international cooperation, countries can coordinate on the development of formal agreements with each other, enabling an exchange of detailed scientific and technical information, or joint sponsorship of activities in areas such as alternatives for geologic disposal environments and long-term storage.

Participation in these types of activities benefits the U.S. through the acquisition and exchange of information, particularly related to complex issues dealing with topics such as performance assessments (PA), database development, and peer review by experts of other participating nations. These international projects serve U.S. goals in advancing scientific understanding, enhancing environmental protection, and improving global safety and security. In fostering international cooperation on spent fuel and radioactive waste management and disposal, the goal is to lead to an optimized national disposal system and promote the exchange of institutional and technical knowledge throughout the international community.

There is general consensus that deep geologic disposal is the preferred option for permanent management of spent fuel and HLW. Consequently, international collaboration with other countries is an important aspect that would allow for increased interactions and sharing of knowledge including: years of world-class science in site investigations and characterization; development of integrated radioactive waste management systems; experience in transporting nuclear materials; opportunities to enhance science on nuclear waste disposition; and innovative technologies and methods.

The U.S. works with other countries internationally on radioactive waste management programs. This collaboration is handled through several venues and organizations. The following list includes a short description of some of the groups with whom the U.S. has continued interactions:

- Organization for Economic Cooperation and Development (OECD)/Nuclear Energy Agency (NEA), Radioactive Waste Management Committee (RWMC). The U.S. delegation participates in annual meetings, provides status reports on the country's radioactive waste and decommissioning programs, and reviews/updates international reports prepared as reference documents.
- International Association for Environmentally Safe Disposal of Radioactive Materials (EDRAM). EDRAM is an association of executives and chairmen of worldwide radioactive waste management organizations that meets biannually to share and compare program information among the eleven member countries: Belgium, Canada, Finland, France, Germany, Japan, Spain, Sweden, Switzerland, United Kingdom, and the U.S.
- The Extended Storage Collaboration Program (ESCP). The ESCP is a consortium of organizations investigating aging effects and mitigation options for the extended storage of spent fuel, followed by transportation. Over the next year, potential research, and identification of available suitable demonstration

facilities in these countries will be pursued. The consortium is also working to identify all relevant information for extended storage that has already been produced worldwide. See Section A.4.1.4.

- International Framework for Nuclear Energy Cooperation (IFNEC),[222] formerly the international portion of the Global Nuclear Energy Partnership. IFNEC is a forum through which participating states explore mutually beneficial approaches to ensure the use of nuclear energy for peaceful purposes proceeds in a manner that is efficient and meets the highest standards of safety, security and non-proliferation. Participating states do not give up any rights and voluntarily engage in information sharing:
    - Reliable Nuclear Fuel Services Working Group – seeks to identify common interests among the participant countries and recommend practical measures for moving towards reliable comprehensive fuel service arrangements.
    - Infrastructure Development Working Group – supports the safe and secure development of nuclear energy infrastructure, including infrastructure needs for international nuclear fuel service frameworks. It has a Sub-Group on Radioactive Waste Management, which aims to share information, experiences, and broader knowledge that could inform countries' development of radioactive waste management positions and strategies.
- International Atomic Energy Agency (IAEA). The IAEA sponsors technical meetings, some of which pertain to different topics related to radioactive waste management such as long-term storage, transportation, safety, among others. Technical experts participate in, and/or monitor the progress of these meetings, depending on the topic and expertise needed.
- Multi-lateral initiatives. The U.S. supports and participates in international cooperative interactions, such as the Joint Standing Committee on Nuclear Energy Cooperation (JSCNEC) with Argentina, Brazil and the Republic of Korea.
- Bilateral agreements and Memoranda of Understanding. The U.S. uses these mechanisms with other countries to establish and address technical cooperative activities for radioactive waste management activities of mutual interest. Cooperation between the parties is based on mutual benefit, equality, and reciprocity. The agreements may include, but may not be limited to: exchange of scientists and engineers; exchange of scientific and technical information and results of R&D; exchange of samples and materials for testing; organization of and participation in seminars and meetings on agreed upon topics; visits to specific facilities of interest; and joint projects for topics of mutual agreement.

K.6 NRC Rulemaking Activities

NRC maintains a regulatory agenda of petitions for rulemaking activities and other planned rulemaking.[223] It contains a summary and the status for each ongoing rulemaking and petition for rulemaking received by the agency. Some rulemaking activities relating to the provisions in the Joint Convention are:

[222] For more information on IFNEC, www.ifnec.org.

[223] This information is updated semiannually at http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr0936/.

1. Continued Storage of Spent Nuclear Fuel (formerly known as Waste Confidence) – (10 CFR Part 51). NRC has prepared a generic EIS to support this rulemaking. The public comment period closed on December 20, 2013, and NRC anticipates publishing a final rule and final generic EIS on September 19, 2014.

2. Low-Level Radioactive Waste Disposal Rulemaking (10 CFR Part 61). NRC submitted 10 CFR Part 61 proposed rule package, *Low-Level Radioactive Waste Disposal*, to the Commission for review on July 18, 2013 (SECY-13-0075). The Commission responded on February 12, 2014, with a number of requirements to modify the rulemaking package. NRC anticipates completion of a revised rulemaking package by early 2015.

   Potential Changes to U.S. LLW Regulatory Framework - As noted above, NRC is pursuing revisions to 10 CFR Part 61 regulatory framework to make it more risk-informed and performance-based. The regulation was originally promulgated in 1983. Since then, other approaches for defining LLW disposal standards were developed, such as IAEA's General Safety Guide GSG-1. NRC's regulation considered waste streams generated at the time the regulation was developed. However, and as noted earlier, there are new waste streams, such as DU from enrichment plants, not considered in the original technical basis. As part of its process for revising 10 CFR Part 61, NRC solicited received stakeholder input on such changes and their impacts.

3. Potential Rulemaking on Transition from Operational Status to Permanent Shutdown. Following the Integrated Regulatory Review Service (IRRS) mission for the purpose of reviewing the regulatory framework for safety of the operating commercial NPPs in the U.S., a recommendation was suggested in the IRRS mission's follow-up report.[224] The IRRS mission and report are addressed in Section A.4.8.

   Prior to the publication of the IRRS mission report, NRC was already performing a Strategic Assessment to align the safety requirements applied to permanently shutdown and defueled commercial power reactors with the reduced risk to public health and safety. Because the development of regulations for operating NPPs often did not consider decommissioning, the requirements imposed on decommissioning nuclear power reactors may no longer align with the resultant safety and risk. As a consequence, licensee and NRC resources are significantly impacted by the many exemptions and amendments required to transition an operating reactor to a decommissioning reactor regulatory framework commensurate with the reduced risk to public health and safety.

   The Strategic Assessment discussed in A.4.8, in part, addresses this inconsistency and possible resolutions. The initiation of any relevant rulemaking will be contingent on the results of the Strategic Assessment, as well as the cooperative evaluation by NRC and the industry in this regard.

[224] See URL: http://www.nrc.gov/reactors/operating/ops-experience/preliminary-report.pdf.

K.7 Disused Sealed Sources

The U.S. has made significant progress in addressing commercial sealed source management and disposal challenges[225]. Disposal options for many commercial Class A, B, and C sealed sources are now available to LLW generators in all 50 states. The U.S. has also made progress in addressing ongoing challenges regarding the disposal of the highest activity sealed sources. Despite this progress, significant commercial sealed source disposal challenges remain, including development of a disposal capability for GTCC LLW and certain higher activity B and C sealed sources (e.g., ^{137}Cs and ^{60}Co sources).

[225] The Energy Policy Act of 2005 (EPAct) established the interagency Task Force on Radiation Source Protection and Security (Task Force).

ANNEXES

Annex D-1A Spent Fuel Management Facilities[226] Government Facilities

State	Installation	Facility	Function	Licensee	Regulator	SF[227] Source	Inventory	Units	Estimated Activity (Bq)
Colorado	U.S. Geological Survey (Denver)	Research/Test Reactor	Wet Storage	U.S. Geological Survey	NRC	2	0.04	MTHM	5.37E+14
	Fort St. Vrain	ISFSI	Dry Storage	DOE	NRC	2	14.73	MTHM	1.73E+17
Idaho	Idaho National Lab	INTEC-666	Wet Storage	DOE	DOE	1, 2	2.93	MTHM	5.96E+17
		Multiple INL facilities	Dry Storage	DOE	DOE	1,2	195.74	MTHM	1.22E+17
		ISFSI[228]	Dry Storage	DOE	NRC	2	81.59	MTHM	1.84E+18
Illinois	Argonne National Lab	ANL Spend Fuel Storage	Dry Storage	DOE	DOE	1, 2	0.12	MTHM	4.11E+15
Maryland	National Institute of Standards and Technology (Gaithersburg)	Research/Test Reactor	Wet Storage	National Institute of Standards and Technology	NRC	2	0.02	MTHM	7.88E+06
	Armed Forces Radiobiology Research Institute (Bethesda)	Research/Test Reactor	Wet Storage	Armed Forces Radiobiology Research Institute	NRC	1	0.02	MTHM	3.02E+14
New Mexico	Sandia National Lab	Multiple SNL Facilities	Dry Storage	DOE	DOE	1, 2	0.24	MTHM	7.40E+16
Rhode Island	Rhode Island Atomic Energy Commission (Narragansett)	Research/Test Reactor	Wet Storage	Rhode Island Atomic Energy Commission	NRC	2	0.02	MTHM	3.96E+14
South Carolina	Savannah River Site	L-Basin	Wet Storage	DOE	DOE	1, 2	29.42	MTHM	1.74E+18
			Dry Storage	DOE	DOE	2	0.01	MTHM	3.40E+15
Tennessee	Oak Ridge Reservation	Multiple ORR Facilities	Wet Storage	DOE	DOE	2	0.47	MTHM	6.73E+17
Washington	Hanford Site	Multiple Hanford facilities	Dry Storage	DOE	DOE	1, 2	2127.88	MTHM	2.01E+18
		K Basin[229]	Wet Storage	DOE	DOE	1	1.50	MTHM	9.95E+14

[226] Data Source: DOE National Spent Fuel Program database 12/31/2010 (best available information, as only small changes have occurred since last report).

[227] SF Sources: 1-Defense applications; 2-Commercial NPPs and Test/Research Reactors.

[228] In addition to this facility, NRC licensed a second DOE ISFSI at Idaho, which DOE subsequently decided not to construct.

[229] K Basin material includes Knock OutPot material, fuel found in burial grounds, and fuel fragments in the pool.

Annex D-1B Spent Fuel Management Facilities University Research Facilities[230]

State	Installation	Facility	Function	Licensee	Regulator	Inventory	Units	Estimated Activity (Bq)
California	University of California (Irvine)	Research Reactor	Wet Storage	University of California	NRC	21.42	kgU	9.99E+13
	University of California (Davis)[231]	Research Reactor	Wet Storage	University of California	NRC	72.31	kgU	9.95E+14
Florida	University of Florida (Gainesville)	Research Reactor	Wet Storage	University of Florida	NRC	23.81	kgU	1.38E+14
Indiana	Purdue University (West Lafayette)	Research Reactor	Wet Storage	Purdue University	NRC	17.53	kgU	`
Kansas	Kansas State University (Manhattan)	Research Reactor	Wet Storage	Kansas State University	NRC	21.08	kgU	7.70E+14
Maryland	University of Maryland (College Park)	Research Reactor	Wet Storage	University of Maryland	NRC	16.35	kgU	4.92E+14
Massachusetts	University of Lowell (Lowell)	Research Reactor	Wet Storage	University of Lowell	NRC	10.13	kgU	1.74E+14
	Massachusetts Institute of Technology (Cambridge)	Research Reactor	Wet Storage	Massachusetts Institute of Technology	NRC	19.85	kgU	3.36E+14
	Worcester Polytechnic Institute (Worcester)	Research Reactor	Wet Storage	Worcester Polytechnic Institute	NRC	22.75	kgU	1.41E+13
Missouri	University of Missouri (Columbia)	Research Reactor	Wet Storage	University of Missouri	NRC	35.44	kgU	5.03E+16
	University of Missouri (Rolla)	Research Reactor	Wet Storage	University of Missouri	NRC	26.46	kgU	3.29E+15
North Carolina	North Carolina State University (Raleigh)	Research Reactor	Wet Storage	North Carolina State University	NRC	315.40	kgU	6.22E+14
Ohio	Ohio State University (Columbus)	Research Reactor	Wet Storage	Ohio State University	NRC	26.15	kgU	3.16E+14
Oregon	Oregon State University (Corvallis)	Research Reactor	Wet Storage	Oregon State University	NRC	77.06	kgU	8.70E+14
	Reed College (Portland)	Research Reactor	Wet Storage	Reed College	NRC	30.86	kgU	4.37E+14
Pennsylvania	Pennsylvania State University (University Park)	Research Reactor	Wet Storage	Pennsylvania State University	NRC	37.57	kgU	1.88E+15
Texas	Texas A&M University (College Station)	Research Reactor (2)	Wet Storage	Texas A&M University	NRC	70.76	kgU	1.30E+15
	University of Texas (Austin)	Research Reactor	Wet Storage	University of Texas	NRC	35.17	kgU	2.68E+14
Utah	University of Utah (Salt Lake City)	Research Reactor	Wet Storage	University of Utah	NRC	26.82	kgU	1.22E+15
Washington	Washington State University (Pullman)	Research Reactor	Wet Storage	Washington State University	NRC	67.48	kgU	3.06E+15
Wisconsin	University of Wisconsin (Madison)	Research Reactor	Wet Storage	University of Wisconsin	NRC	68.06	kgU	4.37E+14

[230] Data Source: DOE National Spent Fuel Program database 12/31/2010 (best available information, as only small changes have occurred since last report).
[231] Formerly McClellan AFB (Sacramento).

