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National Report

Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management

United States Department of Energy

In Cooperation with the
United States Nuclear Regulatory Commission
United States Environmental Protection Agency
United States Department of State

ABSTRACT AND ACKNOWLEDGEMENT

The United States of America 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. This first Review Meeting of the Contracting Parties under the Joint Convention is scheduled to take place in November 2003 in Vienna, Austria. This report documents spent fuel and radioactive waste safety in the United States under the terms of the Joint Convention. Contracting Parties agreed on the report format and contents in December 2002.

The U.S. is in compliance with the terms of the Joint Convention. An extensive set of laws and regulatory structure exist to ensure safety of spent fuel and radioactive waste management in the U.S. The report describes radioactive waste management in the U.S. in both commercial and government sectors, providing annexes (appendices) with information on spent fuel and waste management facilities, spent fuel and waste inventories, and ongoing decommissioning projects. Detailed information is provided on spent fuel and radioactive waste management safety, as well as imports/exports (transboundary movements) 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. Additional information is available on the Internet web sites listed in Section A.

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A. INTRODUCTION

This is the first National Report prepared under the terms of the *Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management*[i] hereafter referred to as the "Joint Convention".

A.1 Purpose and Structure of this Report

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 United States of America (U.S.). The Joint Convention was ratified by the U.S. on April 9, 2003, and will enter into force on July 10, 2003. The Joint Convention is an important part of a global effort to raise the level of nuclear safety at nuclear facilities in the aftermath of the accident at the Chernobyl nuclear power plant in the Ukraine and other events. The Joint Convention provides incentives for nations to take appropriate steps to bring their nuclear activities into compliance with internationally endorsed public health and safety standards or their equivalent. A copy of the Joint Convention is electronically available from the International Atomic Energy Agency (IAEA).[ii]

The Joint Convention is a companion to, and structured similar to the Convention on Nuclear Safety (CNS), which entered into force for the United States on July 10, 1999. The CNS is successfully increasing safety at civilian nuclear power plants throughout the world. In September 2001, the U.S. Nuclear Regulatory Commission (USNRC) published a "National Report for the Convention on Nuclear Safety."[iii] Based on the successful format and content of the CNS, the Joint Convention establishes a series of broad commitments with respect to the safe management of spent fuel and radioactive waste without prescribing specific or mandatory standards on contracting nations. More importantly, the Joint Convention extends the peer review process established in the CNS to spent fuel and radioactive waste management activities.[iv] Each member state having ratified the Joint Convention, hereafter referred to as Contracting Parties, is obligated to prepare a National Report covering the scope of the Joint Convention and subject it to peer review by other contracting parties. Peer review has proven very successful in implementing the CNS. This peer review meeting will occur at the IAEA in Vienna, Austria, in November 2003.

This report was prepared by the U.S. Department of Energy (USDOE), utilizing a working group composed of staff from other agencies of the U.S. Government which are involved in international and domestic nuclear activities: the U.S. Department of State, U.S. Environmental Protection Agency (USEPA), and USNRC.

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[i] International Atomic Energy Agency, Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, INFCIRC/516, December 24, 1997.

[ii] International Atomic Energy Agency, http://www.iaea.org/worldatom/Documents/Legal/jointconv.shtml, Worldatom website.

[iii] U.S. Nuclear Regulatory Commission, United States of America, National Report for the Convention on Nuclear Safety, NUREG-1650, Washington DC, USA, September 2001.

[iv] Disused sealed sources are also within the scope of the Joint Convention, as specified in the preamble of the Convention on Nuclear Safety.

This report describes how the U.S. Government meets the objectives described in Article 1 of the Joint Convention as follows:

1. Achieve and maintain a high-level of nuclear safety worldwide in spent fuel and radioactive waste management through the enhancement of national measures and international cooperation, including where appropriate, safety-related technical cooperation;

2. Ensure that during all stages of spent fuel and radioactive waste management there are effective defenses against potential radiological hazards so that individuals, society, and the environment are protected from harmful effects of ionizing radiation, now and in the future; and

3. Prevent accidents with radiological consequences, and mitigate such consequences should they occur during any stage of management.

The report's format and content follow guidelines agreed to at a preparatory meeting of Contracting Parties to the Joint Convention in December 2001.[i] Chapters and annexes (or appendices) in this report have the same titles as prescribed in these guidelines. This will facilitate peer review by other Contracting Parties familiar with the prescribed organization. Table A-1 provides a cross-reference between the chapters in this report and the specific reporting requirements in the Joint Convention.

Table A-1. Joint Convention Reporting Requirements

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 4-9 ; Articles 11-16; Articles 21-26
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. Planned Activities to Improve Safety	Multiple Articles
L. Annexes	Multiple Articles

The information in this report is derived from publicly available information sources. More detailed information can be found at the Internet web sites listed in Table A-2.

[i] 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, Vienna, Austria, December 13, 2002.

A.2 Safety Issues and Themes

The U.S. has over five decades of experience in the operations of spent fuel and radioactive waste management facilities. The national policy is safe permanent disposal of spent fuel and radioactive waste to ensure long-term containment and isolation from the environment. Section B provides a more thorough discussion of the U.S. polices and practices, including relevant background information on how and why they have evolved over time.

Table A-2. Key Sources of Information Available on the Internet
Code of Federal Regulations
Access to all regulations: http://www.access.gpo.gov/cgi-bin/cfrassemble.cgi?title=200310
Energy, Title 10: (Includes USDOE and USNRC regulations): http://www.access.gpo.gov/cgi-bin/cfrassemble.cgi?title=200310
Protection of the Environment, Title 40: http://www.access.gpo.gov/cgi-bin/cfrassemble.cgi?title=200310
U.S. Department of Energy
Homepage: http://www.energy.gov
Office of Environment, Safety, and Health: http://tis.eh.doe.gov/portal/home.htm
Office of Environmental Management: http://www.em.doe.gov/index4.html
Office of Civilian Radioactive Waste Management: http://www.ocrwm.doe.gov/
Office of Independent Assessment and Performance Assurance: http://www.oa.doe.gov/
Energy Information Administration: http://www.eia.doe.gov/fuelnuclear.html
Integrated Safety Management: http://www.eh.doe.gov/ism/
Orders and directives: http://www.directives.doe.gov/
Technical standards: http://tis.eh.doe.gov/techstds/
Waste Isolation Pilot Plant: http://www.wipp.ws/
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/reading-rm/doc-collections/nuregs/staff/sr0980/
Advisory Committee on Nuclear Waste: http://www.nrc.gov/what-we-do/regulatory/advisory/acnw.html
Radioactive waste: http://www.nrc.gov/waste.html
Nuclear materials: http://www.nrc.gov/materials.html
Decommissioning: http://www.nrc.gov/materials/decommissioning.html
U.S. Environmental Protection Agency
Homepage: http://www.epa.gov/
Regulations: http://www.epa.gov/epahome/cfr40.htm
Major environmental laws: http://www.epa.gov/epahome./laws.htm
Office of Air and Radiation: http://www.epa.gov/oar
Office of Solid Waste: http://www.epa.gov/osw/
Radiation Program: http://www.epa.gov/radiation/
Waste Isolation Pilot Plant Oversight: http://www.epa.gov/radiation/wipp/index.html
Yucca Mountain Standards: http://www.epa.gov/radiation/yucca/index.html
Other
U.S. Department of State, Bureau of Nonproliferation: http://www.state.gov/t/np/
U.S. Defense Nuclear Facilities Safety Board: http://www.dnfsb.gov/
National Academy of Sciences: http://www4.nationalacademies.org/nas/nashome.nsf
National Council on Radiation Protection and Measurements: http://www.ncrp.com/
U.S. Nuclear Waste Technical Review Board: http://www.nwtrb.gov/
Conference of Radiation Control Directors, Inc.: http://www.crcpd.org/

B. POLICIES AND PRACTICES

This section summarizes the U.S. national policy towards nuclear activities, in particular, spent fuel and radioactive waste management. The section also describes:

- The different roles and responsibilities of interested Federal Government agencies and commercial or private sector entities in the use of nuclear energy in the U.S.;
- The classification of spent fuel and the various types of radioactive waste; and
- The practices pertaining to spent fuel and radioactive waste management including relevant background information.

B.1 U.S. National Policy Towards Nuclear Activities

Following World War II, the U.S. Congress engaged in a vigorous and contentious debate over civilian versus military control of the atom. The Atomic Energy Act of 1946 resolved the debate by creating the Atomic Energy Commission (USAEC) to assume authority over the sprawling scientific and industrial complex built by the military during the War. Figure B-1 shows the extent of the nuclear weapons complex in the latter half of the 20th Century. The USAEC was the predecessor of current U.S. Government agencies established to govern nuclear activities.

The Atomic Energy Act of 1954 assigned the USAEC the functions of both encouraging the use of nuclear power and regulating its safety. The USAEC regulatory programs sought to ensure public health and safety from the hazards of nuclear power without imposing excessive requirements that would inhibit the growth of the industry. The Atomic Energy Act of 1954 made the development of commercial nuclear power possible. Since this time, the U.S. Government has actively promoted the development of commercial nuclear power and ensured its safe use.

In the mid 1970's, Congress passed the Energy Reorganization Act of 1974 and redistributed the functions performed by the USAEC to two new agencies. The Energy Reorganization Act of 1974 created the USNRC to regulate the commercial nuclear power sector and the Energy Research and Development Administration (ERDA) to promote energy and nuclear power development and to develop defense applications. The USNRC was established as an independent authority governed by a five-member Commission to regulate the possession and use of nuclear materials as well as the siting, construction, and operation of nuclear facilities. The ERDA was established to ensure the development of all energy sources, increase efficiency and reliability of energy resource use, and carry out the other functions, including but not limited to the USAEC military and production activities and general basic research activities. Supporters and critics of nuclear power agreed that the promotional and regulatory duties of the USAEC for commercial activities should be assigned to different agencies.

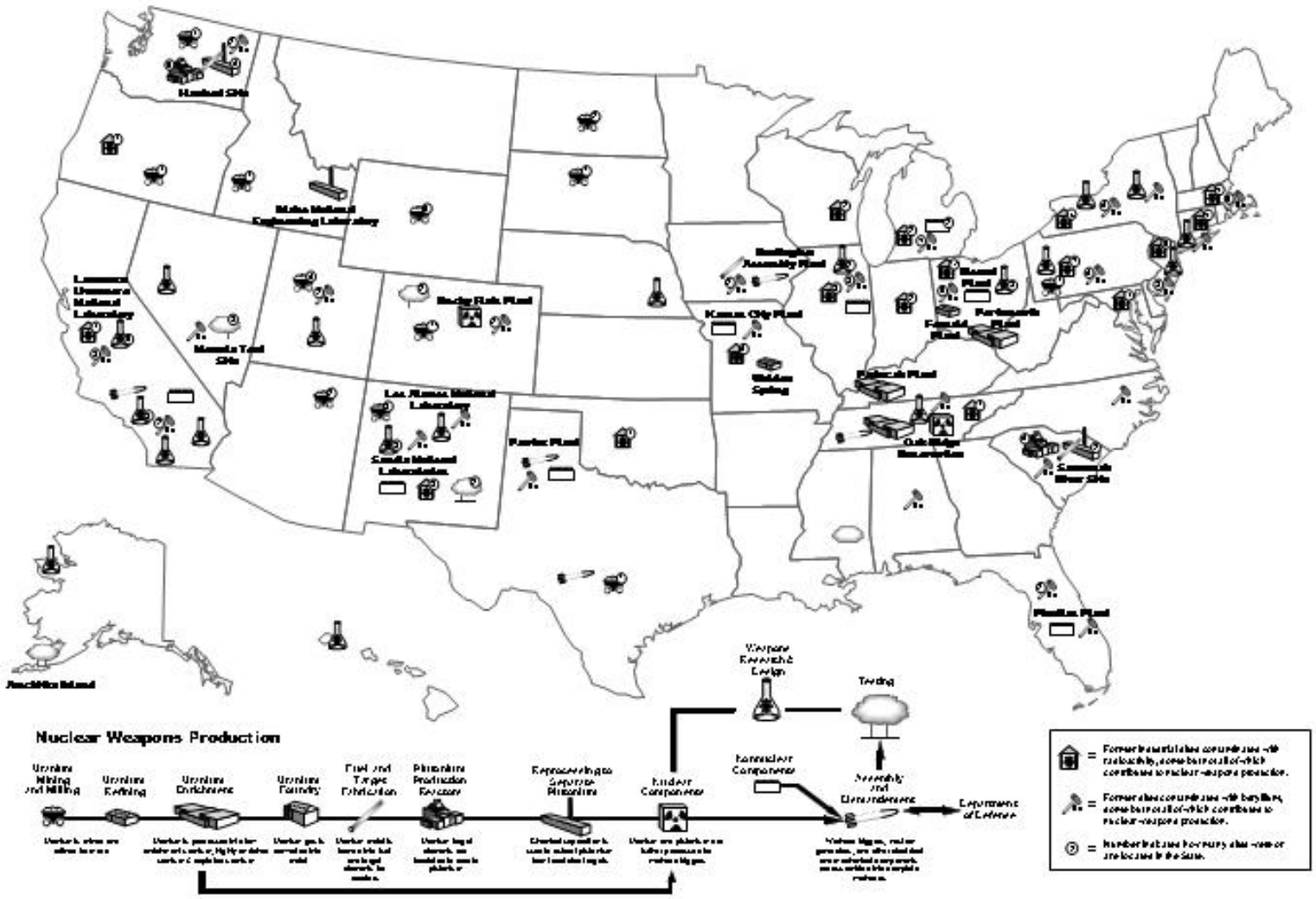


Figure B-1. The Former U.S. Nuclear Weapons Complex

The USNRC began operations on January 19, 1975. It has since performed its regulatory mission by issuing regulations, licensing commercial nuclear reactor construction and operation, licensing the possession of and or use of nuclear materials and wastes, safeguarding nuclear materials and facilities from theft and radiological sabotage, inspecting nuclear facilities, and enforcing regulations. Regulation of the commercial nuclear fuel cycle materials and facilities is performed by the USNRC. In context of the Joint Convention, the USNRC is responsible for licensing of commercial nuclear waste management facilities, independent spent fuel management facilities, and licensing of the proposed Yucca Mountain site for the disposal of high-level waste (HLW) and spent fuel. The USNRC also provides oversight of certain state programs, which have licensing authority over certain types of waste management facilities under their jurisdiction.

The USDOE began operations on October 1, 1977, in response to a need by the U.S. Government to unify energy organization and planning. The Department of Energy Organization Act brought a number of the Federal government's agencies and programs, including ERDA, into a single agency with responsibilities for nuclear energy technology and nuclear weapons programs. Over the past decade, the USDOE has added new nuclear-related activities directed to environmental clean up of contaminated sites and surplus facilities and nonproliferation. The USDOE retains authority under the Atomic Energy Act of 1954 for regulation of its nuclear activities.

The USEPA was created in 1970 to address a growing public demand in the U.S. for cleaner water, air, and land. The USEPA was assigned the daunting task of repairing the damage already done to the natural environment and to establish new criteria to guide Americans in making a cleaner environment a reality. USEPA was given authority, under the Atomic Energy Act, for setting generally applicable standards for radioactivity in the environment. This authority has been used to establish standards for cleanup of active and inactive uranium mill tailing sites, to establish environmental standards for the uranium fuel cycle, and to set environmental radiation protection standards for management and disposal of spent fuel (SNF), HLW, and transuranic (TRU) waste. Standards developed by USEPA are implemented and enforced by other government agencies. The USEPA also regulates disposition of hazardous chemical wastes. However, USEPA does have authority to oversee and enforce USEPA’s generally applicable standards at the Waste Isolation Pilot Plant repository for the disposal of defense-related TRU waste and, under the Clean Air Act, limits airborne emissions of radionuclides from USDOE sites that manage defense-related spent nuclear fuel and radioactive waste. The regulatory roles of the U.S. Government agencies are described in detail in Section E.