Annex D-1C Spent Fuel Management Facilities Other Research and Nuclear Fuel Cycle Facilities
(Inventory as of December 31, 2010, per DOE projections)

State	Installation	Facility	Function	Licensee	Regulator	Inventory	Units	Estimated Activity (Bq)
California	Aerotest Research (San Ramon)	Research/Test Reactor	Wet Storage	Aerotest Research	NRC	17.43	kgU	3.54E+15
	General Electric (Pleasanton)	Research/Test Reactor	Wet Storage	General Electric	NRC	3.86	kgU	3.85E+12
Michigan	Dow Chemical Co. (Midland)	Research/Test Reactor	Wet Storage	Dow Chemical Co.	NRC	14.81	kgU	2.23E+14
Virginia	BWX Technology, Inc.	Fuel Cycle Facility	Dry storage	BWX Technology, Inc.	NRC	101.5	kgU	5.79E+15

Annex D-1D Spent Fuel Management Facilities: Commercial NPPs and ISFSIs [232]

State	Site	Facility (Installation)	Spent Fuel Function	Licensee	Regulator	Inventory	Units
Alabama	Browns Ferry	Browns Ferry 1, 2, & 3	Wet Storage	Tennessee Valley Authority	NRC	1,472	MTHM
		ISFSI	Dry Storage	Tennessee Valley Authority	NRC	489	MTHM
	Farley	Farley 1 & 2	Wet Storage	Southern Nuclear Operating Co.	NRC	999	MTHM
		ISFSI	Dry Storage	Southern Nuclear Operating Co.	NRC	299	MTHM
Arizona	Palo Verde	Palo Verde 1, 2, & 3	Wet Storage	Arizona Public Service Company	NRC	1,178	MTHM
		ISFSI	Dry Storage	Arizona Public Service Company	NRC	1,002	MTHM
Arkansas	Arkansas Nuclear	Arkansas Nuclear One 1 & 2	Wet Storage	Entergy Operations, Inc.	NRC	667	MTHM
		ISFSI	Dry Storage	Entergy Operations, Inc.	NRC	695	MTHM
California	Diablo Canyon	Diablo Canyon 1 & 2	Wet Storage	Pacific Gas & Electric Co.	NRC	906	MTHM
		ISFSI	Dry Storage	Pacific Gas & Electric Co.	NRC	324	MTHM
	Humboldt Bay	ISFSI	Dry Storage	Pacific Gas & Electric Co.	NRC	29	MTHM
	Rancho Seco	ISFSI	Dry Storage	Sacramento Municipal Utility District	NRC	228	MTHM
	San Onofre	San Onofre 1, 2, & 3 (shutdown)	Wet Storage	Southern California Edison Co.	NRC	1,179	MTHM
		ISFSI	Dry Storage	Southern California Edison Co.	NRC	477	MTHM
Connecticut	Haddam Neck	ISFSI	Dry Storage	Connecticut Yankee Atomic Power Co.	NRC	414	MTHM
	Millstone	Millstone 1 (shutdown) Millstone 2 & 3	Wet Storage	Dominion Nuclear Connecticut, Inc.	NRC	1,437	MTHM
		ISFSI	Dry Storage	Dominion Nuclear Connecticut, Inc.	NRC	230	MTHM
Florida	Crystal River	Crystal River 3 (shutdown)	Wet Storage	Duke Energy Carolina, LLC	NRC	619	MTHM
	Saint Lucie	Saint Lucie 1 & 2	Wet Storage	Florida Power & Light Co.	NRC	931	MTHM
		ISFSI	Dry Storage	Florida Power & Light Co.	NRC	320	MTHM
	Turkey Point	Turkey Point 3 & 4	Wet Storage	Florida Power & Light Co.	NRC	947	MTHM
		ISFSI	Dry Storage	Florida Power & Light Co.	NRC	264	MTHM

[232] The preliminary inventory data are based on GC-859 Nuclear Fuel Survey Data collected through June 30, 2013.

Annex D-1D Spent Fuel Management Facilities: Commercial NPPs and ISFSIs [232]

State	Site	Facility (Installation)	Spent Fuel Function	Licensee	Regulator	Inventory	Units
Georgia	Hatch	Hatch 1 & 2	Wet Storage	Southern Nuclear Operating Co., Inc.	NRC	870	MTHM
		ISFSI	Dry Storage	Southern Nuclear Operating Co., Inc.	NRC	677	MTHM
	Vogtle	Vogtle 1 & 2	Wet Storage	Southern Nuclear Operating Co., Inc.	NRC	1,250	MTHM
Illinois	Braidwood	Braidwood 1 & 2	Wet Storage	Exelon Generation Co., LLC	NRC	1,058	MTHM
		ISFSI	Dry Storage	Exelon Generation Co., LLC	NRC	94	MTHM
	Byron	Byron 1 & 2	Wet Storage	Exelon Generation Co., LLC	NRC	1,083	MTHM
		ISFSI	Dry Storage	Exelon Generation Co., LLC	NRC	190	MTHM
	Clinton	Clinton 1	Wet Storage	Exelon Generation Co., LLC	NRC	542	MTHM
	Dresden	Dresden 1 (shutdown) Dresden 2 & 3	Wet Storage	Exelon Generation Co., LLC	NRC	956	MTHM
		ISFSI	Dry Storage	Exelon Generation Co., LLC	NRC	631	MTHM
	La Salle	La Salle County 1 & 2	Wet Storage	Exelon Generation Co., LLC	NRC	1,239	MTHM
		ISFSI	Dry Storage	Exelon Generation Co., LLC	NRC	110	MTHM
	Morris	ISFSI	Wet Storage	General Electric Co.	NRC	529	MTHM
	Quad Cities	Quad Cities 1 & 2	Wet Storage	Exelon Generation Co., LLC	NRC	1,250	MTHM
		ISFSI	Dry Storage	Exelon Generation Co., LLC	NRC	314	MTHM
	Zion	Zion 1 & 2 (shutdown)	Wet Storage	Zion Solutions	NRC	1,021	MTHM
Iowa	Duane Arnold	Duane Arnold	Wet Storage	NextEra Energy Duane Arnold, LLC	NRC	288	MTHM
		ISFSI	Dry Storage	NextEra Energy Duane Arnold, LLC	NRC	223	MTHM
Kansas	Wolf Creek	Wolf Creek 1	Wet Storage	Wolf Creek Nuclear Operating Corp.	NRC	697	MTHM
Louisiana	River Bend	River Bend 1	Wet Storage	Entergy Operations, Inc.	NRC	429	MTHM
		ISFSI	Dry Storage	Entergy Operations, Inc.	NRC	229	MTHM
	Waterford	Waterford 3	Wet Storage	Entergy Operations, Inc.	NRC	578	MTHM
		ISFSI	Dry Storage	Entergy Operations, Inc.	NRC	119	MTHM
Maine	Maine Yankee	ISFSI	Dry Storage	Maine Yankee Atomic Power Co.	NRC	542	MTHM
Maryland	Calvert Cliffs	Calvert Cliffs 1 & 2	Wet Storage	Calvert Cliffs Nuclear Power Plant, LLC	NRC	573	MTHM

Annex D-1D Spent Fuel Management Facilities: Commercial NPPs and ISFSIs [232]

State	Site	Facility (Installation)	Spent Fuel Function	Licensee	Regulator	Inventory	Units
		ISFSI	Dry Storage	Calvert Cliffs Nuclear Power Plant, LLC	NRC	732	MTHM
Massachusetts	Pilgrim	Pilgrim 1	Wet Storage	Entergy Nuclear Operations, Inc.	NRC	574	MTHM
	Yankee Rowe	ISFSI	Dry Storage	Yankee Atomic Electric Co.	NRC	127	MTHM
Michigan	Big Rock Point	ISFSI	Dry Storage	Entergy Nuclear Operations Inc.	NRC	58	MTHM
	D.C. Cook	D.C. Cook 1 & 2	Wet Storage	Indiana Michigan Power Co.	NRC	1,321	MTHM
		ISFSI	Dry Storage	Indiana Michigan Power Co.	NRC	173	MTHM
	Fermi	Enrico Fermi 2	Wet Storage	DTE Electric Co.	NRC	528	MTHM
	Palisades	Palisades	Wet Storage	Entergy Nuclear Operations, Inc.	NRC	176	MTHM
		ISFSI	Dry Storage	Entergy Nuclear Operations, Inc.	NRC	442	MTHM
Minnesota	Monticello	Monticello	Wet Storage	Northern States Power Co. Minnesota	NRC	228	MTHM
		ISFSI	Dry Storage	Northern States Power Co. Minnesota	NRC	163	MTHM
	Prairie Island	Prairie Island 1 & 2	Wet Storage	Northern States Power Co. Minnesota	NRC	433	MTHM
		ISFSI	Dry Storage	Northern States Power Co. Minnesota	NRC	524	MTHM
Mississippi	Grand Gulf	Grand Gulf 1	Wet Storage	Entergy Operations, Inc.	NRC	572	MTHM
		ISFSI	Dry Storage	Entergy Operations, Inc.	NRC	273	MTHM
Missouri	Callaway	Callaway	Wet Storage	Union Electric Co.	NRC	739	MTHM
Nebraska	Cooper	Cooper	Wet Storage	Nebraska Public Power District	NRC	370	MTHM
		ISFSI	Dry Storage	Nebraska Public Power District	NRC	90	MTHM
	Fort Calhoun	Fort Calhoun	Wet Storage	Omaha Public Power District	NRC	292	MTHM
		ISFSI	Dry Storage	Omaha Public Power District	NRC	116	MTHM
New Hampshire	Seabrook	Seabrook 1	Wet Storage	NextEra Energy Seabrook, LLC	NRC	463	MTHM
		ISFSI	Dry Storage	NextEra Energy Seabrook, LLC	NRC	88	MTHM
New Jersey	Hope Creek/Salem [233]	Hope Creek, Salem 1 & 2	Wet Storage	PSE&G Nuclear, LLC	NRC	1,551	MTHM

[233] Hope Creek and Salem nuclear power plants have a combined ISFSI.

Annex D-1D Spent Fuel Management Facilities: Commercial NPPs and ISFSIs [232]

State	Site	Facility (Installation)	Spent Fuel Function	Licensee	Regulator	Inventory	Units
		ISFSI	Dry Storage	PSE&G Nuclear, LLC	NRC	458	MTHM
	Oyster Creek	Oyster Creek	Wet Storage	Exelon Generation Co., LLC	NRC	394	MTHM
		ISFSI	Dry Storage	Exelon Generation Co., LLC	NRC	255	MTHM
New York	FitzPatrick	FitzPatrick	Wet Storage	Entergy Nuclear Operations, Inc.	NRC	408	MTHM
		ISFSI	Dry Storage	Entergy Nuclear Operations, Inc.	NRC	255	MTHM
	Ginna	Ginna	Wet Storage	R.E. Ginna Nuclear Power Plant, LLC	NRC	401	MTHM
		ISFSI	Dry Storage	R.E. Ginna Nuclear Power Plant, LLC	NRC	72	MTHM
	Indian Point	Indian Point 1 (shutdown) Indian Point 2 & 3	Wet Storage	Entergy Nuclear Operations, Inc.	NRC	1,046	MTHM
		ISFSI	Dry Storage	Entergy Nuclear Operations, Inc.	NRC	307	MTHM
	Nine Mile Point	Nine Mile Point 1 & 2	Wet Storage	Nine Mile Point Nuclear Station, LLC	NRC	1,155	MTHM
		ISFSI	Dry Storage	Nine Mile Point Nuclear Station, LLC	NRC	65	MTHM
North Carolina	Brunswick	Brunswick 1 & 2	Wet Storage	Carolina Power & Light Co.	NRC	491	MTHM
		ISFSI	Dry Storage	Carolina Power & Light Co.	NRC	170	MTHM
	McGuire	McGuire 1 & 2	Wet Storage	Duke Energy Carolinas, LLC	NRC	1,095	MTHM
		ISFSI	Dry Storage	Duke Energy Carolinas, LLC	NRC	438	MTHM
	Shearon Harris	Shearon Harris 1	Wet Storage	Carolina Power & Light Co.	NRC	1,492	MTHM
Ohio	Davis-Besse	Davis-Besse 1	Wet Storage	First Energy Nuclear Operating Co.	NRC	498	MTHM
		ISFSI	Dry Storage	First Energy Nuclear Operating Co.	NRC	34	MTHM
	Perry	Perry 1	Wet Storage	First Energy Nuclear Operating Co.	NRC	609	MTHM
		ISFSI	Dry Storage	First Energy Nuclear Operating Co.	NRC	73	MTHM
Oregon	Trojan	ISFSI	Dry Storage	Portland General Electric Corp.	NRC	359	MTHM
Pennsylvania	Beaver Valley	Beaver Valley 1 & 2	Wet Storage	First Energy Nuclear Operating Co.	NRC	1,073	MTHM
	Limerick	Limerick 1 & 2	Wet Storage	Exelon Generation Co., LLC	NRC	1,110	MTHM
		ISFSI	Dry Storage	Exelon Generation Co., LLC	NRC	264	MTHM
	Peach Bottom	Peach Bottom 2 & 3	Wet Storage	Exelon Generation Co., LLC	NRC	940	MTHM

Annex D-1D Spent Fuel Management Facilities: Commercial NPPs and ISFSIs [232]

State	Site	Facility (Installation)	Spent Fuel Function	Licensee	Regulator	Inventory	Units
		ISFSI	Dry Storage	Exelon Generation Co., LLC	NRC	800	MTHM
	Susquehanna	Susquehanna 1 & 2	Wet Storage	PPL Susquehanna, LLC	NRC	838	MTHM
		ISFSI	Dry Storage	PPL Susquehanna, LLC	NRC	721	MTHM
	Three Mile Island	Three Mile Island 1	Wet Storage	Exelon Generation Co., LLC	NRC	596	MTHM
South Carolina	Catawba	Catawba 1 & 2	Wet Storage	Duke Energy Carolina, LLC	NRC	909	MTHM
		ISFSI	Dry Storage	Duke Energy Carolina, LLC	NRC	285	MTHM
	Oconee	Oconee 1, 2, & 3	Wet Storage	Duke Energy Carolinas, LLC	NRC	617	MTHM
		ISFSI	Dry Storage	Duke Energy Carolinas, LLC	NRC	1,446	MTHM
	Robinson	Robinson 2	Wet Storage	Carolina Power & Light Co.,	NRC	130	MTHM
		ISFSI	Dry Storage	Carolina Power & Light Co.,	NRC	169	MTHM
	Summer	Summer	Wet Storage	South Carolina Electric & Gas Co.	NRC	559	MTHM
Tennessee	Sequoyah	Sequoyah 1 & 2	Wet Storage	Tennessee Valley Authority	NRC	711	MTHM
		ISFSI	Dry Storage	Tennessee Valley Authority	NRC	589	MTHM
	Watts Bar	Watts Bar 1	Wet Storage	Tennessee Valley Authority	NRC	411	MTHM
Texas	Comanche Peak	Comanche Peak 1 & 2	Wet Storage	Luminant Generation Co., LLC	NRC	950	MTHM
		ISFSI	Dry Storage	Luminant Generation Co., LLC	NRC	120	MTHM
	South Texas	South Texas 1 & 2	Wet Storage	STP Nuclear Operating Co.	NRC	1,207	MTHM
Vermont	Vermont Yankee	Vermont Yankee	Wet Storage	Entergy Nuclear Operations, Inc.	NRC	478	MTHM
		ISFSI	Dry Storage	Entergy Nuclear Operations, Inc.	NRC	159	MTHM
Virginia	North Anna	North Anna 1 & 2	Wet Storage	Virginia Electric & Power Co.	NRC	624	MTHM
		ISFSI	Dry Storage	Virginia Electric & Power Co.	NRC	666	MTHM
	Surry	Surry 1 & 2	Wet Storage	Virginia Electric & Power Co.	NRC	300	MTHM
		ISFSI	Dry Storage	Virginia Electric & Power Co.	NRC	996	MTHM
Washington	Columbia Generating Station	Columbia Generating Station	Wet Storage	Energy Northwest	NRC	353	MTHM
		ISFSI	Dry Storage	Energy Northwest	NRC	320	MTHM

Annex D-1D Spent Fuel Management Facilities: Commercial NPPs and ISFSIs [232]

State	Site	Facility (Installation)	Spent Fuel Function	Licensee	Regulator	Inventory	Units
Wisconsin	Kewaunee	Kewaunee (shutdown)	Wet Storage	Dominion Energy Kewaunee, Inc.	NRC	422	MTHM
		ISFSI	Dry Storage	Dominion Energy Kewaunee, Inc.	NRC	97	MTHM
	LaCrosse	ISFSI	Dry Storage	Dairyland Power Cooperative	NRC	38	MTHM
	Point Beach	Point Beach 1 & 2	Wet Storage	NextEra Energy Point Beach, LLC	NRC	441	MTHM
		ISFSI	Dry Storage	NextEra Energy Point Beach, LLC	NRC	432	MTHM
Totals	All commercial NPP and ISFSI sites	All NPPs plus Morris ISFSI	Wet Storage	Various	NRC	50,390	MTHM
		All other commercial ISFSIs	Dry Storage	Various	NRC	20,114	MTHM
		All commercial NPPs and ISFSIs	Grand Total	Various	NRC	70,504	MTHM

Annex D-2A Radioactive Waste Management Facilities Government Facilities[234]

State	Installation	Licensee	Regulator	Facility	Function	Waste Source	Waste/ Material Type	Inventory (m^3) [235]	Estimated Activity (Bq) [236]	Rad Cat
California	Lawrence Berkeley National Lab	DOE	DOE	Various Waste Facilities	Storage	2	LLW/MLLW	2.07E+02		6
	Lawrence Livermore National Lab	DOE	DOE	Various Waste Facilities	Storage	1	LLW/MLLW	2.22E+03		1,2,3, 4,5
						1	TRU	2.29E+02	4.77E+14	3
	Stanford Linear Accelerator	DOE	DOE	Various Waste Facilities	Storage	2	LLW/MLLW	3.48E+03		1
Idaho	Idaho Site	DOE	DOE/ID	HLW Tank Farm	Liquid Storage in underground tanks	1	HLW	3.41E+03	1.37E+18	2,3
	Idaho Site	DOE	DOE	Calcined Solids Storage Facility	Storage in underground tanks/bins	1	HLW	4.40E+03	1.20E+18	2,3
			DOE/ID/EPA	Idaho CERCLA Disposal Facility	Disposal in engineered surface disposal cell for D&D wastes	1	LLW	3.14E+05		1,2,3, 4,5
			DOE	RWMC (Includes remote RH vaults)	Disposal in shallow land disposal facility	1	LLW	6.62E+04	2.72E+17	1,2,3, 4,5
	Idaho Site	DOE	DOE/ID	Various Waste Facilities	Storage, characterization, treatment, packaging	1	LLW/MLLW	6.28E+03	1.58E+11	1,2,3, 4,5
	Idaho Site	DOE	DOE	TRU Waste Storage Facilities	Storage	1	TRU	2.46E+04	1.55E+16	2,3

[234] See Key to Annex D-2 on last page of this table.

[235] Stored inventories for LLW/MLLW are as of 9/30/2013 per the DOE FY2014 BLDD. Stored inventories for TRU are as of 12/31/2012 per the Annual Transuranic Waste Inventory Report - 2013. Disposed inventories for LLW/MLLW in active facilities are as of 9/30/2013 per the DOE FY2014 BLDD. Disposed TRU inventory (WIPP) is as of 12/31/2013.

[236] Estimated activities for TRU stored inventories are as of 12/31/2012 per the Annual Transuranic Waste Inventory Report - 2013. Estimated activity for disposed TRU at WIPP is as of 12/31/13 per the WIPP Waste Information System. Activities for other waste types are parametric estimates.

Annex D-2A Radioactive Waste Management Facilities Government Facilities[234]

State	Installation	Licensee	Regulator	Facility	Function	Waste Source	Waste/ Material Type	Inventory (m^3) [235]	Estimated Activity (Bq) [236]	Rad Cat
Illinois	Argonne National Laboratory	DOE	DOE	Various Waste Facilities	Storage	2	LLW/MLLW	9.15E+01		1,2,3, 4,5
				TRU Storage	Storage	1	TRU	4.18E+01	8.62E+14	2,3
	Fermi Lab	DOE	DOE	Various Waste Facilities	Storage	2	LLW/MLLW	4.72E+02		1
Kentucky	Paducah Gaseous Diffusion Plant	DOE	DOE/KY	Various Waste Facilities	Storage, characterization, treatment, packaging	1	LLW/MLLW	1.44E+03		3,4
Missouri	Weldon Springs	DOE	DOE	Onsite Disposal Cell (Closed)	Disposal in engineered, surface disposal cell (Closed)	1	Residual radioactive material	1.12E+06		4
Multiple[237]	Other DOE	DOE	DOE/ various states	Various Waste Facilities	Storage, characterization, treatment, packaging	1	LLW/MLLW	2.38E+02		6
	Other DOE TRU Small Quantity Sites	DOE	DOE	TRU Waste Facilities (small)	Storage	1	TRU	1.90E+00	1.29E+12	3
Nevada	Nevada National Security Site	DOE	DOE	Area 3/Area 5 RWMS	Disposal in trenches and subsidence craters	1	LLW	1.17E+06	5.56E+17	1,2,3, 4,5
	Nevada National Security Site	DOE	DOE/NV	LLW Storage Facility	Storage	1	LLW	5.29E+01		1,2,3, 4,5
				MW Disposal Unit	Disposal in shallow trenches	1	MLLW	1.74E+04	8.02E+13	1,2,3, 4,5
	Nevada National Security Site	DOE	DOE	Greater Confinement Disposal	Disposal in boreholes	1	TRU	2.00E+02	2.11E+15	1,2,3, 4,5
				TRU Waste Facilities	Storage, characterization, packaging	1	TRU	4.67E+01	1.75E+13	3

[237] This entry includes multiple facilities with small inventories of LLW/MLLW stored inventories at Ames Laboratory, IA; Energy Technology Engineering Center, CA; , Kansas City Plant, Missouri; Pacific Northwest National Laboratory, WA; Thomas Jefferson National Accelerator Facility, VA;, and Waste Isolation Pilot Plant, NM; Multiple includes TRU waste inventories at General Electric Vallecitos, CA; Nuclear Radiation Development Site, Inc., NY; U.S. Army Materiel Command, IL.