B.2 Government and Commercial Entities

B.2.1 Government Sector

In the government sector USDOE is responsible for and performs most of the spent fuel and radioactive waste management activities for government-owned and generated waste and materials located for the most part on government-owned sites. These activities include management of spent fuel remaining from decades of defense reactor operations primarily at the Hanford Site, Washington, and Savannah River Site, South Carolina, which ceased in the early 1990s. The reprocessing of spent fuel from defense reactors ceased in 1992. Since that time, USDOE has safely stored the remaining defense spent fuel and spent fuel generated in a number of research and test reactors. The USDOE also provides safe storage for the core of the decommissioned Fort St. Vrain gas-cooled reactor and the damaged core of the Three-Mile-Island Unit 2 reactor that was damaged in an accident in 1979. The USDOE reinstated an aggressive program for the return of "foreign" research reactor fuel originally enriched or supplied by the U.S. Foreign research reactor spent fuel is being returned by other nations for safe keeping in the U.S.

The USDOE has a complete waste management system for government spent fuel and waste. This includes numerous "interim" storage facilities, processing facilities (treatment and conditioning), and disposal facilities for low-level waste (LLW) and the Waste Isolation Pilot Plant for TRU waste, which are described in other sections of this report. Other waste management treatment and disposal systems support cleanup and closure of facilities that are no longer serving a mission to USDOE. More information is provided in Section D on spent fuel and radioactive waste facilities in the government sector.

The USDOE Order 435.1, "Radioactive Waste Management," ensures that all USDOE radioactive waste is managed in a manner that is protective of worker and public health and safety as well as the environment. Throughout this report, numerous references are made to USDOE Order 435.1 and its accompanying technical manual and guidance documents. Section H-2 provides additional detail about USDOE Order 435.1.

The USDOE is pursuing licensing and construction of a geologic repository for spent fuel and HLW at Yucca Mountain, Nevada. If licensed and constructed, the proposed geologic repository will dispose of spent fuel and HLW from commercial and government facilities.

Decommissioning activities generate radioactive waste in both the commercial and government sectors. Decommissioning activities are described in Section D.5.

B.2.2 Commercial Sector

As owners and operators of nuclear power plants and other types of facilities that generate radioactive waste, investor-owned utilities and other private companies in the U.S. are accountable for management of spent fuel and radioactive waste generated by

their facilities. These facilities manage spent fuel from power and research reactors and radioactive waste from reactor facilities, industry, universities, medical centers, etc. The commercial sector is free to pursue private ventures.

Although these wastes and/or spent fuel in the commercial sector are managed by licensees and operators at USNRC licensed facilities, the ultimate waste disposal sites will, in most cases, be owned and administered by the U.S. or appropriate state government. Depending on the type of radioactive waste and generating activity, the governmental custody may occur at different stages of the waste management scheme.

A number of commercial power reactors have independent spent fuel storage facilities. Commercial spent fuel is also stored in a facility in Morris, Illinois. Several companies provide LLW processing and treatment waste management services to both the government and commercial sectors. Additional information on commercial spent fuel and radioactive waste management is provided in Section D.

B.2.3 Classification of Spent Fuel and Radioactive Waste

B.2.3.1 Spent Fuel

The U.S. defines 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. The USDOE allows test specimens of fissionable material irradiated for research and development only, and not production of power or plutonium, to be classified as waste, and managed in accordance with the requirements of USDOE Order 435.1, “Radioactive Waste Management,” when it is technically infeasible, cost prohibitive, or would increase worker exposure to separate the remaining test specimens from contaminated material.

B.2.3.2 Radioactive Waste

The U.S. waste classification system for radioactive waste is composed of two separate subsystems. One classification subsystem applies to commercial waste and is defined in USNRC regulations. The other classification subsystem applies to USDOE waste.

In the U.S. radioactive waste from nuclear operations is classified as HLW, TRU waste, LLW, or 11e(2) byproduct material (including mill tailings). Waste may also contain hazardous waste constituents. Waste with both radioactive and hazardous constituents in the U.S. is called “mixed” waste, e.g. mixed LLW or mixed TRU waste.

In the commercial sector, LLW is further classified as Class A, Class B, Class C and Greater-than-Class C (GTCC) LLW. These classes are defined in USNRC regulations (Title 10, Code of Federal Regulations [CFR], Part 61), 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 compares the commercial waste classification structure to IAEA proposed waste classes.

The USDOE manages waste from its operations using procedures and requirements that are comparable to those used by the USNRC for commercial waste. Both USNRC and USDOE approaches apply similar performance objectives; however, the USDOE does not utilize the USNRC LLW classification system for its near surface disposal systems. For LLW, USDOE requires its facility operators to conduct performance analyses that consider the waste (forms and characteristics), site conditions, and facility design and on that basis defines specific waste acceptance criteria tailored to each of its LLW facilities. Table B-2 compares USDOE disposal classification to IAEA proposed waste classes. The USDOE uses the TRU waste class for long-lived, alpha emitting waste (see Table B-2 for complete definition), while similar USNRC regulated commercial waste falls in the GTCC LLW category.

Tables B-1 and B-2 include a class for byproduct materials called "11e(2)" because the term is defined in section 11e(2) of the Atomic Energy Act. Uranium recovery and byproduct materials are discussed in Section B.4.4.

The crosswalk to the IAEA waste classification scheme is approximate based on available waste management data. Even with some uncertainty, the data provides a reasonable translation of the U.S. waste classes into the IAEA proposed classification system. Because many nations, like the U.S., have their own reporting categories, it is particularly useful to compare national classification schemes to a common classification scheme to gain a common understanding for reviews under the Joint Convention. In 2002 the U.S. provided information to the Net-Enabled Waste Management Data Base program at the IAEA which defines the U.S. waste classification scheme and compares it to waste classes with proposed waste classes in IAEA Safety Guide 111-G-1.1, "Classification of Radioactive Waste*."*

The IAEA proposed waste classes include HLW and low and intermediate level waste (LILW). The LILW class is further subdivided into short-lived (LILW-SL) and long-lived (LILW-LL) subclasses. The IAEA system for classification of radioactive waste does not recognize waste such as those from mining and milling uranium ore. Therefore, Table B-1 and Table B-2 show no correlation for 11e(2) byproduct material. [i]

[i] Classification of Radioactive Waste, A Safety Guide, Safety Series No 111-G-1.1, IAEA1994.

Table B-1. U.S. Commercial Radioactive Waste Classification Compared with the IAEA Proposed Classification for Disposal

Waste Class	U.S. Definition	IAEA[i] HLW	IAEA LILW-LL	IAEA LILW-SL
HLW	(1) The highly radioactive material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations; (2) Irradiated reactor fuel; and (3) Other highly radioactive material that the Commission, consistent with existing law, determines by rule requires permanent isolation. [ii]	100%	0%	0%
Greater than Class C LLW	Waste not generally acceptable for near-surface disposal is waste from which form and disposal methods must be different, and in general more stringent, than those specified in Class C waste. Radionuclide concentration (individual or combinations of isotopes) exceeds 10CFR61.55 limits in Table 1 (long-lived radionuclides) or Table 2, Column 3 (short lived radionuclides).	0%	100%	0%
Class C LLW	Waste that not only must meet more rigorous requirements on waste form to ensure stability but also requires additional measures at the disposal facility to protect against inadvertent intrusion. Must meet both the minimum and stability requirements in the 10CFR61.55. Radionuclide concentration per 10CFR61.55 falls between 10% and 100% of values on Table 1 (long-lived radionuclides) or between the values in Column 2 and Column 3 of Table 2 (short lived radionuclides) with application of sum of fractions rule for isotope mixtures.	0%	25%[iii]	75%
Class B LLW	Waste that must meet more rigorous requirements on waste form to ensure stability. The physical form and characteristics must meet both the minimum and stability requirements in the 10CFR61.56. Concentration limits of certain short-lived radionuclides are higher than Class A limits as defined in 10CFR61.55 Column 2 of Table 2 (short-lived radionuclides).	0%	0%	100%
Class A LLW	The physical form and characteristics must meet the minimum requirements in 10CFR61.56. Concentration is limited in 10CFR61.55, e.g. to concentration limits in Column 1 of Table 2 (short-lived radionuclides) or 10% of limits in Table 1 (long-lived radionuclides) or combinations thereof by sum of fractions rule.	0%	0%	100%
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.[iv]	0%	0%	0%

[i] IAEA, Classification of Radioactive Waste; A Safety Guide, Safety Series No. 111-G-1.1.
[ii] From Title 10 CFR Part 63, Section 63.2; consistent with the Nuclear Waste Policy Act, as amended..
[iii] A reasonable estimate of the split of Class C waste into the IAEA categories is by the fraction of waste classified as Class C by long-lived radionuclides per 10CFR61.55 Table 1 to compare with IAEA LILW-LL. Percentages determined based on commercial disposal data for 1998–2000.
[iv] Title 10 CFR Part 40, Domestic Licensing of Source Material (Section 40.4)

Table B-2. USDOE Radioactive Waste Classification Compared with the IAEA Proposed Classification for Disposal[i]

Waste Class	U.S. Definition	IAEA[i] HLW	IAEA LILW-LL	IAEA LILW-SL
HLW	High-level waste is the highly radioactive waste material resulting from the reprocessing of spent nuclear 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 is determined, consistent with existing law, to require permanent isolation. [Reference: USDOE Manual 435.1, "Radioactive Waste Management," adapted from: Nuclear Waste Policy Act of 1982, as amended]	100%	0%	0%
TRU	Radioactive waste containing more than 3,700 becquerels (100 nanocuries) of alpha-emitting transuranic isotopes per gram of waste, with half-lives greater than 20-years, except for: (1) HLW, (2) waste that the Secretary of Energy has determined, with the concurrence of the Administrator of the USEPA, does not need the degree of isolation required by the 40 CFR Part 191 disposal regulations; or (3) waste that USNRC has approved for disposal on a case-by-case basis in accordance with 10 CFR Part 61. (Reference: USDOE Manual 435.1, "Radioactive Waste Management" citing the Waste Isolation Pilot Plant Land Withdrawal Act of 1992, as amended)	0%	100%	0%
LLW	Radioactive waste that is not HLW, spent fuel, TRU waste, byproduct material (as defined in section 11(e)2 of the Atomic Energy Act of 1954, as amended), or naturally occurring radioactive material. Reference: USDOE Manual 435.1, "Radioactive Waste Management" citing the Nuclear Waste Policy Act of 1982, as amended)	0%	0.5%	99.5%
11e(2) Byproduct Material	The tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content. [Reference: USDOE Manual 435.1, "Radioactive Waste Management" citing Atomic Energy Act of 1954, as amended)]	0%	0%	0%

[i] IAEA, Classification of Radioactive Waste; A Safety Guide, Safety Series No. 111-G-1.1

B.3 Spent Fuel Management Practices

This subsection provides information on spent fuel storage and disposal practices in the U.S. Past reprocessing activities are also described.

B.3.1 Spent Fuel Storage

In the U.S. spent fuel has been produced in commercial nuclear power plants, research reactors, and defense reactors. Currently 104 operating nuclear power reactors provide about 20 percent of the electricity generated in the U.S. As of December 1998, a total of 135,972 spent fuel assemblies from commercial nuclear power reactors were stored in the U.S. Of this total, 131,780 spent fuel assemblies were stored at nuclear power plant sites, which included 126,854 spent fuel assemblies in pools and 4,926 spent fuel assemblies in 11 dry storage facilities.[i]

Today, there are 27 independent spent fuel storage installations (ISFSI) in the U.S. Most ISFSIs are found at nuclear power plant sites and generally use dry cask storage systems. These are discussed further in Section D.

Because nuclear reactor facilities are not considered waste management facilities by the U.S. under the terms of the Joint Convention, reactor facilities and spent fuel in reactor pools are not included in the list of facilities and inventory reported in Section D. However, the total inventory of spent fuel in these facilities is provided in Table B-3, to provide here a complete picture of spent fuel in the U.S.

Table B-3. Summary of U.S. Spent Fuel in Non-Spent Fuel Management Facilities [ii]

Non-Spent Fuel Management Facility Type	Number of Reactors	MTHM [iii]
Commercial Nuclear Power Reactor Spent Fuel Pools	104	37,658[iv]
Government Research Reactors	13	1
Commercial Research Reactors	5	<1
University Research Reactors	27	2

Today, all operating nuclear power reactors are storing spent fuel in USNRC licensed on-site spent fuel pools (SFPs) or ISFSIs. Nuclear power plants undergoing decommissioning may have spent fuel stored on site. When a nuclear power plant is decommissioned, the spent fuel is properly stored pending disposal. Therefore, in 1990 the USNRC amended its regulations to make it possible for licensees to store spent fuel in USNRC-certified dry storage casks, at approved reactor sites. Locations of ISFSIs are shown in Figure B-2 (See Section G.1 for information on licensing, including general and site-specific licenses noted in Figure B-2.)

[i] U.S. Energy Information Administration data as of December 1998 for spent fuel at commercial reactor sites.

[ii] The U.S. does not consider nuclear reactors to be spent fuel management facilities.

[iii] Metric tons of heavy metal is the conventional measure of fuel mass in nuclear reactor fuel assemblies.

[iv] U.S. Energy Information Administration data as of December 1998 for spent fuel in pools at commercial reactor sites.

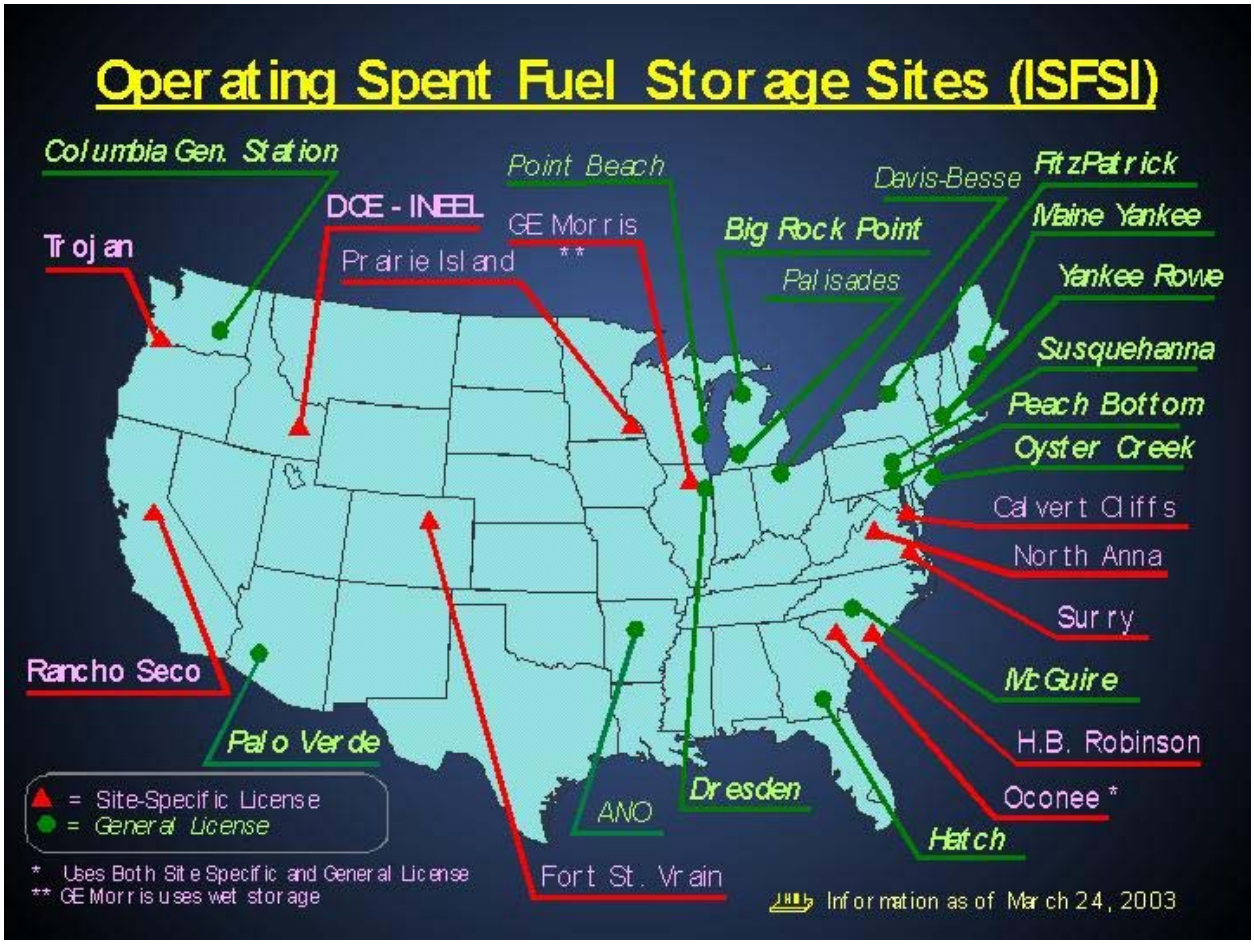


Figure B-2. Locations of U.S. Licensed Independent Spent Fuel Storage Installations

Although less than 4 percent of all commercial spent fuel assemblies was stored in dry casks at utility company ISFSIs in December 1998, this percentage is expected to increase as more utilities' spent fuel pools reach capacity, because they are required to maintain sufficient reserve capacity to accommodate a full core. These reactors were not designed to store the full amount of spent fuel generated during their operational lives, and they contribute between 1,800 and 2,200 metric tons of heavy metal (MTHM) annually to the accumulating amount of spent fuel. Projected spent fuel discharges taking into account plant life extensions could bring the total to 105,000 MTHM by the year 2046.