Annex D-2A Radioactive Waste Management Facilities Government Facilities[234]

State	Installation	Licensee	Regulator	Facility	Function	Waste Source	Waste/ Material Type	Inventory (m^3) [235]	Estimated Activity (Bq) [236]	Rad Cat
New Mexico	Los Alamos National Lab	DOE	DOE	Technical Area 54/Area G	Disposal in shallow land disposal facility	1	LLW	2.63E+05	8.87E+16	1,2,3, 4,5
	Los Alamos National Lab	DOE	DOE/NM	Various Waste Facilities	Storage	1	LLW/MLLW	2.50E+02		1,2,3, 4,5
	Los Alamos National Lab	DOE	DOE	Sealed Source Facilities	Disused Sealed Source Storage	1	Sealed sources container	2.60E+02 Containers	1.6E+13	6
				TRU Waste Facilities	Storage, characterization, packaging	1	TRU	5.85E+03	1.17E+16	2,3
	Sandia National Lab - NM	DOE	DOE/NM	Various Waste Facilities	Storage, characterization, treatment, packaging	1	LLW/MLLW	1.07E+02	7.76E+11	2,3,5
	Sandia National Lab - NM	DOE	DOE	TRU Waste Facilities	Storage, characterization, packaging	1	TRU	1.41E+01	1.95E+12	3
	Waste Isolation Pilot Plant	DOE	DOE/NM EPA	WIPP Disposal	Disposal in deep salt formation	1	TRU	9.10E+04	8.73E+16	1,2,3, 4,5
New York	Niagara Falls Storage Site (FUSRAP)	USACE	NY	Niagara Falls Storage Facility	Restoration Waste Storage	1	Residual radioactive material	1.99E+05		4
	Separations Process Research Unit	DOE	DOE/NY	Various Waste Facilities	Storage	1	LLW/MLLW	3.24E+02		2,3
	West Valley Demonstration Plant	DOE	DOE	HLW Glass Storage Cell	Interim storage of Vitrified HLW in a former process cell	3	HLW	2.08E+02	5.74E+17	2,3
	West Valley Demonstration Plant	DOE	DOE/NY	Various Waste Facilities	Storage, characterization, treatment, packaging	3	LLW/MLLW	3.73E+03		1,2,3
				TRU Waste Facilities	Storage	3	TRU	6.77E+02	1.57E+15	2,3

Annex D-2A Radioactive Waste Management Facilities Government Facilities[234]

State	Installation	Licensee	Regulator	Facility	Function	Waste Source	Waste/ Material Type	Inventory (m^3) [235]	Estimated Activity (Bq) [236]	Rad Cat
Ohio	Fernald Environmental Management Project	DOE	DOE	Onsite Disposal Facility	Disposal (from D&D) in engineered surface disposal cell (Closed)	1	LLW	2.29E+06		4
	Portsmouth Gaseous Diffusion Plant	DOE	DOE/OH	Various Waste Facilities	Storage, treatment, packaging	1	LLW/MLLW	8.68E+03		4
South Carolina	Savannah River Site	DOE	DOE	Saltstone Vaults	Disposal of low-level waste in engineered cells	1	LLW	9.37E+04		1,2,3, 4,5
				HLW Tank Farm	Liquid Storage in underground double-shell, stainless steel tanks	1	HLW	1.42E+05	1.08E+19	1,2,3, 4,5
				Glass Waste Storage Building	Interim Storage of Vitrified HLW[5]	1	HLW	3.00E+03	1.94E+18	1,2,3, 4,5
				E-Area Disposal	Disposal in underground vaults and trenches	1	LLW	3.83E+05	5.75E+16	1,2,3, 4,5
				Old Burial Ground	Historic disposal (Closed)	1	LLW	6.77E+05		1,2,3, 4,5
	Savannah River Site	DOE	DOE/SC	Various Waste Facilities	Storage, characterization, treatment, packaging	1	LLW/MLLW	2.59E+02		1,2,3, 4,5
	Savannah River Site	DOE	DOE	TRU Waste Facilities	Storage, characterization, packaging	1	TRU	1.80E+03	1.08E+16	2,3
Tennessee	Oak Ridge Reservation	DOE	DOE	Hydrofracture	Historic disposal (Closed)	1	LLW	1.73E+04		1,2,3, 4,5
				Old Burial Ground	Historic disposal (Closed)	1	LLW	4.41E+05		1,2,3, 4,5

Annex D-2A Radioactive Waste Management Facilities Government Facilities[234]

State	Installation	Licensee	Regulator	Facility	Function	Waste Source	Waste/ Material Type	Inventory (m^3) [235]	Estimated Activity (Bq) [236]	Rad Cat
				Interim Waste Management Fac.	Disposal in engineered aboveground facility (Closed)	1	LLW	3.70E+03	1.18E+13	1,2,3, 4,5
			DOE/TN EPA	EMWMF	Disposal in engineered surface disposal cell for D&D wastes	1	LLW	1.33E+06		1,2,3, 4,5
			DOE/TN	Various Waste Facilities	Storage (in building and on concrete pad), characterization, treatment, packaging	1	LLW/MLLW	4.93E+03		1,2,3, 4,5
			DOE	TRU Waste Facilities	Storage, characterization, packaging, treatment	1	TRU	1.24E+03	3.54E+15	2,3
Utah	Monticello Remedial Action Project	DOE	DOE	Monticello Disposal Cell	Disposal in engineered, surface disposal cell (Closed)	1	Residual radioactive material	1.91E+06		4
Washington	Hanford Site	DOE	DOE/WA	HLW Tank Farm	Liquid Storage in underground single-and double-shell tanks	1	HLW	2.12E+05	6.51E+18	1,2,3, 4,5
	Hanford Site	DOE	DOE	200 Area Burial Grounds	Disposal in trenches	1	LLW	3.10E+05	1.68E+17	1,2,3, 4,5
			DOE/WA/ EPA	ERDF	Disposal (from D&D) in engineered surface disposal unit	1	LLW	7.61E+06		1,2,3, 4,5
				Decommissioned Submarine Hulls Disposal Area	Navy submarine hulls disposal in trenches	1	LLW	1.25E+02		1
	Hanford Site	DOE	DOE/WA	IDF	Disposal	1	LLW/MLLW	0.00E+00		1,2,3, 4,5

Annex D-2A Radioactive Waste Management Facilities Government Facilities[234]

State	Installation	Licensee	Regulator	Facility	Function	Waste Source	Waste/ Material Type	Inventory (m^3) [235]	Estimated Activity (Bq) [236]	Rad Cat
				Various Waste Facilities	Storage, characterization, treatment, packaging	1	LLW/MLLW	9.11E+01		1,2,3, 4,5
				RMW Trenches	Disposal in lined trenches	1	MLLW	1.21E+05	6.47E+16	1,2,3, 4,5
	Hanford Site	DOE	DOE	WESF	Cs-Sr Storage in hot cells and storage pool	1	Sealed source container	1.93E+03 Sources	2.85E+18	2
				TRU Waste Facilities	Storage, characterization, packaging	1	TRU	1.47E+04	5.44E+16	2,3

Annex D-2 Key				
Waste Source		**Radionuclide Category**		
		Category		**Key Isotopes**
1	Defense applications	1	Activation Products	Primarily ^{36}Cl, ^{55}Fe, ^{54}Mn, ^{65}Zn, ^{58}Co, ^{60}Co, ^{63}Ni,
2	Nuclear applications	2	Mixed Fission Products	Radioactive isotopes and daughters from ^{72}Zn to ^{158}Gd; primary longer-lived isotopes are ^{85}Kr, ^{89}Sr, $^{90}/Y^{-90}Sr$, ^{91}Y, ^{95}Zr, ^{95}Nb, $^{103}/Rh^{103}Ru$, $^{106}/Rh^{-106}Ru$, $^{125}/Te^{-125}Sb$, $^{137}/Ba^{-137}Cs$, ^{141}Ce, $^{144}/r^{-144}Ce$, ^{147}Pm, $m^{151}S$,and ^{155}Eu
3	Commercial	3	Transuranic Isotopes	Isotopes of Cf, Bk, Cm, Am, Pu, and Np, and their respective decay products.
		4	Naturally-Occurring Isotopes	^{238}PU, ^{235}U, ^{234}U, ^{232}Th, and their respective decay products (^{231}Pa, ^{227}Th, ^{228}Th, ^{230}Th, ^{231}Th, ^{234}Th, ^{227}Ac, ^{228}Ac, ^{223}Ra, ^{224}Ra, ^{226}Ra, ^{228}Ra, ^{223}Fr, ^{219}Rn, ^{220}Rn, ^{222}Rn, ^{215}At, ^{218}At, ^{219}At, ^{210}Po, ^{211}Po, ^{212}Po, ^{214}Po, ^{215}Po, ^{216}Po, ^{218}Po, ^{210}Bi, ^{211}Bi, ^{212}Bi, ^{214}Bi, ^{210}Pb, 211Pb, ^{212}Pb, ^{214}Pb, ^{206}Tl, ^{207}Tl, ^{208}Tl, and ^{210}Tl), ^{14}C, ^{40}K, ^{40}V, ^{87}Rb, ^{115}In, ^{123}Te, ^{138}La, ^{142}Ce, ^{144}Nd, ^{147}Sm, ^{148}Sm, ^{149}Sm, ^{152}Gd, ^{156}Dy, ^{176}Lu, ^{174}Hf, ^{180}Ta, ^{187}Re, ^{190}Pt, ^{204}Pb, ^{215}Bi
		5	Tritium	^{3}H
		6	Various	Radioactivity from various sources and categories

Annex D-2B Radioactive Waste Management Facilities Commercial/Other Facilities[238]

State	Installation	Licensee	Regulator	Type	Function	Waste Source	Inventory (m^3)[239]	Estimated Activity (Bq)[240]	Rad Cat
California	Advanced Chemical Transport, Inc.	Advanced Chemical Transport, Inc.	CA	Commercial	Repackage/Broker/Transporter	3	NA		
	B&B Environmental Safety	B&B Environmental Safety	CA	Commercial	Broker/Transporter	3	NA		
	Environmental Management & Controls, Inc	Environmental Management & Controls, Inc	CA	Commercial	Broker/Transporter	3	NA		
	Environmental Management Services, Inc.	Environmental Management Services, Inc.	CA	Commercial	Broker/Transporter	3	NA		
	New World Technology	New World Technology	CA	Commercial	Processor – Waste Treatment Service (Other than compaction)	3	NA		
	PWN Environmental	PWN Environmental	CA	Commercial	Broker/Processor/Transporter	3	NA		
	Thomas Grey Associates	Thomas Grey Associates	CA	Commercial	Processor – Processing of liquids and radium	3	NA		
Colorado	Next Generation Solutions	Next Generation Solutions	CO	Commercial	Broker	3	NA		
Connecticut	Cabrera Services, Inc.	Cabrera Services, Inc.	NRC	Commercial	Processor – Decontamination Services	3	NA		
	Radiation Safety Associates	Radiation Safety Associates	NRC	Commercial	Processor	3	NA		
Florida	Perma-Fix of Florida, Inc.	Perma-Fix	FL	Commercial	Processor	3	NA		
Idaho	Qal-Tek Associates	Qal-Tek Associates	NRC	Commercial	Packaging/Broker (Sealed Sources)	3	NA		
Illinois	ADCO Services Inc.	ADCO Services Inc.	IL	Commercial	Processor – Processing of uranium and thorium	3	NA		

[238] See Key to Annex D-2 on last page of this table.

[240] Estimated activities associated with commercial disposed waste are as of 12/31/13 based on the Integrated Data Base Report (DOE/RW-0006, Rev. 13) and MIMS.