In addition to commercial spent fuel, spent fuel from both domestic and foreign research reactors is stored at USDOE and other research reactor facilities throughout the country. The USDOE also stores spent fuel from former defense production reactors. The inventory of spent fuel stored in USDOE facilities, about 250,000 assemblies and other fuel units, is discussed in Section D. As stated above, because nuclear reactor facilities

are not considered waste management facilities by the U.S. under the terms of the Joint Convention, spent fuel at government research reactors is not included in the inventory reported in Section D. However for completeness, the government research reactor spent fuel inventory is provided in Table B-3.

B.3.2 Spent Fuel Disposal

The Nuclear Waste Policy Act (NWPA) of 1982, as amended, provides for the siting, construction, and operation of a deep geologic repository for the disposal of spent fuel and HLW. The USNRC would license this repository. Yucca Mountain, Nevada, has been selected as the site of the first geologic repository. The Act also assigns responsibilities for the disposal of spent fuel and HLW to 3 Federal agencies as follows:

- The USDOE has the responsibility for developing permanent disposal capability for spent fuel and HLW;
- The USEPA has responsibility for developing public health and safety standards; and
- The USNRC has responsibility for developing regulations to implement the USEPA standards, licensing the repository, and certifying packages used to transport spent fuel and HLW to the repository.

The USDOE currently plans to submit a license application to the USNRC for repository construction authorization in late 2004. A Yucca Mountain repository, if licensed, is scheduled to begin operations in 2010. The USDOE has the responsibility to transport spent fuel from storage locations to the USNRC-licensed geologic repository. The NWPA limits the emplacement of waste at the first geologic repository to 70,000 MTHM until such time as a second repository is in operation. The materials that may be disposed at Yucca Mountain include about 63,000 MTHM of commercial spent fuel; about 2,333 MTHM of USDOE spent fuel; and about 4,667 MTHM of USDOE high-level radioactive waste. The USDOE will submit a report to the President and to the U.S. Congress between 2007 and 2010 on the need for a second repository.

B.3.3 Waste Confidence Determination

In order to continue construction and operation of nuclear power plants in the U.S., the USNRC was required to make a generic determination 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 the operation. Until a permanent disposal facility is licensed, the spent fuel from a reactor can either be stored in an SFP or ISFSI, either onsite or offsite.

The USNRC thus determined that there is reasonable assurance that at least one mined geologic repository will be available within the first quarter of the 21st century. In other words, sufficient repository capacity will be available within 30 years beyond the licensed

life for operation of any reactor to dispose of the commercial high-level waste and spent fuel generated by commercial reactors up to that time.

B.3.4 Reprocessing in the United States

In the 1960's and early 1970's, several reprocessing ventures were contemplated and one operated for a short while. A facility was constructed in West Valley, New York, and operated by Nuclear Fuel Services from 1966 to 1972. This facility processed 640 MTHM from government and commercial nuclear power plants, resulting in 2.3 million liters of liquid HLW. This was the only commercial reprocessing plant operated in the U.S. In 1977, the U.S. Government declared a moratorium on domestic reprocessing of commercial spent fuel, and although it was later rescinded in 1981, commercial reprocessing never resumed because of economics.

In 2002, the West Valley Demonstration Project, a research and development project funded by the USDOE, completed vitrification of the HLW stored at West Valley. The New York State Energy Research and Development Authority now owns the site. Today, about 270 canisters filled with glass are stored at West Valley. In addition to the HLW, 125 remaining spent fuel assemblies that were not reprocessed are awaiting shipment to a USDOE spent fuel storage facility near Idaho Falls, Idaho, and ultimate disposal in a geologic repository.

Although the General Electric Company planned construction of a commercial reprocessing facility near Morris, Illinois, in the late 1960's, only the storage facility was completed and remains in operation today. It currently holds 3,217 spent fuel assemblies from commercial nuclear power plants and is the only stand-alone commercial ISFSI utilizing wet pool storage in the U.S.

B.4 Radioactive Waste Management Practices

Radioactive waste in the U.S. is generated at all steps of the commercial fuel cycle and defense activities. Radioactive waste is a byproduct of the mining, processing, and use of radioactive materials. Uranium mill tailing waste results from commercial uranium ore processing activities following mining and uranium extraction projects. Uranium recovery waste results from in situ leach solution mining activities involving injection and recovery wells. High-level waste resulted from former spent fuel reprocessing activities. Radioactive waste also results from fuel cycle activities, including enrichment, fuel fabrication and reactor operations. It also originates from medical, academic, industrial, and other commercial uses, and generally contains relatively limited concentrations of radioactivity. Decommissioning waste results from the decontamination and removal of radioactive materials encountered during site closure and restoration activities.

B.4.1 Low-Level Waste

Low-level waste typically consists of contaminated protective shoe covers and clothing, wiping rags, mops, filters, reactor water treatment residues, equipment and tools, luminous dials, medical tubes, swabs, injection needles, syringes, and laboratory animal carcasses and tissues. The radioactivity can range from just above background to very high levels, e.g., parts from inside the reactor vessel in a nuclear power plant. The U.S. has a comprehensive LLW management system for the large majority of LLW. Commercial and government facilities exist for LLW processing, e.g. treatment and conditioning, and disposal. Generators prepare LLW for shipment to licensed disposal. Section D provides additional information on the facilities and inventories of LLW.

The volume and radioactivity of LLW disposed varies from year to year based on the types and quantities of LLW generated. Generally, the volume of operational LLW has been decreasing over the years due to the high cost of disposal and significant advances in volume reduction techniques. In recent years, large volumes of waste have been generated from facility decommissioning and site remediation. Similarly, the LLW activity (Becquerels or Curies) has increased.

Commercial LLW disposal facilities are designed, constructed, and operated under licenses issued by either USNRC or an Agreement State (see Section H.3) in accordance with USNRC health and safety requirements. USNRC regulations restrict the quantities, forms, and activity levels of waste that can be disposed in commercial LLW facilities. The USDOE operates disposal facilities for LLW generated in the government sector under authority of the Atomic Energy Act. These practices are described further in Section F and Section H.

Current LLW disposal uses shallow land burial sites. A key factor in the LLW disposal requirements and waste classification system is the goal of protection of individuals from inadvertent intrusion. In fact, the design, operation, and closure of the land disposal facility must ensure protection of any individual inadvertently intruding into the disposal site and occupying the site or contacting the waste at any time after active institutional controls over the disposal site are removed.

The U.S. policy is that near surface disposal is not appropriate for disposal of GTCC LLW. Currently, GTCC LLW is stored until an adequate disposition policy is determined. GTCC LLW disposal is discussed further in Section D.3.5.

B.4.2 Transuranic Waste

By definition, TRU waste falls within the USDOE government sector (non-commercial). TRU waste generally consists of protective clothing, tools, glassware, equipment, soils, and sludge contaminated with manmade radioisotopes heavier than uranium. TRU elements are beyond or “heavier” than uranium on the periodic table of the elements. See Table B-2 for the definition of TRU waste. These elements include plutonium, neptunium, americium, curium, and californium. TRU waste is produced during nuclear fuel assembly; during nuclear weapons research, production, and cleanup; and as a result of reprocessing spent fuel. TRU waste is itself divided into two categories,

contact-handled and remote-handled, based on its surface dose rate. The maximum radiation dose at the surface of a contact-handled TRU waste container is 2mSv per hour (200 mrem per hour). Remote-handled TRU waste emits more radiation than contact-handled TRU waste and must therefore be both handled and transported in shielded casks. Surface radiation levels of unshielded containers of remote-handled TRU waste exceed 2mSv per hour (200 mrem per hour). Section D.3.4 provides information on disposal of TRU waste.

B.4.3 High-Level Waste

In addition to spent fuel disposal, the proposed Yucca Mountain repository will be used for HLW disposal. Commercial HLW was vitrified and is stored at the former reprocessing plant in West Valley, New York; defense HLW is currently stored at 3 USDOE sites. USDOE has programs in place to safely manage liquid HLW at its sites. All such HLW will be treated appropriately for subsequent geologic disposal. More information is provided in Section D.

B.4.4 Uranium Recovery (Byproduct Material – "11e(2)")

Uranium recovery is any activity that results in the production of byproduct material[i], i.e., tailings or waste produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content. This also includes discrete surface wastes resulting from uranium solution extraction processes. All of these wastes have relatively low concentrations of radioactive materials with long half-lives.

Four types of uranium recovery operations are regulated by the USNRC:

1. Milling of uranium or thorium ore involving conventional processes of excavation and extraction,

2. Solution or "in situ" leach mining involving chemical removal of uranium from subsurface layers by pumping fluids through the formation to a withdrawal well and subsequently to a facility to selectively concentrate the uranium,

3. Heap leach operations, similar to (2), but generally performed at the earth's surface by placing dissolution fluids on tailing piles and collecting the uranium bearing liquid which has infiltrated through the tailings, and

4. Processing of radioactive waste as an "alternate feed material" through conventional mills to extract the uranium from the waste.

In the early 1980's, when the price of uranium fell, U.S. uranium mills were shut down or scaled back operations. The only U.S. thorium mill was remediated under the direction of the State of Illinois, an Agreement State. The price of uranium is still depressed and

[i] 10 CFR Part 40 defines byproduct material the same as section 11e(2) of the Atomic Energy Act. This is frequently referred to as "11e2" byproduct material.

many previously operated mills have cleaned or are cleaning up (decommissioning) waste resulting from extracting uranium from ore in accordance with USNRC or Agreement State requirements. This waste, primarily mill tailings (sandy ore residue), poses a potential hazard to public health and safety. As a result the U.S. Congress enacted the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA) and established two programs to protect the public and the environment from uranium mill tailings.

The UMTRCA Title I program established a joint Federal/State-funded program for remedial action at inactive uranium milling sites and contaminated "vicinity properties" that resulted from the production of uranium for sale to the Federal government, with ultimate Federal ownership of the tailings disposal sites under general license from the USNRC. Under Title I, the USDOE is responsible for cleanup and remediation of these sites. The USNRC is required to evaluate USDOE designs and implementation activities and, after remediation, concur that the site meets standards set by the USEPA.

The UMTRCA Title II program is directed towards uranium milling licensed by the USNRC or Agreement States in or after 1978. Title II of the Act provides USNRC authority to control radiological and non-radiological hazards and USEPA authority to set generally applicable standards (40 CFR Part 192) for both radiological and non-radiological hazards. This Act provides for eventual state or Federal government ownership of the disposal sites, under general license from USNRC.

The Office of Surface Mining of the U.S. Department of Interior and individual states regulate mining of uranium ore. Other extraction mining and refinement operations for metals, phosphates, etc. may concentrate naturally occurring radionuclides in these tailings materials. In some cases, some mineral extraction processes (not for nuclear content) are specifically licensed by the USNRC, because they incidentally result from the use, or concentration, of material above 0.05 percent by weight source material. When such a processor is identified, the processor is required to obtain a USNRC license. See Section C-2 for more information on these non-regulated materials.

B.4.5 Waste from Enrichment and Fuel Fabrication Facilities

The product obtained from uranium recovery facilities is processed to enrich the fissile content. Tailings containing depleted uranium in gaseous form are a byproduct of the gaseous enrichment process. After enrichment, fuel-manufacturing facilities fabricate and assemble nuclear fuel assemblies for light water reactors. This activity includes receipt, possession, storage, and transfer of special nuclear material. The manufacturing process results in pellets, which are sintered and then loaded into fuel rods. The fuel rods are placed in storage and are withdrawn as needed and fabricated into fuel assemblies. Other licensed activities support fuel manufacturing and include uranium storage, scrap recovery, waste disposal systems, and laboratory services. Radioactive waste generated from these processes, which vary in type and amount, is managed within the classes described in Table B-1, e.g. Class A LLW.

The U.S. Government has plans to construct and operate a mixed-oxide fuel fabrication facility to manufacture commercial reactor fuel using fissile material identified through

international non-proliferation activities, e.g., strategic weapons reduction. Although this facility is not a radioactive waste management facility, secondary radioactive waste generated by operations will be disposed in USDOE radioactive waste disposal facilities.

B.4.6 Ocean Disposal

The U.S. disposed of some radioactive waste at sea, before such practices were discontinued pursuant to U.S. environmental laws and regulations and international agreements designed to prevent marine pollution, such as the London Convention. The U.S. no longer disposes of radioactive waste in this manner, and although the option of permanent deep sea bed disposal was studied, the concept was abandoned. While incomplete records exist of the volume and type of waste disposed in the ocean by the United States, USEPA records indicate that between 1946 and 1970, more than 55,000 containers of radioactive waste were disposed at three sites in the Pacific Ocean. In addition, almost 34,000 containers of radioactive waste were disposed at three sites off the East Coast of the United States from 1951 to 1962.

B.5 Decommissioning

Decommissioning is an activity that takes place generally at the end of operation of commercial and governmental nuclear facilities. Current USNRC and other governmental agencies' recommendations and, in some cases requirements, include provision for decommissioning planning in the pre-operational design and strategy. The waste that results from decommissioning is managed within the waste classes in Table B-1 and Table B-2. Additional information is found in Section F.12.

C. SCOPE OF APPLICATION

This section covers the application of the Joint Convention in the U.S. described in Article 3. The United States position on the application of the Joint Convention to reprocessing of spent fuel, naturally occurring radioactive material, and defense/military programs is provided below. The section also provides a definition of what the U.S. considers to be spent fuel and waste management facilities under the provisions of the Joint Convention.

C.1 Application to Reprocessing of Spent Fuel

The U.S. has historical experience with reprocessing of spent fuel both in the commercial and governmental sectors, but now has limited activities as explained below. In the governmental sector the USDOE and its predecessor agencies historically reprocessed spent fuel for recovery of nuclear materials for defense purposes. Today, the government's reprocessing is limited to stabilizing certain USDOE defense spent fuel and other nuclear materials. Stabilized materials are safely stored for future use in USDOE missions or disposition. The U.S. does not consider its defense reprocessing facilities to be spent fuel or waste management facilities as specified in Article 3.1.

There is no commercial reprocessing of spent fuel planned or currently in operation in the U.S. as discussed in Section B. The U.S. Government banned reprocessing as a matter of national policy in 1977 and rescinded the ban in 1981. However, no commercial reprocessing has occurred. As discussed in Section B, the only commercial reprocessing facility that operated in the U.S. was Nuclear Fuel Services, Inc. at West Valley, New York, from 1966 until 1972. When reprocessing activities were discontinued in 1972, 125 irradiated spent fuel assemblies were in the storage pool awaiting reprocessing. This spent fuel is now managed by the USDOE. It is currently awaiting transfer to storage facilities at the Idaho National Engineering and Environmental Laboratory, where it will be stored until shipped to the geologic repository, proposed to be located at Yucca Mountain, Nevada, for disposal. The U.S. does not consider the former reprocessing plant at West Valley, New York, to be a spent fuel management facility in accordance with Article 3.1 of the Joint Convention. However the spent fuel awaiting transfer from West Valley is accounted for and is included in the inventory.

C.2 Application to Naturally Occurring Radioactive Materials

Under Article 3.2, the Joint Convention does not apply to naturally occurring radioactive materials (NORM) originating outside the nuclear fuel cycle, except when a disused sealed source containing naturally occurring radioactive material is declared as radioactive waste by the Contracting Party.

The U.S. has not declared as radioactive waste under the Joint Convention any byproduct material containing only NORM and originating outside the nuclear fuel cycle. The U.S also considers technologically enhanced NORM (TENORM) materials in the same category as NORM for Convention purposes.

The U.S. has programs in place to retrieve disused sealed sources, some of which may contain only naturally occurring radionuclides. Additional information on the U.S. Sealed Source Recovery Program is provided in Section J.4.

C.3 Application to Defense Activities

Under Article 3.3, the Joint Convention does not apply to the safety of spent fuel or waste within defense or military programs, unless declared specifically by the Party under the Joint Convention. The U.S. Government has determined that the Joint Convention does not apply to spent fuel or waste managed within the military programs in the U.S. The U.S. military programs primarily reside in the United States Department of Defense and the National Nuclear Security Administration. The National Nuclear Security Administration is a separate agency within the USDOE, which oversees the military application of nuclear energy; maintenance and enhancement of the safety, reliability, and performance of the United States nuclear weapons stockpile; and development of naval propulsion plants for the U.S. Navy, among other functions.

The amount of spent fuel and radioactive waste in the military programs is relatively small in comparison to that in the commercial nuclear power sector or other governmental programs. Although not determined to fall under the Joint Convention under provisions in Article 3.3, spent fuel and waste in military programs are managed in accordance with the objectives stated in Article 1 of the Joint Convention.

Spent fuel and radioactive waste in military programs will ultimately be disposed in facilities operated by the USDOE for which the Joint Convention is applicable. When waste and spent fuel is permanently transferred to an exclusively civilian program, the Joint Convention applies to the safe management of this waste and spent fuel. For example, the Joint Convention will apply to naval reactor spent fuel when accepted for disposal in the proposed geologic repository at Yucca Mountain along with commercial spent fuel.

The U.S. Government has determined that the Joint Convention applies to spent fuel and radioactive waste permanently managed by the USDOE within the Environmental Management program and other activities outside of the National Nuclear Security Administration. Much of the legacy spent fuel and waste within activities of the Environmental Management program originated from decades of activities within defense programs. These activities fall within the Joint Convention, with the only exception being any spent fuel or waste that remains classified for national security purposes. For example, spent fuel is reported which originated from former defense material production reactors, is permanently transferred for storage, and awaits future disposal at the USDOE proposed geologic repository.

C.4 Spent Fuel Management Facilities

The Joint Convention defines spent fuel management as all activities relating to the handling or storage of spent fuel, excluding off-site transportation. A spent fuel management facility is defined as any facility or installation the primary purpose of which is spent fuel management, i.e. handling or storage of spent fuel. In the U.S. most commercial and research reactor spent fuel will remain in storage pools within nuclear power plants or research facilities until the geologic repository proposed to be located at Yucca Mountain is operating. Because the primary purpose of the reactor building is not spent fuel management, reactor facilities are not included in this report. More information on U.S. commercial nuclear power plants is provided in the U.S. National Report prepared under the Convention on Nuclear Safety.[i] Like commercial nuclear power plants, the U.S. does not consider a research reactor facility containing a spent fuel storage pool or vault to meet the definition of a spent fuel management facility under the Joint Convention. Although not within the scope of the Joint Convention per se, spent fuel activities in all nuclear reactor facilities subscribe to the same objectives found in Article 1 of the Joint Convention.

The U.S. considers spent fuel management facilities within the context of the Joint Convention to include independent spent fuel storage installations and a geologic repository proposed to be located at the Yucca Mountain site. In addition to the commercial ISFSIs, the Joint Convention also applies to USDOE governmental spent fuel storage facilities, including those used to store foreign research reactor and U.S. research reactor spent fuel transferred to USDOE.

C.5 Radioactive Waste Management Facilities

The Joint Convention defines radioactive waste management as all activities, including decommissioning activities, which relate to the handling, pretreatment, treatment, conditioning, storage, or disposal of radioactive waste, excluding off-site transportation. A radioactive waste management facility is defined as any facility or installation the primary purpose of which is radioactive waste management, including a facility being decommissioned only if it is designated by the contracting party as a radioactive waste management facility.

In the U.S. there are commercial and governmental radioactive waste management facilities that meet this definition. In Article 2, where the definitions are found, the Joint Convention defines storage as the means of holding radioactive waste in a facility that provides for its containment, with the intention of retrieval. In the context of this report the U.S. does not consider facilities as radioactive waste storage facilities where, for a short period of time, e.g., less than a year, a waste generator collects radioactive waste for shipment or processing before sending it to a treatment or disposal facility. This excludes a very large number of “interim” storage facilities at nuclear power plants, hospitals, universities, research facilities, industries, etc., who routinely may generate radioactive waste and periodically make shipments to disposal sites. These facilities are subject to the regulations under licenses to possess nuclear materials, but for the

[i] The United States of America, National Report for the Convention on Nuclear Safety, NUREG-1650, U.S. Nuclear Regulatory Commission, Washington DC, September 2001.

purpose of Joint Convention reporting they are not considered by the U.S. to have a primary purpose of radioactive waste management. 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 facilities in the decommissioning phase that are also considered a waste management facility by virtue of their construction of onsite disposal facilities for some of the radioactive waste being generated during cleanup activities. Examples of these facilities include:

- The Fernald Environmental Management Project, Fernald, Ohio, location of a former defense uranium processing plant now undergoing decommissioning, including an on-site waste disposal cell and

- The Weldon Spring Site Remedial Action Project, St. Charles, Missouri, location of a former defense uranium processing plant with decommissioning nearly completed, including an on-site waste disposal cell.

This report further discusses all ongoing decommissioning and site remediation activities in Sections D.5.1.

C.6 Materials Considered Radioactive Waste

In the U.S. radioactive waste has many designations pertaining to the hazards associated with it as well as the circumstances and processes in which it is created. For uranium mill tailings, which are the final byproduct of the uranium ore extraction process, these are considered radioactive wastes. The day-to-day rubbish generated in medical laboratories and hospitals, which are contaminated by medical radioisotopes, is also designated as radioactive waste. However, tailings resulting from industrial extraction of metals and minerals of value (such as molybdenum or vanadium) are not routinely considered to be radioactive waste. In some cases where tailings have elevated levels of natural radionuclides, the processor may be licensed by the USNRC. In the U.S. the laws, standards, and regulations direct how materials with hazardous properties are to be regulated. The laws also specify which chemical and physical forms are to be regulated and controlled and also by which Federal or state entity. Most of the U.S. regulation of radioactive waste, as well as its designation, originated from the authority of the Atomic Energy Act of 1954 and subsequent amendments. Section B discussed the various types of materials and radioactive wastes that are subject to control.

It should be noted that the USNRC does not regulate all sources of radioactivity. The USNRC has responsibility for regulating LLW and HLW disposal and the use of source material (uranium and thorium), special nuclear material (enriched uranium and plutonium), and byproduct material (material made radioactive in a reactor and residues from the milling of uranium and thorium).

The USNRC authority covers waste forms, which consist of source, special nuclear and byproduct materials. Regulations, which address various aspects of the generation and

control of radioactive wastes and other nuclear activities, are codified in the U.S. Code of Federal Regulations (CFR); specifically in Title 10, "Energy," of CFR. These regulations address the storage, treatment, and possession of radioactive waste 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 Material Special Nuclear Material."

The siting, design and construction, safety assessment, operation, and post-closure requirements are identified in additional USNRC regulations. The USNRC lists comprehensive radioactive waste disposal requirements in 10 CFR Part 20, Subpart K. The USNRC specifically licenses the land disposal of LLW in 10 CFR Part 61, "Licensing Requirements for Land Disposal of Radioactive Waste," which corresponds to the international understanding of near surface disposal of LLW.
The disposal of HLW is addressed in:

- 10 CFR Part 60, "Disposal of High-level Radioactive Wastes in Geologic Repositories," and
- 10 CFR Part 63, "Disposal of High-Level Radioactive Wastes in a Proposed Geologic Repository at Yucca Mountain, Nevada."

Other aspects of radioactive waste management are addressed in:

- 10 CFR Part 71, "Packaging and Transportation of Radioactive Material;"
- 10 CFR Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste;"
- 10 CFR Part 73, "Physical Protection of Plants and Materials;" and
- 10 CFR Part 75, "Safeguards on Nuclear Material Implementation of US/IAEA Agreement."

Uranium mill tailings are addressed in 10 CFR Part 40, with specific criteria described in "Appendix A, 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." The criteria in Appendix A cover the siting and design of tailings impoundments, disposal of tailings or wastes, decommissioning of land and structures, groundwater protection standards, testing of the radon emission rate from the impoundment cover, monitoring programs, airborne effluent and offsite exposure limits, inspection of retention systems, financial surety requirements for decommissioning and long-term surveillance and control of the tailings impoundment, and eventual government ownership of the tailings site under a USNRC general license.

It should be noted that in the U.S., the individual states[i] usually regulate the sources of radiation that USNRC does not. For example, naturally occurring radioactive materials such as radium and radon, and radioactive materials produced in particle accelerators, such as cobalt-57, are regulated by the states rather than USNRC. Radiation producing machines, such as particle accelerators and x-ray machines (both medical and industrial) are also regulated by the states.

[i] In this context, “states” within the United States of America are similar to provinces or departments indicating the next level of government below the federal level.

D. INVENTORIES AND LISTS

This section covers the reporting obligations under Article 32, Paragraph 2, of the Joint Convention. The following sections and tables for the U.S.:

- List and describe the spent fuel and radioactive waste management facilities,
- Provide an inventory of spent fuel and radioactive waste subject to the Joint Convention, and
- List and summarize the status of nuclear facilities in the process of being decommissioned.

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

D.1 Spent Fuel Management Facilities

Article 32, Paragraph 2(i), of the Joint Convention states the National Report shall include "*a list of the spent fuel management facilities subject to this Convention, their location, main purpose and essential features.*" As shown in Table D-1, the U.S. currently has 26 licensed commercial dry cask storage facilities (independent spent fuel storage installations), 1 commercial wet spent fuel storage facility (GE Morris, Illinois), 16 spent fuel management (storage and treatment) facilities at government-owned sites, and one proposed spent fuel geologic repository. Annex D-1 provides a complete list. The following sections provide a brief description of the major types of spent fuel management facilities.

Table D-1. Summary of Spent Fuel Management Facilities

Sector	Type	Number
Government	Storage Facilities	16
Government / Commercial	Proposed Yucca Mountain Geologic Repository	1
Commercial	Independent Spent Fuel Storage Installations	27

D.1.1 Spent Fuel Storage

In the late 1970s and early 1980s, the need for alternative storage began to grow when pools at many commercial nuclear reactors began to fill up with stored spent fuel. Dry cask storage allows spent fuel that has already been cooled in the spent fuel pool for at least one year to be surrounded by inert gas inside a container called a cask. The casks are typically steel cylinders that are either welded or bolted closed. The steel cylinder provides a leak-tight containment of the spent fuel. Additional steel, concrete, or other material to provide radiation shielding to workers and members of the public surrounds

each cylinder. Some of the cask designs can be used for both storage and transportation.

There are various dry storage cask system designs. With some designs, the steel cylinders containing the fuel are placed vertically in a concrete vault; other designs orient the cylinders horizontally. The concrete vaults provide the radiation shielding. Other cask designs orient the steel cylinder vertically on a concrete pad at a dry cask storage site and use both metal and concrete outer cylinders for radiation shielding. Figure D-1 shows typical dry cask storage systems.

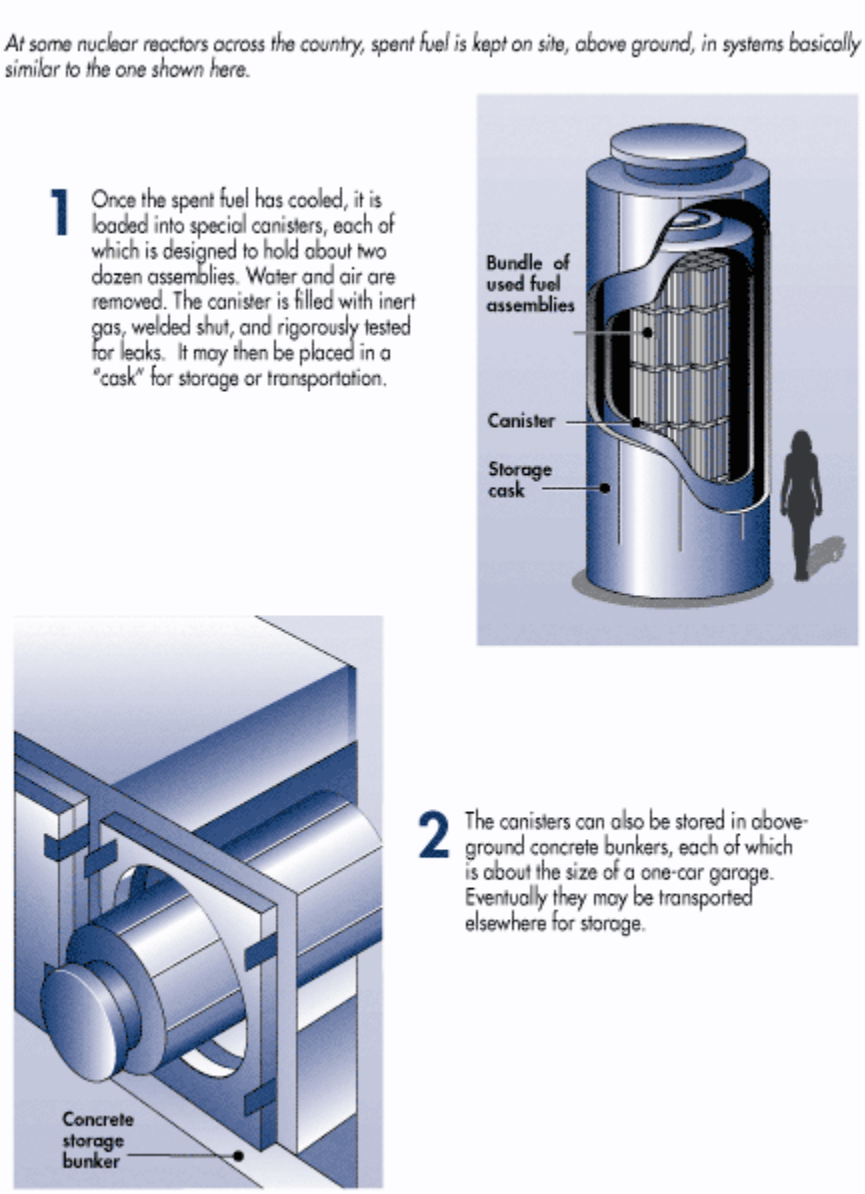


Figure D-1. Typical Dry Cask Storage Systems

D.1.2 Spent Fuel Disposal

The Nuclear Waste Policy Act of 1982, as amended, provides for the siting, construction, and operating of a deep geologic repository that could be used to dispose of spent nuclear fuel and high-level radioactive waste. Any such repository would be licensed by the USNRC.

Based on the results of more than 20 years of intensive science and engineering work at the Yucca Mountain site, the President signed the Congressional Joint Resolution on July 23, 2002, which designated the Yucca Mountain site to be considered for licensing. The USDOE plans to submit a license application to the USNRC in 2004 and if a license is granted, begin waste acceptance in 2010.

Yucca Mountain is located about 160 kilometers northwest of Las Vegas, Nevada, on unpopulated desert land owned by the Federal Government. Geological information indicates that the regional climate has changed little over the past million years, and the long-term average precipitation has been about 30 centimeters per year. Yucca Mountain itself is a ridge composed of a sequence of tilted layers of variably welded and fractured tuffs. The host rock proposed for the potential repository is a welded tuff unit located about 300 meters below the surface and 300 meters above the water table.