Annex D-2B Radioactive Waste Management Facilities Commercial/Other Facilities[238]									
State	**Installation**	**Licensee**	**Regulator**	**Type**	**Function**	**Waste Source**	**Inventory (m^3)[239]**	**Estimated Activity (Bq)[240]**	**Rad Cat**
	Dept. Of The Army Rock Island Arsenal	Dept. Of The Army	NRC	Other Government	Processor/Storage – Waste Disposal Service Processing and/or Repackaging.	3	NA		
	Sheffield	State of Illinois	IL	Commercial	LLW– All Classes (Closed)	3	8.83E+04	2.23E+15	1,2,3, 4,5
Kentucky	Maxey Flats	State of Kentucky	KY	Commercial	LLW– All Classes (Closed)	3	1.35E+05	8.88E+16	1,2,3, 4,5
Maryland	Chesapeake Nuclear Services, Inc.	Chesapeake Nuclear Services, Inc.	MD	Commercial	Broker	3	NA		
	Clym Environmental Services, LLC	Clym Environmental Services, LLC	MD	Commercial	Broker	3	NA		
	Dept. Of The Army Ft. Detrick	Dept. Of The Army	NRC	Other Government	Processor – Waste Disposal Service Processing and/or Repackaging.	3	NA		
	Ecology Services	Ecology Services	MD	Commercial	Processor – Mixed waste processing	3	NA		
	RSO, Inc.	RSO, Inc.	MD	Commercial	Broker/Transporter	3	NA		
Michigan	Pharmacia & Upjohn Company	Pharmacia & Upjohn Company	NRC	Private	Processor – Manufacturing and Distribution Type A Broad	3	NA		
Minnesota	University of Minnesota	University of Minnesota	MN	Academic	Processor – Waste Disposal Service Processing and/or Repackaging.	3	NA		
Missouri	R.M. Wester	R.M. Wester	NRC	Commercial	Processor	3	NA		
	R&R Trucking	R&R Trucking	NRC	Commercial	Broker/Transporter	3	NA		
Montana	HHS, Dept. Of USPHS, NIH, Rocky Mountain Laboratories	Dept. of Health & Human Services	NRC	Other Government	Processor – Research and Development Type A Broad	3	NA		
Nevada	Beatty	None	NV	Commercial	LLW– All Classes (Closed)	3	1.37E+05	2.37E+16	1,2,3, 4,5

Annex D-2B Radioactive Waste Management Facilities Commercial/Other Facilities[238]									
State	**Installation**	**Licensee**	**Regulator**	**Type**	**Function**	**Waste Source**	**Inventory (m^3)[239]**	**Estimated Activity (Bq)[240]**	**Rad Cat**
New Jersey	BASF Corporation	BASF Corporation	NRC	Commercial	Processor – Research and Development Type A Broad	3	NA		
	Radiac Research Corp.	Radiac Research Corp.	NY	Commercial	Processor – Waste Disposal Service Prepackaged only.	3	NA		
New York	West Valley NRC-licensed Disposal Area and State-licensed Disposal Area	New York State Energy Research and Development Administration	NRC & NY	Commercial	LLW– All Classes (Closed)	3	7.71E+04	3.09 E +16	
North Carolina	HHS, Dept. Of Public Health Service	Dept. of Health & Human Services	NRC	Other Government	Processor – Research and Development Type A Broad	3	NA		
	V.A. Medical Center	Dept. of Veterans Affairs	NRC	Other Government	Processor – Medical Institution Broad	3	NA		
Ohio	Solutient Technologies	Solutient Technologies	OH	Commercial	Processor – Processing	3	NA		
Pennsylvania	Alaron Corporation	Alaron Corporation	PA	Commercial	Processor – Waste Disposal Service Processing and/or Repackaging.	3	NA		
	Applied Health Physics, Inc.	Applied Health Physics, Inc.	PA	Commercial	Processor – Waste Disposal Service Prepackaged only.	3	NA		
	BWX Technologies, Inc.	BWX Technologies	NRC	Commercial	Processor – Decommissioning of Advanced Fuel R&D and Pilot Plants	3	NA		
	Fox Chase Cancer Center	Fox Chase Cancer Center	PA	Private	Processor – Medical Institution Broad	3	NA		
	MHF Logistical Solutions, Inc.	MHF Logistical Solutions, Inc.	PA	Commercial	Broker/Transporter	3	NA		
South Carolina	Energy*Solutions* (Barnwell)	Energy*Solutions* (Barnwell)	SC	Commercial	LLW Disposal Class A	3	7.18E+05	7.59E+17	1,2,3, 4,5
					LLW Disposal Class B	3	5.31E+04		
					LLW Disposal Class C	3	2.69E+04		
	GTS-Duratek/ Chem-Nuclear Systems, Inc.	GTS-Duratek, Inc	SC	Commercial	Processor – Decommissioning of Byproduct Material Facilities	3	NA		
	Hittman Transport Services	Energy*Solutions*	SC	Commercial	Transporter	3	NA		
Tennessee	Ameriphysics, LLC	Ameriphysics, LLC	TN	Commercial	Broker	3	NA		
	Bionomics	Bionomics	TN	Commercial	Processor	3	NA		

Annex D-2B Radioactive Waste Management Facilities Commercial/Other Facilities[238]									
State	**Installation**	**Licensee**	**Regulator**	**Type**	**Function**	**Waste Source**	**Inventory (m^3)[239]**	**Estimated Activity (Bq)[240]**	**Rad Cat**
Tennessee	Chase Environmental	Chase Environmental Group, Inc.	TN	Commercial	Processor	3	NA		
	DeNuke Services	DeNuke Services	TN	Commercial	Decon, decommissioning, mixed waste, encapsulation, transport	3	NA		
	Diversified Technologies Services, Inc	Diversified Technologies Services, Inc	TN	Commercial	Processor (Liquid wastes)	3	NA		
	Energy*Solutions* LLC	Energy*Solutions* Bear Creek	TN	Commercial	Processor	3	NA		
	Energy*Solutions* LLC	Energy*Solutions* Gallagher Road	TN	Commercial	Processor	3	NA		
	Perma-Fix DSSI	Perma-Fix	TN	Commercial	Processing of resins, sludges, and liquids	3	NA		
	Perma-Fix M&EC	Perma-Fix	TN	Commercial	Processing/treatment of mixed wastes	3	NA		
	Philotechnics	Philotechnics, Ltd.	TN	Commercial	Broker/Processor	3	NA		
	Energy*Solutions*	Energy*Solutions*	TN	Commercial	Processor – Processing of large equipment	3	NA		
			TN	Commercial	Processing Treatment	3	NA		
	Toxco Incorporated	Toxco Incorporated	TN	Commercial	Processor	3	NA		
	V.A. Medical Center	Dept. of Veterans Affairs	NRC	Other Government	Processor – High Dose Rate Remote Afterloader	3	NA		
	Visionary Solutions	Visionary Solutions	TN	Commercial	Mixed waste, encapsulation, transport	3	NA		
Texas	MKM Engineers, Inc.	MKM Engineers, Inc.	TX	Commercial	Processor – Waste Disposal Service Processing and /or Repackaging	3	NA		

Annex D-2B Radioactive Waste Management Facilities Commercial/Other Facilities[241]									
State	**Installation**	**Licensee**	**Regulator**	**Type**	**Function**	**Waste Source**	**Inventory (m^3)[242]**	**Estimated Activity (Bq)[243]**	**Rad Cat**
Texas	NSSI	NSSI	TX	Commercial	MLLW processing	3	NA		
	USA Environment	USA Environment	TX	Commercial	Broker/Processor/Transporter	3	NA		
	Waste Control Specialists (WCS)	WCS	TX	Commercial	GTCC Storage	2	4.30E+01		1,3
					MLLW Treatment	3	NA		
					11e.(2) Storage and Disposal	1	2.12E+04		4
					Commercial LLW Disposal	3	7.16E+02	6.54E+12	
					Federal LLW Disposal	1,2	8.56E+02		
Utah	EnergySolutions	EnergySolutions	UT	Commercial	MLLW Treatment and Disposal	3	1.22E+05		1,2,3, 4,5
					LLW–Class A Disposal	3	3.31E+06	2.41E+15	1,2,3, 4,5
					11e.(2) Disposal	3	1.40E+06		1,2,3, 4,5
Virginia	B&W Energy Services	B&W Energy Services	NRC	Commercial	TRU Storage (DOE)	1	1.00E+01	7.81E+13	3
Washington	PermaFix Northwest	PermaFix Northwest	WA	Commercial	MLLW treatment and processing	3	NA		1,2,3, 4,5
	US Ecology - Richland	US Ecology	WA	Commercial	LLW–Class A Disposal	3	3.93E+05	2.73E+17	
					LLW–Class B Disposal	3	3.73E+03		
					LLW–Class C Disposal	3	2.80E+03		
Wisconsin	RAM Services	RAM Services	WI	Commercial	Sealed sources, leak testing	3	NA		

[241] See Key to Annex D-2 on last page of this table.
Estimated activities associated with commercial disposed waste are as of 12/31/13 based on the Integrated Data Base Report (DOE/RW-0006, Rev. 13) and MIMS.

Multiple	Multiple ISFSIs	Various utilities	NRC	Commercial	GTCC Storage	3	1.00E+00		1,3

Annex D-2B Radioactive Waste Management Facilities Commercial/Other Facilities[244]

State	Installation	Licensee	Regulator	Type	Function	Waste Source	Inventory (m^3)[245]	Estimated Activity (Bq)[246]	Rad Cat
Past Practices									
Ocean Disposal	Atlantic			Past Practice	LLW	1,2,3	8.60E+03	2.94E+15	
	Pacific			Past Practice	LLW	1,2,3	1.40E+04	5.54E+14	

Annex D-2 Key

Waste Source		Radionuclide Category		
		Category		Key Isotopes
1	Defense applications	1	Activation Products	Primarily ^{36}Cl, ^{55}Fe, ^{54}Mn, ^{65}Zn, ^{58}Co, ^{60}Co, ^{63}Ni
2	Nuclear applications	2	Mixed Fission Products	Radioactive isotopes and daughters from ^{72}Zn to ^{158}Gd; primary longer-lived isotopes are ^{85}Kr, ^{89}Sr, $^{90}/Y$-^{90}Sr, ^{91}Y, ^{95}Zr, ^{95}Nb, $^{103}/Rh^{103}Ru$, $^{106/}Rh$-^{106}Ru, $^{125}/Te$-^{125}Sb, $^{137}/Ba$-^{137}Cs, ^{141}Ce, $^{144}/r$-^{144}Ce, ^{147}Pm, $m^{151}S$,and ^{155}Eu
3	Commercial	3	Transuranic Isotopes	Isotopes of Cf, Bk, Cm, Am, Pu, and Np, and their respective decay products.
		4	Naturally-Occurring Isotopes	^{238}U, ^{235}U, ^{234}U, ^{232}Th, and their respective decay products (^{231}Pa, ^{227}Th, ^{228}Th, ^{230}Th, ^{231}Th, ^{234}Th, ^{227}Ac, ^{228}Ac, ^{223}Ra, ^{224}Ra, ^{226}Ra, ^{228}Ra, ^{223}Fr, ^{219}Rn, ^{220}Rn, ^{222}Rn, ^{215}At, ^{218}At, ^{219}At, ^{210}Po, ^{211}Po, ^{212}Po, ^{214}Po, ^{215}Po, ^{216}Po, ^{218}Po, ^{210}Bi, ^{211}Bi, ^{212}Bi, ^{214}Bi, ^{210}Pb, ^{211}Pb, ^{212}Pb, ^{214}Pb, ^{206}Tl, ^{207}Tl, ^{208}Tl, and ^{210}Tl), ^{14}C, ^{40}K, ^{40}V, ^{87}Rb, ^{115}In, ^{123}Te, ^{138}La, ^{142}Ce, ^{144}Nd, ^{147}Sm, ^{148}Sm, ^{149}Sm, ^{152}Gd, ^{156}Dy, ^{176}Lu, ^{174}Hf, ^{180}Ta, ^{187}Re, ^{190}Pt, ^{204}Pb, ^{215}Bi
		5	Tritium	^{3}H
		6	Various	Radioactivity from various sources and categories

[244] See Key to Annex D-2 on last page of this table.
Estimated activities associated with commercial disposed waste are as of 12/31/13 based on the Integrated Data Base Report (DOE/RW-0006, Rev. 13) and MIMS.