The repository is legislatively limited to a capacity of 70,000 MTHM of spent fuel and HLW that would be transported to the proposed Yucca Mountain repository by truck and rail in specially designed shipping casks approved by the NRC. Upon arrival, the material would ultimately be transferred into robust corrosion resistant waste packages for disposal. Approximately 10,000 waste packages will be required (Figure D-2).

The three primary design objectives for the repository are: (1) to protect the health and safety of both the workers and the public during the period of repository operations; (2) to minimize the amount of radioactive material that may eventually reach the accessible environment; and (3) to minimize life cycle costs. The design of the repository will permit it to be kept open, with only routine maintenance, for approximately 50 to 125 years from the start of waste emplacement. However, the design will not preclude keeping the repository open for as long as 300 years with appropriate maintenance and monitoring (Figure D-3). This flexibility will enable repository operations to meet future societal needs. Furthermore, the geologic repository operations area (GROA) must be designed so that any or all of the emplaced waste could be retrieved on a reasonable schedule starting at any time up to 50 years after waste emplacement operations are initiated, unless a different time period is approved or specified by the USNRC. Additional information on the licensing process is provided in Section F.3

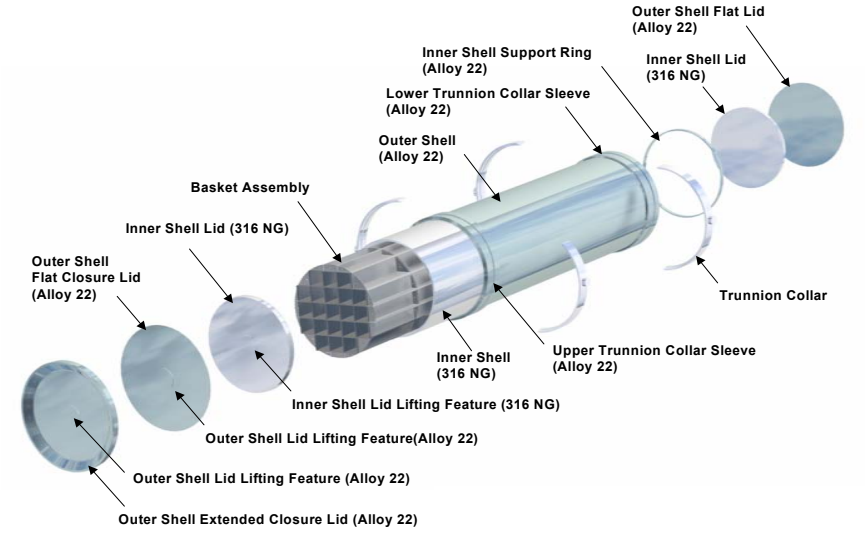


Figure D-2. Conceptual View of Waste Package for Disposal

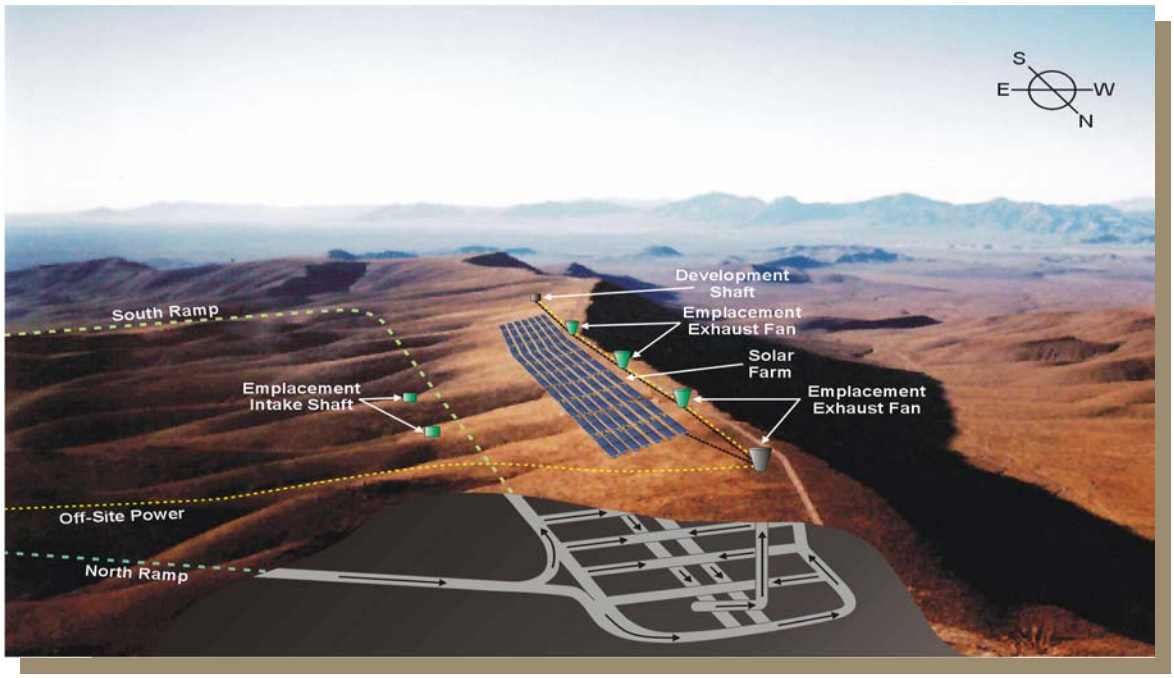


Figure D-3. Repository Conceptual View

D.2 Spent Fuel Inventory

Article 32, Paragraph 2(ii), of the Joint Convention states the National Report shall include "*an inventory of spent fuel that is subject to this Convention and that is being held in storage and of that which has been disposed. This inventory shall contain a description of the material and, if available, give information on its mass and its total activity."*

The amount of spent fuel in storage in the U.S., exclusive of spent fuel stored in pools at commercial nuclear reactors, is about 7,322 metric tons-heavy metal (MTHM). Of that total, 4,848 MTHM is stored at commercial installations and 2,474 MTHM is stored at government installations. Annex D-2 shows the amount of spent fuel stored at each installation, the total activity of the spent fuel, and a brief description of the material if readily available.

D.3 Radioactive Waste Management Facilities

Article 32, Paragraph 2(iii), of the Joint Convention states the National Report shall include "*a list of the radioactive waste management facilities subject to this Convention, their location, main purpose and essential features.*" Table D-2 is a summary of the U.S. radioactive waste management facilities. Annex D-3 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.

Table D-2. Summary of Radioactive Waste Management Facilities

Sector	Type	Number
Government	Storage/Treatment Facilities	54
Government	LLW (includes "Mixed" LLW) Disposal Facilities	16
Government	TRU Waste Disposal Facility	1
Government	Closed Greater Confinement Disposal	1
Government	Operating 11e2/Past Practice	1
Government	Closed 11e2/Past Practice	2
Government/Commercial	Proposed Yucca Mountain Geologic Repository	1
Commercial	Commercial Treatment/Processing	44
Commercial	Operating LLW Disposal Facilities	3
Commercial	Closed LLW Disposal Facilities	4
Government/Commercial	Title I UMTRCA	21
Commercial	Title II UMTRCA	36

D.3.1 Treatment Facilities

Radioactive wastes are primarily treated to produce a final waste form that is structurally stable and minimizes the release of radioactive and hazardous components. The U.S. does not commonly make a differentiation between the terms treatment and conditioning. In the international community, conditioning is defined as an operation that produces a waste package suitable for handling, such as conversion of a liquid to a solid, enclosure of the waste in containers, or overpacking, and treatment is defined as operations intended to benefit the safety and/or economy by changing the characteristics of the waste, through volume reduction, removal of radionuclides, and change in composition.[i] In the U.S. the terminology covering both conditioning and treatment is generally referred to as treatment or processing. In this report, treatment is used in this broader context.

The U.S. generally vitrifies HLW for ultimate disposal at the proposed Yucca Mountain geologic repository. For example, the vitrification process at the Savannah River Site treats the highly radioactive portion by mixing a sand-like borosilicate glass (called "frit") with the waste. The waste/frit mixture is then sent to the melter. Electricity is used to heat the mixture to nearly 1,150 Celsius (2,100 degrees Fahrenheit) until molten. This molten glass-waste mixture is poured into stainless steel canisters to cool and harden. Each canister is 3 meters (10 feet) tall and 0.6 meters (2 feet) in diameter; it takes approximately 24 hours to fill one canister. A filled canister weighs about 2.3 metric tons (2.5 tons).

The U.S. also treats radioactive wastes to remove free liquids, stabilize or destroy other hazardous components contained in the waste, and/or reduce the volume to be disposed through compaction. This treatment is limited to some TRU wastes and some LLW. In the U.S., there are private companies called “waste brokers” that provide packaging, treatment, and disposal services. Some of these waste brokers serve limited clientele; others perform these services for a wider spectrum of clients. Annex D-3 includes a number of these brokers.

D.3.2 Low-Level Waste (Near-Surface) Disposal Facilities

At present there are three active, licensed commercial LLW disposal sites; however none can accept GTCC LLW:

- The GTS-Duratek / Chem-Nuclear (Barnwell, South Carolina) site - Access is authorized for all LLW generators at the present time, but it will be closed to waste outside of the Atlantic Compact (South Carolina, Connecticut, and New Jersey) in 2008;
- The U.S. Ecology (Richland, Washington) site—Restricted access to only the Northwest and Rocky Mountain Compacts; and

[i] International Atomic Energy Agency, Establishing a National System for Radioactive Waste Management, Safety Series No 111-S-1.1, Vienna Austria, 1995.

- The Envirocare of Utah (Clive, Utah) site— is not licensed to accept Class B and Class C LLW.

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).

The USDOE operates disposal facilities for government sector LLW at: Fernald, Ohio; Hanford, Washington; Idaho National Engineering and Environmental Laboratory, Idaho; Los Alamos National Laboratory, New Mexico; Nevada Test Site, Nevada; Oak Ridge Reservation, Tennessee; and Savannah River Site, South Carolina. Figure D-4 illustrates the construction detail of the Hanford Environmental Restoration Disposal Facility.

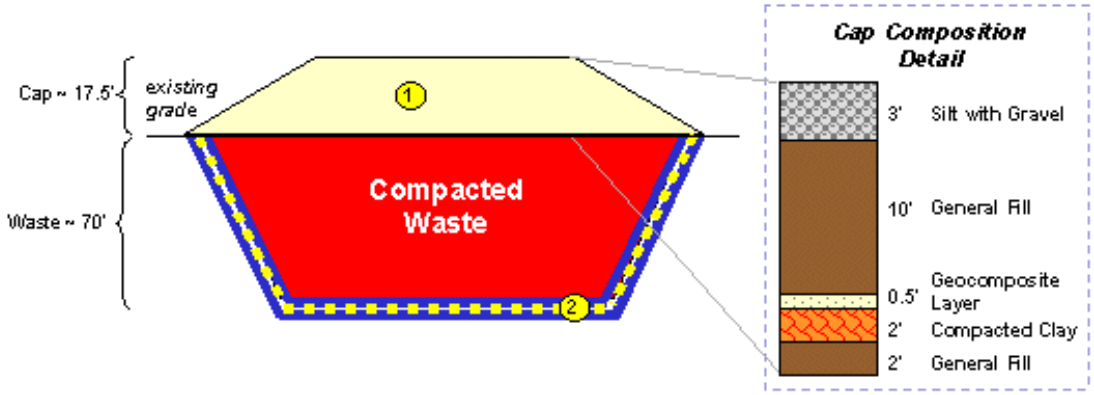


Figure D-4. Schematic of the Hanford Site Environmental Restoration Disposal Facility

D.3.3 Uranium Mill Tailings

A uranium mill is a chemical plant designed to extract uranium from mined ore. A conventional mill uses uranium ore extracted by either open pit or deep mining. The mined ore is brought to the milling facility via truck where the ore is crushed and leached. The leaching agent not only extracts uranium from the ore, but also several other constituents like molybdenum, vanadium, selenium, iron, lead, and arsenic. In most cases, sulfuric acid is used as the leaching agent, but alkaline leaching can also be used. The extraction processes concentrate the uranium into a uranium-oxygen compound called yellow cake U_3O_8, because of its yellowish color. The remainder of the crushed rock, in processing fluid slurry, is placed in a “tailings” pile/cell.

Mill tailings consist of fine-grained, sand-like and silty materials, usually deposited in large piles next to the mill that processed the ore. Tailings are generated during the milling of certain ores to extract uranium and thorium. These wastes have relatively low concentrations of radioactive materials with long half-lives, which include radium

(generates radon by radioactive decay), thorium, and small residual amounts of uranium that were not extracted during the milling process.

The conventional tailings pile is actually a constructed impoundment or a former uranium mine pit that must meet criteria in 10 CFR Part 40, Appendix A. These criteria include requirements for siting and design of the pile, cover performance, and financial surety for decommissioning, reclamation, and long-term surveillance.

Mills are typically located in areas of low population density, and they process ores from mines within about 50 kilometers (30 miles) of the mill. Most mills in the U.S. are in decommissioning mode; three mills are in standby mode; and one mill is in operation.

In-situ leach (ISL) facilities are another means of extracting uranium from underground. ISLs recover uranium from low-grade ores that may not be economically recoverable by other methods. In this process, a leaching agent such as oxygen with sodium carbonate is injected through wells into the ore body to dissolve the uranium. The leach solution is pumped from the formation, and ion exchange is used to separate the uranium from the solution.

Solution or ISL mining of uranium became an important component of the U.S. uranium recovery industry in the 1970's. Most of the USNRC regulated solution mines are in the States of New Mexico, Wyoming, and Nebraska. This method of mining is most effective in permeable geologic formations at shallow to moderate depths under the surface where uranium ore bodies are formed in narrow zones by flow of uranium-bearing groundwater from oxidizing to reducing conditions.

Surface facilities may be dismantled after operations cease in one solution mine field area and reassembled and used in another licensed site. Ultimate decommissioning includes the surface facilities and restoration of ground water quality in the mine site with the goal of achieving pre-mining conditions. About 12 such ISL facilities exist in the U.S. Of these, 6 are licensed by the USNRC. Texas, an Agreement State, licenses the rest.

Uranium recovery facilities are located principally in the Western U.S., where deposits of uranium ore are located. USNRC requires licensees to meet USNRC regulations that are compatible with USEPA standards for cleanup of uranium and thorium milling sites after processing operations have permanently closed. This includes requirements for long-term stability of byproduct material disposal piles, radon emissions control, water quality protection and cleanup, and cleanup of lands and buildings.

D.3.3.1 Title I - Reclamation Work at Inactive Mill Tailings Sites

The Uranium Mill Tailings Radiation Control Act of 1978 required USDOE to complete surface remediation and groundwater cleanup at inactive uranium milling sites and contaminated vicinity properties where uranium was processed solely for sale to the Federal government and which were not licensed in 1978. Tailings from some sites were combined, resulting in 19 tailings disposal sites. These piles range in size from 46,000 to 3.5 million cubic meters of material. Except for a site at Canonsburg,

Pennsylvania, and an associated property at Burrell, Pennsylvania, the inactive sites are located in western states.

In 1993, USDOE became a licensee of USNRC under the general license provisions of 10 CFR 40.27. The covered sites are listed in Annex D-4.

D.3.3.2 Title II - Licensed Uranium Recovery Facilities/Mill Tailings Sites

Of the 24 uranium recovery facilities currently licensed by the USNRC (see Figure D-5) under its regulations (10 CFR Part 40), there are 16 conventional uranium mills, 6 ISL facilities, one mine water ion-exchange facility, and one mill tailings waste disposal facility. Two of the conventional mill site licenses have been terminated and the reclaimed tailings areas transferred to the USDOE for long-term care under the general license provisions of 10 CFR 40.28. Annex D-5 lists the uranium recovery facilities directly licensed by the USNRC.

Source: U.S. Nuclear Regulatory Commission.

Figure D-5. Locations of Uranium Milling Facilities

The Envirocare of Utah facility at Clive, Utah, includes a disposal cell that is also licensed by USNRC as an 11e(2) byproduct disposal facility; however, it was never an active uranium recovery operation site. As mentioned in Section D.3.2, the Envirocare facility includes a separate licensed LLW disposal site.