Annex D-3 Uranium Mill Tailings and Related Sites

State	Site Name/Location	Licensee	Type	Status	Regulator	Regulatory Program	Quantity of Contaminated Material	Quantity Units	^{226}Ra-Activity (TBq)
Arizona	Tuba City	DOE	Surface residual radioactive material disposal cell	Under general NRC license, in DOE Long-Term Surveillance Plan (LTSP) program; property owned by Navajo Indian Nation.	NRC	UMTRCA Title I	2250000	Dry Tonnes	35
Colorado	Cheney Disposal Cell (residual radioactive material removed from the former Grand Junction Climax site)	DOE	Surface residual radioactive material disposal cell	Active until 2023 to accept residual radioactive material from other sites.	NRC	UMTRCA Title I	3414792	m^3	TBD
	Cotter	Cotter Corp. USA	Conventional mill	Standby/various D&D actions are underway.	Colorado	UMTRCA Title II	2000000	Dry Tonnes	N/A
	Cotter Schwarzwalder Mine	Cotter Corp. USA	Uranium mine ore separation and size reduction	Modifying D&D plan for license termination; most physical decommissioning completed.	Colorado	Colorado Mined Land Reclamation Act	6150	Dry Tonnes	N/A
	Durango	DOE	Conventional mill and surface residual radioactive material disposal cell	Under general NRC license, in DOE LTSP program	NRC	UMTRCA Title I	3700000	Dry Tonnes	52
	Gunnison	DOE	Conventional mill and surface residual radioactive material disposal cell	Under general NRC license, in DOE LTSP program	NRC	UMTRCA Title I	1140000	Dry Tonnes	6.5
	Homestake Mining and Pitch	Homestake Mining Company	Mine drainage treatment & residuals repository	US Forest Service land; joint regulation with Colorado - Reclamation Mining & Safety	US Forest Service & Colorado	UMTRCA Title II	N/A		N/A

Annex D-3 Uranium Mill Tailings and Related Sites

State	Site Name/Location	Licensee	Type	Status	Regulator	Regulatory Program	Quantity of Contaminated Material	Quantity Units	^{226}Ra-Activity (TBq)
	Maybell	DOE	Conventional mill and surface residual radioactive material disposal cell	Under general NRC license, in DOE LTSP program; annual groundwater monitoring inspections.	NRC	UMTRCA Title I	4291928	Dry Tonnes	17
	Maybell - West	DOE	Heap Leach Site	NRC accepted long-term surveillance plan. Site is closed.	Colorado	UMTRCA Title II	1800000	Dry Tonnes	3.6
	Naturita	DOE	Surface residual radioactive material disposal cell	Under general NRC license, in DOE LTSP program.	NRC	UMTRCA Title I	971762	Dry Tonnes	2.9
	Rifle	DOE	Surface residual radioactive material disposal cell	Under general NRC license, in DOE LTSP program	NRC	UMTRCA Title I	4967451	Dry Tonnes	101
	Slick Rock	DOE	Surface residual radioactive material disposal cell	Under general NRC license, in DOE LTSP program	NRC	UMTRCA Title I	1140000	Dry Tonnes	6.5
	Sweeney	EPA Superfund	Conventional mill	No activity; site under State Order	Colorado	UMTRCA Title II	N/A		N/A
	UMETCO/ Uravan	EPA Superfund	Conventional mill	Reclamation/decommissioning; CRR is preparation.	Colorado	UMTRCA Title II	9500000	Dry Tonnes	N/A
Idaho	Lowman	DOE	Surface residual radioactive material disposal cell	Under general NRC license, in DOE LTSP program	NRC	UMTRCA Title I	222230	Dry Tonnes	0.4
Nebraska	Crow Butte	Crow Butte Resources, Inc.	In situ site	Operating	NRC	UMTRCA Title II	N/A		N/A
New Mexico	Ambrosia Lake	DOE	Conventional mill and surface residual radioactive material disposal cell	Under general NRC license, in DOE LTSP program	NRC	UMTRCA Title I	6931000	Dry Tonnes	69

Annex D-3 Uranium Mill Tailings and Related Sites

State	Site Name/Location	Licensee	Type	Status	Regulator	Regulatory Program	Quantity of Contaminated Material	Quantity Units	^{226}Ra-Activity (TBq)
	Ambrosia Lake	Rio Algom Mining LLC	Conventional mill	Not yet on LTSP. Completing reclamation; site closure is expected in Autumn 2015.	NRC	UMTRCA Title II	30100000	Dry Tonnes	N/A
	Bluewater	DOE	Conventional mill and surface mill tailings disposal cell	Under general NRC license, in DOE LTSP program	NRC	UMTRCA Title II	24000000	Dry Tonnes	457
	Church Rock	United Nuclear Corporation Mining and Milling	Conventional mill; groundwater restoration program	Co-disposal with mine waste and ground-water remain issues for EPA, NRC, New Mexico and the Navajo Nation. License amendment in progress.	NRC	UMTRCA Title II	3200000	Dry Tonnes	N/A
	Crown Point	Hydro Resources, Inc.	In situ site	Technical review for license renewal.	NRC	UMTRCA Title II	N/A		N/A
	Grants	Homestake Mining Co	Conventional mill; groundwater restoration program	April 2013 submitted updated D&D and Reclamation Plan for NRC review and approval. Expected closure 2022.	NRC	UMTRCA Title II	20300000	Dry Tonnes	N/A
	L-Bar (Sohio Western Mining)	DOE	Conventional mill and surface mill tailings disposal cell	Under general NRC license, in DOE LTSP program	NRC	UMTRCA Title II	1900000	Dry Tonnes	N/A
	Shiprock	DOE	Conventional mill and surface residual radioactive material disposal cell	Under general NRC license, in DOE LTSP program	NRC	UMTRCA Title I	2520000	Wet Tonnes	28

Annex D-3 Uranium Mill Tailings and Related Sites

State	Site Name/Location	Licensee	Type	Status	Regulator	Regulatory Program	Quantity of Contaminated Material	Quantity Units	^{226}Ra-Activity (TBq)
Oklahoma	Sequoyah Fuels Corporation	Sequoyah Fuels Corp.	UF6 Facility	NRC reviewing the groundwater corrective action plan; cleanup estimate completion by end of 2018.	NRC	UMTRCA Title II	248318	m^3	0.11
Oregon	Lakeview	DOE	Conventional mill and surface residual radioactive material disposal cell	Under general NRC license, in DOE LTSP program	NRC	UMTRCA Title I	736000	Dry Tonnes	1.6
Pennsylvania	Burrell	DOE	Surface residual radioactive material disposal cell	Under general NRC license, in DOE LTSP program; groundwater monitoring and maintenance program to maintain site integrity.	NRC	UMTRCA Title I	86000	Dry Tonnes	0.15
	Canonsburg	DOE	Conventional mill and surface residual radioactive material disposal cell	Under general NRC license, in DOE LTSP program; surface and groundwater under monitoring regime.	NRC	UMTRCA Title I	226000	Dry Tonnes	4
South Dakota	Edgemont	DOE	Conventional mill and surface mill tailings disposal cell	Under general NRC license, in DOE LTSP program	NRC	UMTRCA Title II	4000000	Dry Tonnes	19
Texas	Uranium One Inc./ Bruni	Uranium One	In situ site	The site has been decommissioned and released for unrestricted use.	Texas	UMTRCA Title II	N/A		N/A
	Conoco Conquista	Conoco Conquista	Conventional mill	All structures and equipment have been removed. Settlement and ground-water issues remain to be resolved.	Texas	UMTRCA Title II	11800000	Dry Tonnes	N/A

Annex D-3 Uranium Mill Tailings and Related Sites

State	Site Name/Location	Licensee	Type	Status	Regulator	Regulatory Program	Quantity of Contaminated Material	Quantity Units	^{226}Ra-Activity (TBq)
	Hobson, Tex-1 & Mt. Lucas Projects/ Dinero (3 locations)	South Texas Mining Venture	In situ site	Hobson is an active site; Tex-1 & Mt. Lucas nearing completion of in reclamation.	Texas	UMTRCA Title II	N/A		N/A
	La Palangana	South Texas Mining Venture	In situ site	Operational	Texas	UMTRCA Title II	N/A		N/A
	Ray Point Felder	Exxon	Conventional mill	Exxon needs to submit a license amendment to dispose vicinity property contamination; all other reclamation has been completed.	Texas	UMTRCA Title II	400000	Dry Tonnes	N/A
	Falls City	DOE	Conventional mill and surface residual radioactive material disposal cell	Under general NRC license, in DOE LTSP program.	NRC	UMTRCA Title I	7143000	Dry Tonnes	47
	Zamzow & Lamprech Projects /S. Texas	International Energy Corporation	In situ site	Licensee abandoned site without completing decommissioning; Texas is pursuing legal actions.	Texas	UMTRCA Title II	N/A		N/A
	Alta Mesa	Mestena Uranium LLC	In situ site	Operational	Texas	UMTRCA Title II	N/A		N/A
	RGR/Chevron (aka Panna Maria)	Rio Grande Resources Corporation	Conventional mill	All structures and equipment have been removed. Ground-water contamination remains an issue. The licensee is seeking application of ACLs[247] . Also considering in situ	Texas	UMTRCA Title II	5900000	Dry Tonnes	N/A

[247] ACL = alternate concentration limits.

Annex D-3 Uranium Mill Tailings and Related Sites

State	Site Name/Location	Licensee	Type	Status	Regulator	Regulatory Program	Quantity of Contaminated Material	Quantity Units	^{226}Ra-Activity (TBq)
				leach uranium recovery processing facility.					
	Hobson	Rio Grande Resources Corporation	Resin Processing	Under Review	Texas	UMTRCA Title II	N/A		N/A
	Kingsville Dome	URI	In situ site	Ground-water restoration progressing in nine well fields; upon completion URI expects to resume operations.	Texas	UMTRCA Title II	N/A		N/A
	Vasquez	URI	In situ site	Well restoration in progress; URI has submitted a renewal of permits to resume operations.	Texas	UMTRCA Title II	N/A		N/A
Utah	Moab/ Crescent Junction	DOE	11e.(2) byproduct material disposal site	Transportation of Moab (Atlas) tailings to the Crescent Junction disposal site is continuing. Only 41 % complete.	NRC	UMTRCA Title I	6270000	Dry Tonnes	N/A
	Green River	DOE	Conventional mill and surface residual radioactive material disposal cell	Under general NRC license, in DOE LTSP program; groundwater monitoring regime.	NRC	UMTRCA Title I	501000	Dry Tonnes	1.1
	Lisbon	Rio Algom Mining Corp	Conventional mill	Structures have been removed and radioactive material has been disposed in the two tailings embankments that have final cover. Not yet on LTSP; transfer expected in	Utah	UMTRCA Title II	3500000	Dry Tonnes	N/A

Annex D-3 Uranium Mill Tailings and Related Sites

State	Site Name/Location	Licensee	Type	Status	Regulator	Regulatory Program	Quantity of Contaminated Material	Quantity Units	^{226}Ra-Activity (TBq)
				2016. This is a candidate for restart.					
	Mexican Hat	DOE	Conventional mill and surface residual radioactive material disposal cell	Under general NRC license, in DOE LTSP program	NRC	UMTRCA Title I	4400000	Dry Tonnes	67
	Moab	DOE	Mill & Tailings Disposal	Under active reclamation by DOE; site will not come under general license in 10 CFR 40.27 until surface reclamation is complete.	NRC	UMTRCA Title I	7668000	Dry Tonnes	N/A
	Salt Lake City Disposal Cell (Clive)	DOE	Surface residual radioactive material disposal cell	Under general NRC license, in DOE LTSP program	NRC	UMTRCA Title I	2798000	Dry Tonnes	57
	Salt Lake City Processing Site Central Valley Water Reclamation Facility	DOE	Currently a sewage treatment facility	Institutional controls maintained by DOE	DOE	UMTRCA Title I	TBD	Residual ^{226}Ra-and ^{230}Th-contaminated material	N/A
	Shootaring Canyon	Uranium One Americas, Inc	Conventional uranium mill	Current operating license extension of six months by State of Utah.	Utah	UMTRCA Title II	78000	Dry Tonnes	N/A
	White Mesa	International Uranium Corporation	Conventional uranium mill	Operating, capable of processing alternate feed	Utah	UMTRCA Title II	3200000	Dry Tonnes	N/A
Washington	Dawn Mining	Dawn Mining Company	Conventional uranium mill	D&D continuing and final radon barrier to be completed summer of 2014. Continuing ground-water issues are unresolved.	WA[248]	UMTRCA Title II	2800000	Dry Tonnes	N/A

[248] WA – State of Washington

Annex D-3 Uranium Mill Tailings and Related Sites

State	Site Name/Location	Licensee	Type	Status	Regulator	Regulatory Program	Quantity of Contaminated Material	Quantity Units	^{226}Ra-Activity (TBq)
	WNI Sherwood	DOE	Conventional uranium mill	Under general NRC license, in DOE LTSP program	NRC	UMTRCA Title II	2600000	Dry Tonnes	17
Wyoming	Bear Creek	Bear Creek Uranium Co	Conventional uranium mill	DOE has deed to the site, and is in the process of taking site as LTSP custodian. Estimated time for closure 2014.	NRC	UMTRCA Title II	4300000	Dry Tonnes	N/A
	Gas Hills	American Nuclear Corporation	Conventional uranium mill	DP approved 10/1998; reclamation incomplete due to insolvency. Reclamation lead taken by Wyoming; lack of funding - TBD	NRC	UMTRCA Title II	7300000	Dry Tonnes	N/A
	Gas Hills	Pathfinder Mines Corp -- Lucky MC	Conventional uranium mill	Not yet on LTSP. Estimated Date For Closure 2014.	NRC	UMTRCA Title II	10600000	Dry Tonnes	N/A
	East Gas Hills	Umetco Minerals Corp	Conventional uranium mill	Not yet on LTSP. NRC approved Construction Completion Report. DOE & BLM land transfer process. Estimated Date For Closure 2014	NRC	UMTRCA Title II	7300000	Dry Tonnes	N/A
	Highlands	Exxon Mobil Corp	Conventional uranium mill	Reclamation hampered by surface water contamination offsite.	NRC	UMTRCA Title II	10300000	Dry Tonnes	N/A
	Willow Creek Project (formerly Christensen Ranch)	Uranium One	In situ site	Operational; license issued March 2013.	NRC	UMTRCA Title II	N/A		N/A
	Moore Ranch	Uranium One	In situ site	Licensed; In May 2013, Uranium One notified NRC to suspend further licensing activities	NRC	UMTRCA Title II	N/A		N/A