There are four Agreement States (Colorado, Illinois, Texas, and Washington) that license Atomic Energy Act section 11e(2) byproduct material. The USNRC is required to make a determination that all applicable standards and requirements have been met by uranium mills before termination of their Agreement State license. Annex D-5 lists the Title II uranium recovery facilities regulated by the Agreement States.

D.3.4 Geologic Repository for Transuranic Waste

The WIPP is a geologic repository licensed to safely and permanently dispose of TRU radioactive waste left from the research and production of nuclear weapons. WIPP began operations on March 26, 1999, after more than 20 years of scientific study, public input, and regulatory review.

The WIPP is located in the remote Chihuahuan Desert of southeastern New Mexico, about 80 kilometers (50 miles) from Carlsbad, New Mexico. The repository consists of disposal rooms mined 655 meters (2,150 feet) underground in a 600 meter-thick (2,000 feet) salt formation that has been stable for more than 200 million years (see Figure D-6). The TRU waste currently stored at 23 locations nationwide will be shipped to and disposed of at WIPP over the next 35 years. WIPP is expected to receive about 170,000 cubic meters of waste in 37,000 shipments. At the close of 2002, 9,300 cubic meters of contact-handled TRU waste were disposed at WIPP.

The WIPP cannot currently accept remote-handled TRU waste until regulatory actions are complete. These actions are currently ongoing.

By law WIPP cannot accept:

- Remote-handled TRU waste with a surface dose rate in excess of 10 Sv per hour (1000 rems per hour),
- More than 5 percent by volume of remote-handled TRU waste with a surface dose rate in excess of 1 Sv per hour (100 rems per hour), and
- More than 1.8E5 Tbq (5.1 million curies) of remote-handled TRU waste.

There is also a limit on the volume, 7,079 cubic meters (250,000 cubic feet), of remote-handled TRU waste that, if permitted, can be disposed in the WIPP.

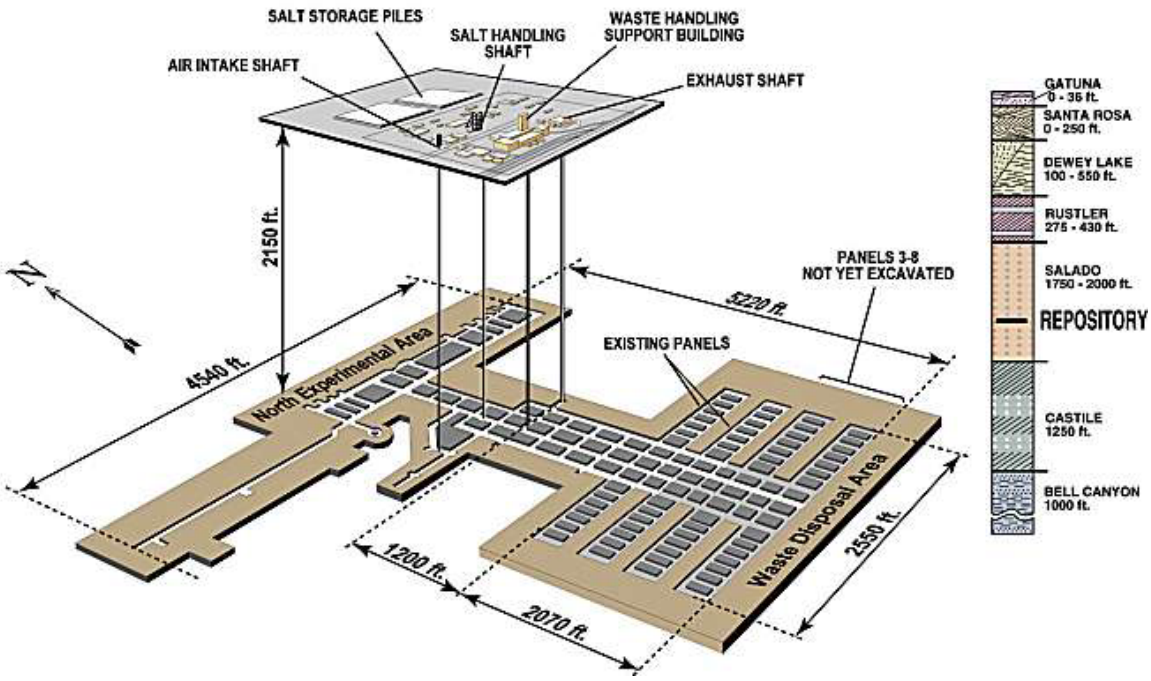


Figure D-6. WIPP Schematic and Stratigraphic Sequence

D.3.5 Management of Greater-Than-Class-C Low-Level Waste

The USNRC has classified LLW based on its potential hazards. Greater-than-Class-C LLW (GTCC waste) is not considered appropriate for near surface disposal. The waste contains long and short-lived radionuclides and its properties dictate a more robust disposal strategy than for other classes of LLW.[i]

Greater-than-Class-C waste is a form of low-level radioactive waste with high enough concentrations of long-lived radioactive materials that it is generally unsuitable for near-surface land disposal. The GTCC waste at nuclear power plants includes irradiated metal components from reactors, as well as filters and resins from reactor operations and decommissioning. The authority to possess this type of radioactive material is included under the reactor license. Most forms of GTCC waste are generated by routine operations at nuclear power plants, fuel research facilities, and manufacturers of radiopharmaceuticals and sealed sources. The decommissioning of nuclear power reactors generates GTCC waste. Most of the GTCC waste is generated by nuclear power plant operations and decommissioning. Other generators include commercial radioisotope producers, commercial research facilities, universities and academic institutions, fuel fabricators, and sealed source manufacturers. Examples of GTCC waste include activated metal hardware (e.g., nuclear power reactor control rods), spent fuel disassembly hardware, ion exchange resins, filters, evaporator residues, sealed

[i] Title 10, Code of Federal Regulations, Part 61.55, Tables 1 and 2 for long and short lived radionuclides, respectively.

sources that are used in medical and industrial applications, moisture and density gauges, and contaminated trash. Typical radionuclides that are associated with GTCC waste are ^{14}C, ^{59}Ni, ^{94}Nb, ^{60}Co, ^{99}Tc, ^{129}I, ^{90}Sr, and ^{137}Cs.[i]

The expected volume of this waste necessitates, as additional nuclear power plants are decommissioned, a permanent disposition in light of future inventories of nuclear waste in the U.S. Until an adequate disposition policy is determined, GTCC is being stored. The Low-Level Radioactive Waste Policy Act of 1980, as amended, requires that GTCC be disposed in a USNRC-licensed facility. Environmental impacts are being analyzed on the various options for GTCC disposal.

Table D-3 provides estimates of GTCC quantities. The estimates shown in this table, though a decade old, provide insight into the expected inventories. Based on actual decommissioning experience, the quantity of GTCC being generated is generally lower than the estimates. However, the projected amounts of sealed sources in Table D-3 may be underestimated.

Table D-3. Greater-Than-Class-C Waste Inventory[ii]

Source	1993 Inventory (m^3)	Projected Future Life-Cycle Inventory (m^3)
Nuclear electric utility	26	1,300
Sealed sources	39	240
Other Generators	74	470
Totals	***139***	***2,010***

D.4 Radioactive Waste Inventory

Article 32, Paragraph 2(iv), of the Joint Convention states the National Report shall include:

"A*n inventory of radioactive waste that is subject to this Convention and that:*

- *Is being held in storage at radioactive waste management and nuclear fuel cycle facilities;*
- *Has been disposed of; or*
- *Has resulted from past practices.*

This inventory shall contain a description of the material and other appropriate information available, such as volume or mass, activity and specific radionuclides."

[i] Taken from http://www.state.nv.us/nucwaste/gtcc/gtcc.htm
[ii] From Yucca Mountain EIS, primary source is DIRS 101798-DOE (1994)

D.4.1 Radioactive Waste Held in Storage

As of September 30, 2000, the U.S. inventory of radioactive waste in storage is shown in Table D-4, rounded to 3 significant digits. Additional details are provided in Annex D-6.

Wastes generated and in storage at U.S. national laboratories are primarily the result of research and science activities. Wastes generated and in storage at current and former weapons complex installations such as Hanford, Rocky Flats, Savannah River, and Los Alamos National Laboratory are the result of experimentation, design, and production of nuclear weapons during the Cold War era (see Figure B-1).

Table D-4. Summary of Inventory of Stored Radioactive Waste

Government	**Volume (m^3)**
HLW	354,000
TRU	111,000
LLW [i]	204,000
11e(2)	0
Commercial	**Volume (m^3)**
HLW	230
LLW (Class A, B, and C)	195,000
11e(2)	0

D.4.2 Inventory of Radioactive Waste Disposed

As of September 30, 2000, the cumulative inventory of disposed radioactive waste in the U.S. is shown in Table D-5, rounded to 3 significant digits. Annex D-7 provides more detailed information on the quantities for each disposal facility. The commercial and government sectors combined yield 4 million cubic meters of LLW disposed in the U.S. to date and 163 million metric tons of uranium mill tailings/11e(2) materials.

[i] Includes Mixed LLW.

Table D-5. Summary of Inventory of Disposed Radioactive Waste		
Government	**Quantity**	**Units**
HLW	0	m^3
TRU	9,300	m^3
LLW [i]	2,260,000	m^3
11e(2)	5,970,000	m^3
Commercial	**Quantity**	**Units**
HLW	0	m^3
GTCC LLW	0	m^3
LLW (Class A, B, C)	1,730,000	m^3
UMTRCA Titles I & II	163,000,000	Metric Tons

Figure D-7 provides a representative breakdown of the sources for 96,100 cubic meters of LLW commercially disposed in 2001, a representative year. About 57% of the LLW commercially disposed in 2001 by volume is from industrial sources, about 10% is from nuclear power plant operations, and less than 1% are from academic and medical sources. The remaining 33% by volume of LLW is generated in the government sector, but disposed in commercial LLW facilities.

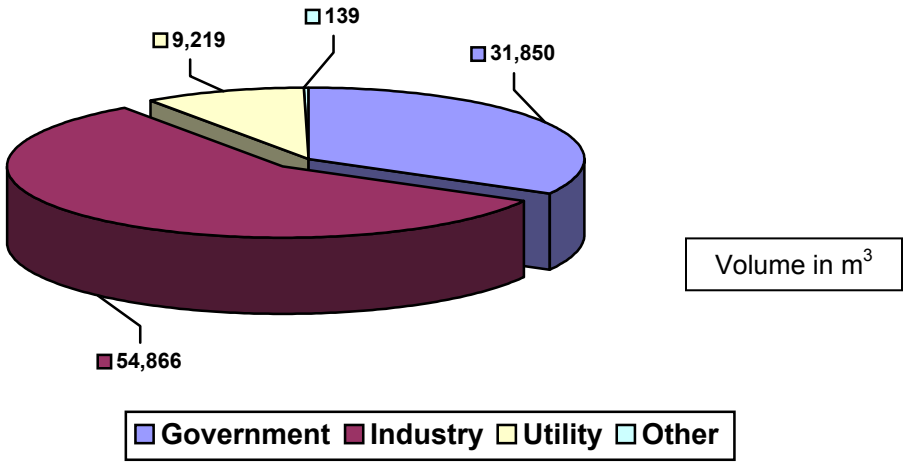


Figure D-7. Volume of Low-Level Waste Received at U.S. Disposal Facilities from the Commercial Sector in 2001

No commercial LLW is disposed in USDOE (government facilities). By volume, over 90% of the LLW disposed at commercial sites was Class A LLW disposed at the Clive, Utah, site, with the remaining volume of LLW split between the Barnwell, South Carolina, and Richland, Washington, sites. The Clive, Utah, site currently is licensed for only Class A LLW disposal. In contrast, nearly 90% of the activity (curies) was disposed at the Barnwell site, with most of the remainder disposed at the Richland site. More than 99% by volume of commercial LLW disposed in 2001 was Class A LLW, excluding UMTRCA waste.

[i] Includes Mixed LLW

D.5 Decommissioned Nuclear Facilities

Article 32, Paragraph 2(v), of the Joint Convention states the National Report shall include "*a list of nuclear facilities in the process of being decommissioned and the status of decommissioning activities at those facilities.*"

Table D-6 summarizes the ongoing decommissioning activities within the Joint Convention context in the U.S. More information is provided in the following subsections corresponding to each of the entries in Table D-6.

D.5.1 USDOE Sites with Decommissioning/Remediation Projects

The U.S. has a large legacy of radioactive waste resulting from past government activities and events that span nearly half a century. There are a total of 114 geographic sites composed of over 2 million acres of land used by the U.S. Government for nuclear research and development and nuclear weapons production activities. To date, 75 of these geographic sites have been completed. Most of the land at these sites is not contaminated, but within the boundaries of the geographic sites are numerous

Table D-6. Summary of Decommissioning Activities in Progress.

Sector	Type	Number
Government	USDOE Nuclear/Radioactive Facilities for which Decommissioning is Ongoing or Pending	1186
Government/Commercial	Formerly Utilized Sites Remedial Action Program (FUSRAP)	26
Government/Commercial	Decommissioning Materials Sites	41
Commercial	Nuclear Power Plants	23
Commercial	Other Non-Power Reactor Facilities	15

radiological-controlled areas with thousands of individual facilities and remediation sites. To date just over 5,000 remediation sites have been completed at USDOE facilities, and another 5,400 remain.

Some USDOE sites, such as Rocky Flats, are located nearby and adjacent to growing suburban neighborhoods, while others are secluded and many remain kilometers from any community. The U.S. government at its facilities continues to safeguard nuclear materials, dispose of waste, remediate extensive surface and groundwater contamination, and deactivate and decommission thousands of excess contaminated facilities. Annex D-9 shows a summary of the remaining 1186 nuclear/radioactive facility decommissioning projects, and also a summary of remaining remediation projects at the USDOE sites undergoing cleanup.

Some of the large decommissioning projects currently in progress are:

- Brookhaven Graphite Research Reactor,
- Rocky Flats plutonium processing buildings,
- Plutonium Finishing Plant at the Hanford Site,
- Fast Flux Test Facility at the Hanford Site,
- East Tennessee Technology Park, K-25 and K-27 buildings, and
- Alpha-4 Building at Oak Ridge Y-12 Complex.

D.5.2 Formerly Utilized Sites Remedial Action Program

During the 1940s, 1950s, and 1960s, work was performed at sites throughout the United States as part of the nation's early atomic energy program. Some sites' activities can be traced back as far as World War II and the Manhattan Engineer District (MED). Other sites were involved in peacetime activities under the USAEC. Most sites that became contaminated during the early atomic energy program were cleaned up under the guidelines in effect at the time. Generally, those cleanup guidelines were not as strict as today's, so trace amounts of radioactive materials remained at some of the sites. Over the years, contamination was spread to other locations, either by demolition of buildings, intentional movement of materials, or by natural processes.

The USDOE established the Formerly Utilized Sites Remedial Action Program (FUSRAP) in 1974 to study these sites and take appropriate cleanup action. When contamination is suspected at a site, old records are reviewed and the site is surveyed. If contamination is found that is connected to a MED or USAEC activity, cleanup is authorized under FUSRAP. The U.S. Congress also added some sites to FUSRAP with industrial contamination similar to that produced by MED or USAEC activities. The Energy and Water Development Appropriations Act for Fiscal Year 1998, P.L. 105-62, signed into law on October 13, 1997, transferred responsibility for the administration and execution of FUSRAP from the USDOE to the U.S. Army Corps of Engineers (USACE). The USACE contract strategy concentrates on individual site-specific remediation contracts. The USACE pursues more efficient remedial actions through the use of performance-based specifications using fixed-price and cost-type contracts, as appropriate.

The contaminants at FUSRAP sites are primarily low levels of uranium, thorium, and radium, with their associated decay products. None of these sites pose an immediate threat to human health or the environment. When materials containing low levels of radioactive residues are excavated they are packaged and transported for disposal at licensed commercial disposal sites, such as Envirocare of Utah, or to hazardous waste landfills, as appropriate. Annex D-10 provides a listing of FUSRAP sites where remediation is ongoing.

D.5.3 Complex Licensed Materials Sites Decommissioning (USNRC)

The USNRC regulates the decontamination and decommissioning of materials and fuel cycle facilities, power reactors, research and test reactors, and uranium mill tailings facilities, with the ultimate goal of license termination. Approximately 300 materials licenses are terminated each year. Most of these license terminations are routine, and the sites require little, if any, remediation to meet USNRC's unrestricted release criteria. The decommissioning program includes termination of licenses that are not routine because the sites involve more complex decommissioning activities.

Annex D-11 provides a list of 41 materials sites subject to decommissioning. Ten of these have been transferred to state or other Federal agencies. The USNRC is currently committed to terminating one site from the list of material sites under decommissioning each year.

D.5.4 Power and Non-Power Reactor Decommissioning

Over the last year the USNRC has been reviewing decommissioning plans for 18 nuclear power plant reactors; examples of these include: Maine Yankee, Saxton, Connecticut Yankee, and Big Rock Point. Over the same time period, 12 research and test reactors were issued decommissioning orders or amendments by USNRC. Additionally, four research and test reactors are in "possession-only" status, either waiting for shutdown of another research or test reactor at the site or removal of the spent fuel from the site by the USDOE. Annexes D-8 and D-12 list these sites.

D.5.5 Other Non-Power Facility Decommissioning

The USNRC continues to work closely with the states and USEPA to regulate remediation of unused portions of fuel cycle facilities. In 2002, one conversion facility (Honeywell), two Navy fuel manufacturers (BWX Technologies and Nuclear Fuel Services), and four commercial fuel manufacturers (Framatome Richland, General Atomics, Westinghouse Hematite, and ABB Windsor) had decommissioning activities in progress.

E. LEGISLATIVE AND REGULATORY SYSTEMS

E.1 Legislative System

The national policy on regulatory control of radioactive waste management in the U.S. has evolved through a series of laws that established the Federal governmental agencies responsible for the safety of radioactive materials as described in Section A. In the U.S., Federal legislation is enacted by the U. S. Congress and signed into law by the President. Laws of the nation apply to all 50 states and territories. Legislation on matters related to safety of spent fuel and radioactive waste can be traced back for 5 decades. Table E-1 provides a summary of the legislation mentioned below.

In 1954, the U.S. Congress passed legislation that for the first time permitted the wide use of atomic energy for peaceful purposes. The 1954 Atomic Energy Act (AEA) legislation redefined the atomic energy program by ending the government monopoly on technical data and making the growth of a private commercial nuclear industry an urgent national goal.

The three types of regulated nuclear materials are:

- Special nuclear material—consists of uranium-233 or uranium-235, enriched uranium, or plutonium,

- Source material—natural uranium or thorium, or depleted uranium that is not suitable for use as reactor fuel, and

- Byproduct material—generally, nuclear material (other than special nuclear material) that is produced or made radioactive in a nuclear reactor. Also the tailings and waste produced by extraction or concentration of uranium or thorium from an ore processed primarily for its source material content.

The Atomic Energy Act directed the USAEC "...to encourage widespread participation in the development and utilization of atomic energy for peaceful purposes." At the same time, it instructed the USAEC to prepare regulations that would protect public health and safety from radiation hazards. Thus, the 1954 Act assigned the USAEC three major roles: to continue its weapons program, to promote the private use of atomic energy for peaceful applications, and to protect public health and safety from the hazards of commercial nuclear power.

In 1969, Congress passed the National Environmental Policy Act (NEPA), which among other things established a national policy for the environment and provided for the establishment of the Council on Environmental Quality. Subsequently, the USEPA was created in 1970. At that time, USEPA was given AEA authority for setting generally applicable standards for radioactivity in the environment outside the boundaries of USAEC-owned facilities. A separate statute, the Waste Isolation Pilot Plant Land Withdrawal Act (WIPP LWA) provides USEPA authority to periodically certify that WIPP meets USEPA generally applicable standards (40 CFR Part 191). In addition, under provisions of two

Table E-1. Key U.S. Policy Laws Governing Radioactive Waste Management

Atomic Energy Act of 1954, as amended, established the Atomic Energy Commission, the predecessor to the USNRC and USDOE, with Federal responsibility to regulate the commercial use of nuclear materials, byproducts and sources including the regulation of civilian nuclear reactors. Under Reorganization Plan No. 3 of 1970, which created USEPA, authority to establish generally applicable environmental standards was transferred to USEPA.

National Environmental Policy Act (NEPA) of 1969, as amended, requires Federal agencies to consider environmental values and factors in agency planning and decision-making. Full compliance with the letter and spirit of the NEPA, the U.S. national charter for protection of the environment, is an essential priority for USEPA, Council on Environmental Quality, USDOE and USNRC.

Energy Reorganization Act of 1974, as amended, established the USNRC and ERDA – the predecessor of USDOE.

Uranium Mill Tailings and Radiation Control Act of 1978, as amended, vested the USEPA with overall responsibility for establishing health and environmental cleanup standards for uranium milling sites and contaminated vicinity properties, the USNRC with responsibility for licensing and regulating uranium production and related activities, including decommissioning, and USDOE with responsibility for long-term monitoring of the decommissioned sites. Uranium recovery and tailings disposal sites are divided into two categories: Title I dealing with USDOE-remedial action programs of former mill tailings sites in which all or substantially all of the uranium was produced for sale to any Federal agency prior to January 1971 under a contract with any Federal agency; and Title II dealing with non-USDOE mill tailings sites; and *in-situ* leach uranium solution mining sites licensed by the USNRC or an Agreement State according to USNRC regulations.

Low-Level Radioactive Waste Policy Act of 1980 and the Low-Level Radioactive Waste Policy Amendments Act of 1985 authorized the states – rather than the Federal Government – responsibility to provide additional disposal capacity for commercial LLW from regional compacts (groups of states) for the safe disposal of such LLW; and decide whether to exclude waste generated outside a Compact. The Act also provided a system of milestones, incentives, and penalties to encourage states and regional compacts to be responsible for their own LLW.

The U.S. Congress authorized WIPP in the National Security and Military Applications of Nuclear Energy Authorization Act of 1980 (Public Law 96-164). Section 213 (a) of the Act authorizes WIPP "for the express purpose of providing a research and development facility to demonstrate the safe disposal of radioactive wastes resulting from defense activities and programs of the United States exempted from regulation by the Nuclear Regulatory Commission."

The West Valley Demonstration Act of 1980 authorized the USDOE to conduct a technology demonstration project for solidifying HLW, disposing of waste created by the solidification, and decommissioning the facilities used in the process. The Act required the USDOE to enter into an agreement with the State of New York for carrying out the Project.

Nuclear Waste Policy Act of 1982 (NWPA) and the Nuclear Waste Policy Amendments Act of 1987 (NWPAA) provide for the siting, construction, and operating of a deep geologic repository that could be used to dispose of spent fuel and HLW. Any such repository would be licensed by the USNRC. Pursuant to the NWPA, the Secretary of Energy, the President, and the U.S. Congress have acted to designate Yucca Mountain as the site of the first such repository. The USDOE is preparing a license application for submission to the USNRC to receive authorization to begin construction of a repository at Yucca Mountain. The USNRC will review this license pursuant to 10 CFR Part 63.

Waste Isolation Pilot Plant Land Withdrawal Act (WIPP LWA) of 1992, as amended withdraws land from the public domain for operation of the Waste Isolation Pilot Plant. Defines operational limitations and the role of the U.S. Environmental Protection Agency and the U.S. Mine Safety and Health Administration. Exempts TRU mixed waste destined for disposal at WIPP from treatment requirements and land disposal prohibitions under the Solid Waste Disposal Act. Includes provisions for economic assistance to the State of New Mexico. The Act also defines transportation and emergency preparedness requirements pertaining to WIPP, including USNRC certification of WIPP shipping containers. The Act provides for USEPA continuing regulatory role at WIPP, including recertification that WIPP meets USEPA standards.

Energy Policy Act (EnPA) of 1992 mandated a new and different process for developing the HLW disposal regulations for the proposed repository at Yucca Mountain, Nevada. Congress, through EnPA, directed the NAS to evaluate the scientific basis for a Yucca Mountain standard, and directed USEPA to promulgate site-specific public health and safety standards based on and consistent with the findings and recommendations of the NAS. Once the final standards are promulgated by USEPA, the EnPA directs the USNRC staff to modify its technical requirements to conform to the new USEPA standards.

major environmental statutes, the Clean Air Act and the Safe Drinking Water Act, USEPA has the responsibility for regulating and enforcing the levels of radioactivity in air emissions and in drinking water. Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), USEPA can determine soil cleanup values and other residual radioactivity limits at contaminated sites where there are releases or potential for releases of hazardous substances into the environment. USEPA also has authority to provide Federal guidance on radiation protection matters that affect public health.

In 1974, U.S. Congress passed the Energy Reorganization Act, which separated the USAEC into the USNRC and ERDA, predecessor of the USDOE. Additional legislation further defined the roles of the USNRC and the USDOE and introduced a role for the states through the Low-Level Radioactive Waste Policy Act of 1980 (LLWPA) and the Low-Level Radioactive Waste Policy Amendments Act of 1985 (LLWPAA). This legislation assigned to the states, rather than the U.S. Government, the responsibility to provide additional disposal capacity for commercial LLW.

With regard to HLW, the NWPA and the NWPAA provide for the siting, construction, and operating of a deep geologic repository that could be used to dispose of spent fuel and HLW. Any such repository would be licensed by the USNRC. Pursuant to the NWPA, the Secretary of Energy, the President, and the U.S. Congress have acted to designate Yucca Mountain as the site of the first such repository. The USDOE is preparing a license application for submission to the USNRC to receive authorization to begin

construction of a repository at Yucca Mountain. The USNRC will review this license pursuant to 10 CFR Part 63.

NWPA defined the relationship between the Federal Government and the state governments with respect to the disposal of such waste, and established:

- A schedule for the siting, construction, and operation of repositories that will provide a reasonable assurance that the public and the environment will be adequately protected from the hazards posed by HLW as may be disposed of in a repository;

- The disposal of such waste as a matter of Federal policy, and;

- The creation of a Nuclear Waste Fund, composed of payments made by the generators and owners of such waste, that will ensure that the costs of carrying out activities relating to the disposal of such waste will borne by the persons responsible for generating such waste.

In 1987, Congress amended NWPA through NWPAA. The major elements were:

- Creation by the U.S. Congress of the Nuclear Waste Technical Review Board (NWTRB) as an independent agency;

- Establishment of a Nuclear Waste Negotiator;

- Direction to USDOE to study (characterize) only the Yucca Mountain site;

- Requirement for a report to Congress between 2007 and 2010 on the need for a second repository; and

- Consultative role of the USNRC during the site characterization process, on which the USDOE makes a recommendation of a potential site as a candidate for a geologic repository.

The Energy Policy Act (EnPA) of 1992 mandated a new and different process for developing the HLW disposal standards for the proposed repository at Yucca Mountain, Nevada. The U.S. Congress, through EnPA, directed the National Academy of Sciences (NAS) to evaluate the scientific basis for a Yucca Mountain standard, and directed USEPA to promulgate new public health and safety standards based on and consistent with the findings and recommendations of the NAS. Moreover, once the final standards were promulgated, EnPA directed the USNRC staff to modify its technical requirements to conform to the new USEPA standards. EnPA directed the NAS to provide USEPA with recommendations on the following issues:

- Whether health-based standards based on doses to individual members of the public from releases to the accessible environment will provide a reasonable standard for protection of the health and safety of the general public;

- Whether it is reasonable to assume that a system of post-closure oversight of the repository can be developed, based on active institutional controls, that will prevent an unreasonable risk of breaching the repository's engineered or

geologic barriers or increasing the exposure of individual members of the public to radiation beyond allowable limits, and

- Whether it is possible to make scientifically supportable predictions of the probability that the repository engineered or geologic barriers will be breached as a result of human intrusion over a period of 10,000 years.

After the end of fiscal year 2001, the regulatory framework was finalized. USEPA finalized its radiation protection standards and issued the final rule, 40 CFR Part 197, on June 13, 2001. The standards are designed to protect individuals in the accessible environment outside a Yucca Mountain repository by establishing maximum levels that are within USEPA acceptable risk range for radiation dose limits.

As directed by the EnPA, the USNRC role is to implement the public health and safety standards established by USEPA in any licensing process USNRC may conduct for a repository at Yucca Mountain. USNRC finalized its licensing criteria and published the final 10 CFR Part 63 on November 2, 2001, incorporating USEPA public health and environmental standards. USDOE issued its final repository site suitability guidelines, "General Guidelines for the Recommendation of Sites for Nuclear Waste Repositories; Yucca Mountain Site Suitability Guidelines," 10 CFR Part 963, on November 14, 2001. The USDOE used the guidelines in 10 CFR Part 963 to determine whether the proposed Yucca Mountain site is suitable for development as a repository. A licensing process involving an adjudicatory hearing will result in a determination by the USNRC regarding authorization to construct a repository at the proposed Yucca Mountain site. Prior to the start of repository operation, the USNRC must make another determination regarding authorization to receive and possess waste at the repository.

E.2 Regulatory System

The regulatory system for spent fuel and radioactive waste management in the U.S. involves several agencies. The key agencies are the USNRC, which regulates the commercial nuclear sector, the USEPA which regulates under authority of the environmental statutes, and the USDOE which regulates its government programs, except as specifically mandated by law. A detailed description of the regulatory functions of these agencies is described in subsections below. In accordance with the AEA, certain USNRC regulatory functions are relinquished to some of the 50 states within the U.S., designated as Agreement States. This is the case for operating commercial LLW disposal sites and uranium mill tailings sites, which includes regulatory authority over the disposal of the tailings. Some states have regulatory authority delegated to them by the USEPA, such as for discharges of certain industrial or mining practices.

In addition to the three primary Federal agencies, two independent boards provide oversight to various radioactive waste programs. These are the NWTRB, which provides independent scientific and technical oversight of the HLW disposal program of USDOE program and is described below, and the Defense Nuclear Facilities Safety Board, which provides oversight to all USDOE defense-related activities and also is

described below. Also, the Advisory Committee on Nuclear Waste provides advice to the USNRC on technical waste related issues.

The applicable general regulations for the each of the three Federal Agencies principally responsible for radioactive waste regulation are contained in Title 10 (for USNRC and USDOE) and Title 40 (for USEPA) of the U.S. Code of Federal Regulations (CFR), which is published annually. U.S. Government regulations are developed through an open process, including the opportunity for public comment, and are published daily, in proposed or final forms, in the Federal Register. A listing of specific regulations for each Agency is provided in Table E-2. Copies of these regulations are available in print and electronically[i].