Annex D-3 Uranium Mill Tailings and Related Sites

State	Site Name/Location	Licensee	Type	Status	Regulator	Regulatory Program	Quantity of Contaminated Material	Quantity Units	^{226}Ra-Activity (TBq)
	Hank & Nichols	Uranerz Energy	In situ site	Licensed; operational start-up pends approval from NRC	NRC	UMTRCA Title II	N/A		N/A
	Lost Creek	Lost Creek	In situ site	Operational	NRC	UMTRCA Title II	N/A		N/A
	Shirley Basin	Pathfinder Mines Corp	Conventional uranium mill	Facility intends to operate its ISL disposal area for the foreseeable future.	NRC	UMTRCA Title II	7400000	Dry Tonnes	N/A
	Shirley Basin – South	DOE	Conventional uranium mill	Under general NRC license, in DOE LTSP program	NRC	UMTRCA Title II	6300000	Dry Tonnes	N/A
	Smith Ranch – Highland	Power Resources, Inc.	In situ site	Operating	NRC	UMTRCA Title II	N/A		N/A
	Split Rock	Western Nuclear Inc.	Conventional uranium mill	DOE/LM has not submitted a LTSP for NRC review. TBD	NRC	UMTRCA Title II	7000000	Dry Tonnes	N/A
	Spook	DOE	Conventional mill and surface residual radioactive material disposal cell	Under general NRC license, in DOE LTSP program	NRC	UMTRCA Title I	1500000	M^3	N/A
	Sweetwater	Kennecott Uranium Co	Conventional uranium mill	On standby status; license expires 11/2014.	NRC	UMTRCA Title II	2100000	Dry Tonnes	N/A

Sources: http://www.lm.doe.gov/pro_doc/references/framework.htm; http://www.radiationcontrol.utah.gov/. http://www.eia.doe.gov/cneaf/nuclear/dupr/dupr.html; http://www.doh.wa.gov/.

Annex D-4 Formerly Utilized Sites Remedial Action Program Sites in Progress		
State	**Site**	**Status**
Connecticut	Combustion Engineering Site (Windsor)	Ongoing Remediation
Indiana	Joslyn Manufacturing and Supply Company (Fort Wayne)	Currently Under Site Investigation
Iowa	Iowa Army Ammunition Plant (Middletown)	Ongoing Remediation
Maryland	W.R. Grace Site (Baltimore)	Ongoing Remediation
Massachusetts	Shpack Landfill (Norton/Attleboro)	Ongoing Remediation
Missouri	Latty Avenue Properties (Hazelwood)	Ongoing Remediation
	St. Louis Airport Site (St. Louis)	Remediation Complete; groundwater monitoring and long-term management activities continue
	St. Louis Airport Site Vicinity Properties (St. Louis)	Ongoing Remediation
	St. Louis Downtown Site (St. Louis)	Ongoing Remediation
New Jersey	Maywood Chemical Superfund Site (Maywood)	Ongoing Remediation
	Middlesex Sampling Plant (Middlesex)	Ongoing Remediation
	DuPont Chamber Works (Deepwater)	Ongoing Remediation
New York	Niagara Falls Storage Site (Lewiston)	Ongoing Remediation
	Former Linde Air Products (Tonawanda)	Ongoing Remediation
	Guterl Specialty Steel (Lockport)	Remedial Investigation
	Seaway Industrial Park (Tonawanda)	Ongoing Remediation
	Colonie Site (Colonie)	Ongoing Remediation
	Sylvania Corning Plant (Hicksville)	Remedial Investigation
	Tonawanda Landfill	Remedial Investigation
Ohio	Luckey Site (Luckey)	Ongoing Remediation
	Painesville Site (Painesville)	Ongoing Remediation
	Harshaw Chemical Company (Cleveland)	Remedial Investigation
Pennsylvania	Shallow Land Disposal Area (Parks Township)	Ongoing Remediation
	Superior Steel (Carnegie)	Remedial Investigation scheduled to begin summer of 2014

Source: US Army Corps of Engineers, Formerly Utilized Sites Remedial Action Program Update, January 2013.
Some of these sites are also included in the Materials Decommissioning Program (Annex D-6).

Annex D-5 Decommissioning of Complex Licensed Materials Sites[249]			
NRC Regulated Sites			
State	**Installation**	**Location**	**Decommissioning Status[250]**
California	Hunter's Point Naval Shipyard[251]	San Francisco	Estimated closure to be determined
	Alameda Naval Air Station	Alameda	Estimated closure to be determined
	McClellan (former Air Force Base)[3]	Sacramento	Estimated closure to be determined
Connecticut	UNC Naval Products (a.k.a. United Nuclear)	New Haven	Estimated closure to be determined
Indiana	Jefferson Proving Ground (Department of the Army)	Madison	Estimate closure 2015, under restricted release.
Maryland	Beltsville Agricultural Research Laboratory	Beltsville	Estimated closure in 2014, under unrestricted release
Michigan	AAR Manufacturing Group, Inc.	Livonia	Estimated closure to be determined, under restricted release
Missouri	Mallinckrodt Chemical Inc.	St. Louis	Estimated closure in 2014, under unrestricted release
	Sigma-Aldrich	Maryland Heights	Estimated closure in 2014, under unrestricted release
	Westinghouse Electric Corp. (Hematite Facility)	Jefferson City	Estimated closure in 2015, under unrestricted release
New Jersey	Stepan Chemical Company[252]	Maywood	Estimated closure in 2014, under unrestricted release
New York	West Valley Demonstration Project	West Valley	Estimated closure to be determined
Oklahoma	FMRI (Fansteel), Inc.	Muskogee	Estimate closure after 6/2023, under unrestricted release
	Kerr-McGee – Cimarron	Cimarron	Estimated closure after 1/2017, under unrestricted release
Pennsylvania	Babcock & Wilcox SLDA[253]	Vandergrift	Estimated closure in 2020, under restricted release

[249] Source: NUREG 1814.

[250] Unspecified closure dates pending resolution of site-specific regulatory provisions; e.g., financial assurance, waste management arrangements, etc.

[251] The Navy's Hunter's Point Shipyard site and the Air Force's McClellan site are being remediated by the Navy and Air Force, respectively, under the required CERCLA process and EPA oversight. NRC has not licensed these sites, but has approved a "limited approach" and will rely on the ongoing CERCLA process and EPA oversight.

[252] Although New Jersey is now a licensed Agreement State, the Stepan site remained under NRC jurisdiction because of the presence of FUSRAP material.

[253] NRC retains regulatory authority, including decommissioning phase, at sites having special nuclear material in quantities sufficient to form a critical mass.

Annex D-5 Decommissioning of Complex Licensed Materials Sites[254]			
Agreement State Regulated Sites			
State	**Installation**	**Location**	**Project Completion Status**
California	Halaco	Oxnard	EPA Superfund Site – TBD
	The Boeing Company	Simi Valley	Dual jurisdiction and mixed waste have complicated the release
	Chevron Mining, Inc. (Formerly Molycorp)	Mountain Pass	Ongoing, awaiting final status survey
	Isotope Specialties	Burbank	Ongoing
	Magnesium Alloy Products	Compton	Ongoing
Colorado	Colorado School of Mines Research Institute Table Mtn.	Golden	TBD – delay for financial assurance issues
	Colorado School of Mines Research Institute Creekside	Golden	TBD – delay for financial assurance issues
	Redhill Forest-domestic water treatment	Fairplay	TBD – delay for financial assurance issues.
	Clean Harbors	Deer Trail	TBD – Current legal dispute with local government about site certificate of designation
Florida	Iluka Resources, Inc.	Green Cove Springs	TBD – D&D activities underway
Illinois	Spectrulite Consortium	Madison	License termination, pending final certifications and cost recovery fees
	TRONOX-Rare Earths & Thorium (Formerly Kerr-McGee)	West Chicago	TBD – pending results from groundwater contamination monitoring and corrective action; under EPA superfund
Kansas	Air Capitol Dial	Wichita	TBD – joint consent agreement process to address ground-water contamination from nonradiological constituents
	Aircraft Instrument & Development/RC Allen Instruments	Wichita	TBD – awaiting results from assessment report.
	Century Instruments Corporation	Wichita	TBD
Massachusetts	Shpack Landfill	Norton	TBD – complicated by multiple jurisdictions
	BASF (Formerly Engelhard Corporation)	Plainville	TBD
	Starmet Corp. (Formerly Nuclear Metals)	Concord	TBD
	Wyman Gordon Co.	North Grafton	TBD
	Texas Instruments	Attleboro	TBD
	Norton/St. Gobain	Worcester	TBD – environmental remediation ongoing
Nebraska	University of Nebraska Disposal	Mead	Ongoing; U.S. Army Corp of Engineers performing under EPA

[254] Source: NUREG 1814.

Annex D-5 Decommissioning of Complex Licensed Materials Sites[254]			
Agreement State Regulated Sites			
State	**Installation**	**Location**	**Project Completion Status**
	Trenches		oversight
New Jersey	Shieldalloy Metallurgical Corp.[255]	Newfield	NRC reinstated New Jersey's authority to regulate Shieldalloy Metallurgical Corporation on August 5, 2013. TBD
Ohio	Ineos USA, LLC (Formerly BP Chemical)	Lima	TBD - D&D resumption delayed until 2019; due to state prohibitions
	Advanced Medical Systems, Inc.	Cleveland	2016
Oregon	TDY Industries Dba Wah Chang	Albany	Ongoing
	PCC Structurals, Inc.	Portland	Continuous monitored sewer sediment collection and cleanup.
Pennsylvania	Curtis-Wright	Cheswick	D&D plan under development; awaiting final comprehensive survey
	Keystone Metals Reduction	Cheswick	TBD – undergoing analysis of remediation alternatives
	Karnish Instruments	Lock Haven	TBD
	Global Tungsten & Powders Corporation	Towanda	TBD
	Remacor	West Pittsburg	Undergoing characterization
	Molycorp, Inc. (Washington)	Washington	TBD
	Superbolt (formerly Superior Steel)	Carnegie	TBD – USACE waiting funding to proceed with site cleanup activities.
	Quehanna (formerly Permagrain Products, Inc.)	Karthaus	TBD
	Safety Light Corporation	Bloomsburg	TBD –Transferred to EPA – conducting cleanups & stabilizing waste piles
	Strube Incorporated	Lancaster County	TBD – awaiting financial influx for proceeding with cleanup
	Westinghouse Electric Corp. (Waltz Mill)	Madison	2014 – facility is under active license and will expand operational activities.
	Whittaker Corporation	Greenville	Ongoing decommissioning
Tennessee	Duratek Services	Oak Ridge	D&D plan approved 10/2012.
Texas	ASARCO	Houston	Investigation and cleanup ongoing.

[255] Transfer of regulatory authority of the Shieldalloy site was set aside because of a judicial appeal.

Annex D-6 NRC-Licensed Power and Demonstration Reactors Under Decommissioning				
State	**Facility**	**Reactor Type**	**Power**	**D&D Status**
Commercial Power Reactors				
California	Humboldt Bay 3	Boiling Light-Water Reactor	63 MWe	DECON
	San Onofre – Unit 1	Pressurized Light-Water Reactor	436 MWe	SAFSTOR
	San Onofre – Unit 2	Pressurized Light-Water Reactor	1,080 MWe	Awaiting PSDAR
	San Onofre – Unit 3	Pressurized Light-Water Reactor	1,080 MWe	Awaiting PSDAR
	Vallecitos BWR	Boiling Light-Water Reactor	5 MW	SAFSTOR
Connecticut	Millstone – Unit 1	Boiling Light-Water Reactor	660 MWe	SAFSTOR
Florida	Crystal River	Pressurized Light-Water Reactor	860 MWe	SAFSTOR in progress
Illinois	Dresden – Unit 1	Boiling Light-Water Reactor	200 MWe	SAFSTOR
	Zion – Unit 1	Pressurized Light-Water Reactor	1040 MWe	DECON
	Zion – Unit 2	Pressurized Light-Water Reactor	1040 MWe	DECON
Michigan	Fermi – Unit 1	Liquid Metal Fast Breeder Reactor	61 MWe	DECON
New York	Indian Point – Unit 1	Pressurized Light-Water Reactor	257 MWe	SAFSTOR
Pennsylvania	Peach Bottom – Unit 1	High Temperature Gas Reactor	40 MWe	SAFSTOR
	Three Mile Island – Unit 2	Pressurized Light-Water Reactor	792 MWe	Monitored SAFSTOR
Virginia	Nuclear Ship Savannah	Pressurized Light-Water Reactor	80 MW	SAFSTOR
Wisconsin	La Crosse	Boiling Light-Water Reactor	50 MWe	SAFSTOR
	Kewaunee	Pressurized Light-Water Reactor	556 MWe	SAFSTOR in progress
Research and Test Reactors				
California	General Atomics	TRIGA Mark F	1500 kW	DECON
	General Atomics	TRIGA Mark I	250 kW	SAFSTOR
	General Electric Co.	GETR (Tank)	50 MW	SAFSTOR Possession Only
	General Electric Co.	VESR	2 MW	SAFSTOR Possession Only
Massachusetts	Worcester Polytechnic Institute	Pool	10 kW	DECON
Michigan	Ford Nuclear Reactor	Pool	2 MW	DECON
New York	University of Buffalo	Pool	2 MW	SAFSTOR Possession Only

Annex F Requirements for Notifying NRC of Emergency and Non-Emergency Events[256]
Specific requirements for NRC-licensed radioactive materials[257]
Standards for Protection Against Radiation (10 CFR Part 20):
• Section 20.1906 Procedures for receiving and opening packages. [Section 20.1906(d) notification of removable radioactive surface contamination]
• Section 20.2201 Reports of theft or loss of licensed material.
• Section 20.2202 Notification of incidents.
• Section 20.2203 Reports of exposures, radiation levels, and concentrations of radioactive material exceeding the constraints or limits.
• Section 20.2204 Reports of planned special exposures.
Domestic Licensing of Byproduct Material (10 CFR Part 30):
• Section 30.50 Reporting requirements.
• Section 30.55 Tritium reports.
Domestic Licensing of Source Material (10 CFR Part 40):
• Section 40.60 Reporting requirements.
• Section 40.64 Reports. [Section 40.64(c)(2) notification for any attempt of theft or unlawful diversion]
Domestic Licensing of Production and Utilization Facilities (10 CFR Part 50):
• Section 50.72 Immediate notification requirements for operating nuclear power reactors.
• Section 50.73 Licensee event reporting system
Disposal of High-Level Radioactive Wastes In Geologic Repositories (10 CFR 60.78, Material Control and Accounting Records and Reports).
Disposal of High-Level Radioactive Wastes In A Geologic Repository at Yucca Mountain, Nevada (10 CFR 63.73, Reports of Deficiencies).
Domestic Licensing of Special Nuclear Material (10 CFR Part 70):
• Section 70.50 Reporting requirements.
• Section 70.52 Reports of accidental criticality or loss or theft or attempted theft of special nuclear material.
• Section 70.74 Additional reporting requirements. (Appendix A -Reportable Safety Events)
Appendix A to Part 70--Reportable Safety Events.
Packaging and Transportation of Radioactive Material. (10 CFR 71.95 Reports)
Licensing Requirements for Independent Storage of Spent Fuel and High-Level Radioactive Waste (10 CFR Part 72):
• Section 72.32 Emergency Plan. (8) Notification and coordination.
• Section 72.74 Reports of accidental criticality or loss of special nuclear material.
• Section 72.75 Reporting requirements for specific events and condition.
Physical Protection of Plants and Materials (10 CFR part 73):
• Section 73.27 Notification requirements.
• Section 73.67 Licensee fixed site and in-transit requirements for the physical protection of special

[256] For more information on NRC Incident Investigation Program, see NRC Management Directive 8.3, NRC Incident Investigation Program accessible at: http://pbadupws.nrc.gov/docs/ML0312/ML031250592.pdf.
[257] There are equivalent requirements for the relevant Agreement States.

Annex F Requirements for Notifying NRC of Emergency and Non-Emergency Events[256]
nuclear material of moderate and low strategic significance.
• Section 73.71 Reporting of safeguards events
Appendix G to Part 73--Reportable Safeguards Events
Material Control and Accounting of Special Nuclear Material (10 CFR 74.11 Reports of loss or theft or attempted theft or unauthorized production of special nuclear material)
Certification of Gaseous Diffusion Plants (10 CFR 76.120 Reporting requirements
Export and Import of Nuclear Equipment and Material (10 CFR 110.50 Terms)
Examples of non-reactor incident reports
NUREG-1405, *Inadvertent Shipment of a Radiographic Source from Korea to Amersham Corporation, Burlington, Massachusetts* (Publication Date: May 1990)
NUREG-1450, *Potential Criticality Accident at the General Electric Nuclear Fuel and Component Manufacturing Facility*, May 29, 1991 (Publication Date: August 1991)
NUREG-1480, *Loss of an Iridium-192 Source and Therapy Misadministration at Indiana Regional Cancer Center Indiana, Pennsylvania on November 16, 1992* (Publication Date: February 1993)
NUREG-1535, *Ingestion of Phosphorus-32 at Massachusetts Institute of Technology, Cambridge, Massachusetts*, Identified on August 19, 1995 (Publication Date: December 1995).
Links to Additional Information on Response to Incidents
Federal Emergency Management Agency (FEMA) State Offices and Agencies of Emergency Management: http://www.fema.gov/about/contact/statedr.shtm
FEMA: http://www.fema.gov/
Department of Energy (DOE): http://energy.gov
U.S. Environmental Protection Agency (EPA): http://www.epa.gov/
Department of Agriculture (USDA): http://www.usda.gov/
Department of Health and Human Services (HHS): http://www.hhs.gov/
Department of State (DOS): http://www.state.gov/
Federal Bureau of Investigation (FBI): http://www.fbi.gov/

LIST OF ACRONYMS AND ABBREVIATIONS

Acronym	Name
ADAMS	Agency-wide Documents Access and Management System (NRC)
ADR	Alternative Dispute Resolution
AEA	Atomic Energy Act of 1954
AEC	Atomic Energy Commission
ALARA	As Low as Reasonably Achievable
ANSI	American National Standards Institute
ANS-8	American Nuclear Society Standards Subcommittee 8
ARARs	Applicable or Relevant and Appropriate Requirements
ASERs	Annual Site Environmental Reports
BRC	Blue Ribbon Commission
CAA	Clean Air Act
CBP	Customs and Border Protection
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CoC	Certificate of Compliance
CRCPD	Conference of Radiation Control Program Directors
CSD	Considered Sites Database
D&D	Decontamination & Decommissioning
DCS	Derived Concentration Standards
DECON	Immediate Dismantlement
DEIS	Draft Environmental Impact Statement
DHS	Department of Homeland Security
DNFSB	U.S. Defense Nuclear Facilities Safety Board
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOL	U.S. Department of Labor
DoS	U.S. Department of State
DP	Decommissioning Plan
DU	Depleted Uranium
EA	Environmental Assessment
EDRAM	International Association for Environmentally Safe Disposal of Radioactive Materials
EHSS	Office of Environment Health, Safety and Security
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
EPAct05	Energy Policy Act of 2005
EPAct92	Energy Policy Act of 1992
EPRI	Electric Power Research Institute

Acronym	Name
ESCP	Extended Storage Collaboration Program
FBI	Federal Bureau of Investigation
FEMA	Federal Emergency Management Agency
FFA	Federal Facility Agreements
FRMAC	Federal Radiological Monitoring and Assessment Center
FR	Federal Register
FSAR	Final Safety Analysis Report
FTCP	Federal Technology Capability Program
FTE	Full-Time Equivalent
FWF	Federal Waste Disposal Facility
FUSRAP	Formerly Utilized Sites Remedial Action Program
GLE	Global Laser Enrichment
GTCC	Greater-than-Class C Low-Level Waste
GTRI	Global Threat Reduction Initiative
HEPA	High Efficiency Particulate Air
HEU	Highly-Enriched Uranium
HHS	Department of Health & Human Services
HLW	High-Level Waste
HSS	Office of Health, Safety and Security
HWFP	Hazardous Waste Facility Permit
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
IEA	Office of Independent Enterprise Assessment
IFNEC	International Framework for Nuclear Energy Cooperation
IMPEP	Integrated Materials Performance Evaluation Program
INDs	Improvised Nuclear Devices
INES	International Nuclear Event Scale
INL	Idaho National Laboratory
IRRS	Integrated Regulatory Review Service
ISFSI	Independent Spent Fuel Storage Installation
ISMP	Integrated Source Management Portfolio
ISR	In Situ Recovery
JSCNEC	Joint Standing Committee on Nuclear Energy Cooperation
LA	License Application
LAW	Low-Activity Waste
LES	Louisiana Energy Service
LEU	Low-Enriched Uranium
LFRG	Low-Level Waste Disposal Facility Federal Review Group
LLD	Lower Limit of Detection

Acronym	Name
LLEA	Local Law Enforcement Agency
LLRWPA	Low-Level Radioactive Waste Policy Act of 1980
LLRWPAA	Low-Level Radioactive Waste Policy Amendments Act of 1985
LLW	Low-Level Waste
LSN	Licensing Support Network
LTP	License Termination Plan
LTSP	Long-Term Surveillance Plan
LVS	License Verifications System
LWA	Land Withdrawal Act
m^3	Cubic Meters
MOU	Memorandum of Understanding
MRS	Monitored Retrievable Storage
MT	Metric Tons
MTU	Metric Tons Uranium
MTHM	Metric Tons Heavy Metal
NAS	National Academy of Sciences
N/A	Not Applicable or Not Available
NCRP	National Council on Radiation Protection And Measurements
NEPA	National Environmental Policy Act
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NNSA	National Nuclear Security Administration
NORM	Naturally Occurring Radioactive Materials
NOV	Notices of Violations
NPDES	National Pollution Discharge Elimination System
NPL	National Priorities List for CERCLA
NPP	Nuclear Power Plant
NRC	U.S. Nuclear Regulatory Commission
NRF	National Response Framework
NRIA	Nuclear/Radiological Incident Annex
NSTS	National Source Tracking System
NUREG	Nuclear Regulatory Commission Regulation designates a publication prepared by NRC staff
NWPA	Nuclear Waste Policy Act of 1982, as amended
NWPAA	Nuclear Waste Policy Amendments Act of 1987
NWTRB	U.S. Nuclear Waste Technical Review Board
OECD/NEA	Organization for Economic Cooperation and Development/Nuclear Energy Agency
ORO	Offsite Response Organization
OSRP	Off-Site Source Recovery Project
PA	Performance Assessments

Acronym	Name
PAGs	Protective Action Guides
PFS	Private Fuel Storage, LLC
PSDAR	Post Shutdown Decommissioning Activity Report
QA	Quality Assurance
RCRA	Resource Conservation and Recovery Act of 1976
RDDs	Radiological Dispersal Devices
REIRS	Radiation Exposure Information and Reporting System
RESRAD	RESidual RADiation
R&D	Research and Development
RWMC	Radioactive Waste Management Committee
SAFSTOR	A nuclear facility is safely stored until subsequently decontaminated to permit release for unrestricted use.
SCATR	Source Collection and Threat Reduction Program
SDWA	Safe Drinking Water Act
SER	Safety Evaluation Report
SFP	Spent Fuel Pool
SRS	Savannah River Site
SSAB	Site-Specific Advisory Boards
SUPERFUND	Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
Sv	Sievert
SWPF	Salt Waste Processing Facility
Task Force	Task Force on Radiation Source Protection and Security
TED	Total Effective Dose
TEDEs	Total Effective Dose Equivalents
TENORM	Technologically Enhanced NORM
TRU	Transuranic
UMTRCA	Uranium Mill Tailings Radiation Control Act
URL	Underground Research Laboratories, Uniform Resource Locator
U.S.	United States of America
USACE	U.S. Army Corps of Engineers
U&Th	Uranium and Thorium
WBL	Web-based Licensing
WCS	Waste Control Specialists
WIPP	Waste Isolation Pilot Plant
WIPP LWA	Waste Isolation Pilot Plant Land Withdrawal Act of 1992
WSB	Waste Solidification Building
WTP	Waste Treatment and Immobilization Plant

ADDITIONAL REFERENCES

Numerous references to laws, regulations, regulatory guides, standards, and DOE Orders are provided throughout this report and are not repeated here (see Table E-1 and Table E-2) for brevity. Internet web sites are also provided in Table A-2. The following additional resources were used:

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