Table E-2. Spent Fuel and Radioactive Waste Management Regulations

U.S. Nuclear Regulatory Commission

10 CFR Part 20, "Standards for protection against radiation"

10 CFR Part 30, "Rules of general applicability to domestic licensing of byproduct material"

10 CFR Part 40, "Domestic Licensing of Source Material"

10 CFR Part 51, "Environmental protection regulations for domestic licensing and related regulatory functions"

10 CFR Part 60, "Disposal of High-Level Radioactive Wastes in Geologic Repositories"

10 CFR Part 61, "Licensing Requirements for Land Disposal of Radioactive Waste"

10 CFR Part 62, "Criteria and Procedures for Emergency Access to Non-Federal and Regional Low Level Waste Disposal Facilities"

10 CFR Part 63, "Disposal of High-Level Radioactive Wastes in a Geologic Repository at Yucca Mountain, Nevada"

10 CFR Part 70, "Domestic Licensing of Special Nuclear Material"

10 CFR Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste"

10 CFR Part 73, "Physical Protection of Plants and Materials"

10 CFR Part 75, "Safeguards on Nuclear Material Implementation of US/IAEA Agreement"

10 CFR Part 76, "Certification of Gaseous Diffusion Plants"

10 CFR Part 110, "Export and Import of Nuclear Equipment and Material"

[i] Electronic versions of the Code of Federal Regulations are available on the internet at: http://www.access.gpo.gov/nara/cfr/index.html

Table E-2. Spent Fuel and Radioactive Waste Management Regulations

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 960, "General Guidelines for the Recommendation for Sites for Nuclear Waste Repositories"

10 CFR Part 963, "General Guidelines for the Recommendation of Sites for Nuclear Waste Repositories: Yucca Mountain Site Suitability Guidelines”

10 CFR 830, “Nuclear Safety Management”

10 CFR 835, “Occupational Radiation Protection”

10 CFR 1021, “National Environmental Policy Act Implementing Regulation”

The following USDOE Orders are applicable to safety:

- Order 151.1A, “Comprehensive Emergency Management System”
- Order 231.1, Change 2, “Environment, Safety, and Health”
- Order 232.1A, “Occurrence Reporting and Processing of Operations Information”
- Order 360.1B, “Federal Employee Training”
- Order 414.1A, “Quality Assurance”
- Order 420.1A, “Facility Safety”
- Guide 421.1-2; Guide 423.1-1; DOE Guide 424.1-1, “Implementation Guides for 10 CFR 830”
- Order 425.1B, “Startup and restart of Nuclear Facilities”
- Order 430.1A, “Life Cycle Asset Management”
- Order 433.1, “Maintenance Management Program”
- Order 435.1, “Radioactive Waste Management,” (Manual and Implementation Guide, M 435.1-1 and G 435.1-1)
- Order 440.1A, Change 3, “Worker Protection Management for DOE Federal and Contractor Employees”
- Order 470.2A, “Security and Emergency Management Independent Oversight and Performance Assurance Program”
- Order 5400.1, “General Environmental Protection Program”
- Order 5400.5, Change 2, “Radiation Protection of the Public and the Environment”
- Order 5480.2A, “Personnel Selection, Qualification, and Training Requirements for USDOE Nuclear Facilities”

U.S. Environmental Protection Agency

40 CFR Part 61, “National Emission Standards for Hazardous Air Pollutants”

- Subpart B, radon from underground uranium mines,
- Subpart H, radionuclide emissions, other than radon, from USDOE facilities,

Table E-2. Spent Fuel and Radioactive Waste Management Regulations
• Subpart I, radionuclide emissions from federal facilities other than USDOE or NRC licensed facilities, • Subpart K, radionuclide emissions from elemental phosphorus plants, • Subpart Q, radon from USDOE facilities, • Subpart R, radon from phosphogypsum stacks, • Subpart T, radon from disposal of mill tailings, and • Subpart W, radon from tailings at operating mills. 40 CFR Part 191, "Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes" 40 CFR Part 192, “Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings” 40 CFR Part 194, "Criteria for the Certification and Re-Certification of the Waste Isolation Pilot Plant's (WIPP) Compliance with the 40 CFR Part 191 Disposal Regulations" 40 CFR Part 197, "Public Health and Environmental Radiation Protection Standards for Yucca Mountain, Nevada" Title 40, Code of Federal Regulations relating to radiation protection include: • Part 141, “National Primary Drinking Water Regulations,” • Part 147, “State Underground Injection Control Programs,” • Part 148, “Hazardous Waste Injection Restrictions,” • Part 195, “Radon Proficiency Programs,” • Parts 220 and 133, “Ocean Dumping,” • Part 300, “National Oil and Hazardous Substances Pollution Contingency Plan,” • Part 302, “Designation, Reportable Quantities, and Notification,” and • Part 440, “Ore Mining and Dressing Point Source Category (Uranium, Radium, and Vanadium Ores subcategory).”

E.2.1 U.S. Nuclear Regulatory Commission

The USNRC is an independent regulatory agency established by the Congress under the Energy Reorganization Act of 1974 to ensure adequate protection of the public health and safety and the environment and to promote the common defense and security in the civilian use of nuclear materials. The USNRC scope of responsibility includes regulation of:

- Commercial nuclear power; non-power research, test, and training reactors;
- Fuel cycle facilities; medical, academic, and industrial uses of nuclear materials; and
- Transport, storage, and disposal of nuclear materials and waste.

The USNRC regulates manufacture, production, transfer, receiving, acquisition, ownership, possession, and use of commercial radioactive materials, including waste. The scheme of regulation can be viewed as depicted in Figure E-1.

This diagram gives an overview of USNRC regulatory process, which has five main components:

- Developing regulations and guidance for applicants and licensees,
- Licensing or certifying applicants to use nuclear materials or operate nuclear facilities,
- Inspecting licensee operations and facilities to enforce that licensees comply with safety requirements, which includes holding hearings to address the concerns of parties affected by agency decisions,
- Evaluating operational experience at licensed facilities or involving licensed activities, and
- Conducting research and obtaining independent reviews to support regulatory decisions.

The USNRC regulates waste in 3 broad classification types as described is Section B:

- LLW - includes radioactively contaminated protective clothing, tools, filters, rags, medical tubes, and many other items.
- HLW – includes "irradiated" or spent fuel (spent fuel is classified in the broader context of HLW in USNRC regulations)
- Uranium Mill Tailings - the residues remaining after the processing of natural ore to extract uranium and thorium.

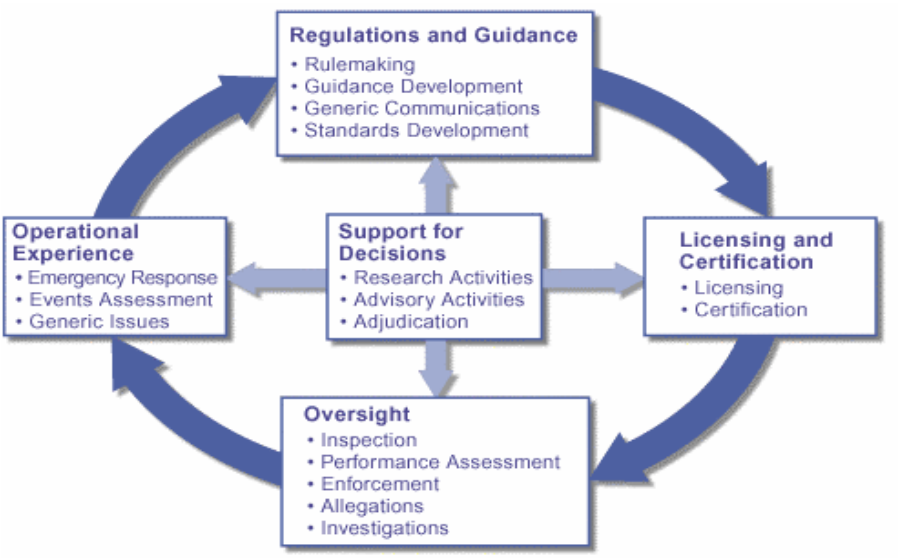


Figure E-1. The USNRC Regulatory Process

The following activities are key components of the USNRC regulatory program.

Regulations and Guidance

- Rulemaking-Ruleforum—developing and amending regulations that licensees must meet to obtain or retain a license or certificate to use nuclear materials or operate a nuclear facility.

- Guidance Development—developing and revising guidance documents, such as regulatory guides, standard review plans, and the USNRC Inspection Manual to provide guidance to USNRC staff for implementing regulations and acceptable approaches to licensees in meeting safety requirements.

- Generic Communications—sending applicants and licensees information about events or requests for information from licensees.

- Standards Development—working with industry standards organizations to develop consensus standards associated with systems, equipment, or materials used by the nuclear industry so that these standards may be referenced in USNRC regulations or guidance or where industry standards are not available, developing standards with public involvement.

Licensing and Certification

- Licensing - authorizing an applicant to use or transport nuclear materials or to operate a nuclear facility (includes new licenses, renewals, amendments, transfers and related Topical Reports).

- Certification - authorizing an applicant to manufacture spent fuel casks, transportation packages for nuclear materials, and sealed sources and devices and authorizing an applicant to operate a gaseous diffusion plant.

Oversight

- Inspection - verifying that a licensee's activities are properly conducted to ensure safe operations in accordance with USNRC regulations.

- Enforcement - issuing sanctions to licensees who violate USNRC regulations.

- Assessment of Performance - determining appropriate agency action from reviews of licensee performance documented in inspection reports.

- Allegations- responding to reports of wrongdoing by USNRC licensees, applicants for licenses, or licensee contractors or vendors.

- Investigations - investigating wrongdoing by USNRC licensees.

Operational Experience

- Emergency Response - leading and coordinating USNRC response to safety-related incidents in accordance with their severity.

- Events Assessment - daily review and long term trend analysis of accidents and other reportable incidents to determine the appropriate regulatory response.

- Generic Issues - identifying and resolving safety issues that affect more than one licensed facility.

Support for Decisions

- Research - experiments, technical studies, and analyses to help USNRC make realistic decisions, assess the safety significance of potential technical issues, and prepare the agency for the future by evaluating potential safety issues involving new designs and technology.

- Advisory Activities - review and independent assessment of regulatory proposals by independent advisory bodies reporting to or chartered by the USNRC.

- Adjudication- listening to concerns of parties affected by licensing or enforcement actions in a legal setting.

The regulatory system established by the USNRC has its authority in legislation listed in Table E-1. To fulfill this agency's Congressionally mandated mission, the USNRC has established licensing procedures for regulating the use of byproduct, source, and special nuclear materials. Specifically, the goals for radioactive waste management are to: ensure treatment, storage, and disposal of waste produced by civilian use of nuclear materials in ways that do not adversely affect future generations; and to protect the environment in connection with civilian use of source, byproduct, or special nuclear materials through the implementation of the AEA and NEPA.

The USNRC conducts licensing and inspection activities associated with domestic nuclear fuel cycle facilities, uses of nuclear materials, transport of nuclear materials, management and disposal of LLW and HLW, and decontamination and decommissioning of facilities and sites. USNRC also is responsible for establishing the technical basis for regulations, and provides information and technical basis for developing acceptance criteria for licensing reviews.

An important aspect of the USNRC regulatory program is its inspection and enforcement activities. The USNRC has four regional offices (Region I in King of Prussia, Pennsylvania; Region II in Atlanta, Georgia; Region III in Lisle, Illinois; and Region IV in Arlington, Texas), that conduct inspections of licensed facilities including nuclear waste facilities. USNRC also has an Office of State and Tribal Programs, which establishes and maintains communication with state and local governments and Tribes, and administers the Agreement States Program. An Agreement State is a state that has signed an agreement with the USNRC allowing the State to regulate the use of radioactive material within that State, consistent with the USNRC regulations. Out of the 50 states, 32 are Agreement States.

USNRC issues guidance on how to implement its regulations in the form of Regulatory Guides, NUREGs, and Staff Positions. The USNRC staff develops Regulatory Guides to establish a standard approach to licensing. They are not intended to be regulatory requirements, but they do reflect methods, procedures, or actions, which would be considered acceptable by the staff for implementing specific parts of USNRC regulations.

Regulatory Guides (NUREGs) describe the standard format and content for license applications. Staff Positions are divided into two general types: so-called “generic” positions, dealing with issues which relate to licensing activities for nuclear facilities independent of the technology or site selected; and site-specific positions, which give site guidance or advice applicable to a specific site. A listing of guidance issued by USNRC is provided in Annex E-1. In addition to the guidance, the USNRC staff uses Standard Review Plans, which provide guidance to the USNRC staff in reviewing licensee submittals. These plans are made public, so that licensees and applicants understand what is needed to comply with regulations. In this respect, the licensees and applicants have this third type of guidance to assist them in preparing their demonstration of compliance with the applicable regulations and standards.

Important guidance for radiation protection programs is provided in International Commission on Radiation Protection (ICRP) and the National Council on Radiation Protection and Measurements (NCRP) technical guidelines (See Section F.10). Applicable recommendations are cited in USNRC staff documents, which focus on dose assessments.

E.2.1.1 Uranium Recovery Regulation

UMTRCA charged the USEPA with the responsibility for issuing generally applicable standards for control of uranium mill tailings. In 1983, USEPA issued standards for both Title I and Title II sites. The Title I program established a joint federal/state funded program for remedial action at abandoned mill tailings sites, with ultimate Federal ownership under license from USNRC. Under Title I USNRC must evaluate USDOE designs and concur that USDOE actions meet standards set by USEPA. Recently the Atlas site (Moab, Utah) was designated a Title I site and will undergo surface remedial action. For all other Title I sites, only reviews for the groundwater remedial action program remain, as all surface remedial action was completed in fiscal year 1999. USNRC and USDOE have a memorandum of understanding to minimize or eliminate unnecessary duplication of effort between the two agencies.

The USNRC staff is responsible for planning and implementing the regulatory programs under UMTRCA. The Title I (of UMTRCA) program involves managing, coordinating, and conducting the safety and environmental reviews of remediation activities and the review and concurrence of documents related to the cleanup and licensing of abandoned uranium mill tailings sites.

In November of 1985, as mandated by UMTRCA, USNRC changed its regulations in 10 CFR Part 40, Appendix A, to be consistent with USEPA Title II standards. Since 1985, various changes have been made to Part 40 for the Title II sites. In 1995, USEPA issued final Title I UMTRCA ground water standards.

The Title II (of UMTRCA) program involves planning and directing the activities related to active, licensed uranium recovery facilities, including facility licensing and operation, as well as mill tailings management and decommissioning. The Title II program deals with sites under license to the USNRC or Agreement States. Under Title II USNRC has the authority to control radiological and non-radiological hazards and ensure that USNRC—and Agreement State—licensed sites meet all applicable standards and requirements during operations and before termination of the license. The staff reviews Title II licensee plans for operation, reclamation, decommissioning, and ground-water corrective action; license applications and renewals; license conditions changes; and annual surety up-dates. The staff also prepares environmental assessments for certain licensing actions. Long-term care of reclaimed tailings sites (by a state or USDOE) is licensed by the USNRC under general licenses at 10 CFR Part 40.27 (for Title I sites) and 40.28 (for Title II sites).

Specific USNRC staff activities under the (UMTRCA) encompass the following:

- Oversight and programmatic direction for the uranium recovery program;
- Implementation of policies and programs; and
- Review of uranium recovery licensing and inspection programs for technical adequacy and consistency.

The USNRC also provides technical assistance to Agreement States on uranium recovery issues and implements an active interface program including ongoing consultation with Federal agencies, states, Indian tribes, and other entities to promote understanding of uranium programs and to resolve concerns in a timely manner.

E.2.1.2 HLW Regulation

The USNRC is the regulator for disposal of HLW. In its Strategic Plan, the USNRC has committed itself in the HLW area to:

- Prepare to review a potential USDOE license application for a HLW repository at a pace consistent with the national program;

- Participate in the development of a practical and implementable HLW radiation safety standard, which it has done. USNRC will implement the HLW radiation standard through site-specific, risk-informed and performance (assessment)-based regulation;

- Focus on resolving the key technical issues that are considered most important to the potential performance of any Yucca Mountain repository to provide early feedback to USDOE on potentially significant site, design, or assessment flaws as they are identified during the site characterization; and

- Increase public confidence.

On June 13, 2001, the USEPA issued final standards for Yucca Mountain at 40 CFR 197. On November 2, 2001, USNRC published conforming licensing regulations at 10 CFR Part 63. In preparing its final regulations, USNRC considered: (1) the insights acquired from international guidelines for regulation of HLW disposal; (2) USNRC and USDOE performance assessments; (3) the results of systematic analyses of the existing regulations; (4) advances in the incorporation of uncertainty in risk-informed decision-making; and (5) a large amount of site-specific information, for Yucca Mountain, all of which have become available since Part 60 was developed.

The USNRC regulations contain risk-informed, performance-based criteria for both pre-closure operations and post-closure performance of the proposed geologic repository for spent fuel and HLW at Yucca Mountain, Nevada. The USEPA standards and USNRC regulations are generally consistent with recommendations of the NAS and with national and international recommendations for radiation protection standards. The USNRC regulatory program for HLW disposal is currently focused on prelicensing activities and on activities to determine how it will regulate the HLW repository throughout its lifecycle if a license is issued to the USDOE

The USNRC site characterization review included identifying specific concerns that may impact licensing. The USNRC observed and commented on USDOE plans for repository surface and subsurface facilities, quality assurance program, site characterization, evaluations of potential performance, and related activities.

Prelicensing activities with the USDOE are conducted under a formal prelicensing agreement and are open to participation by the states, Indian Tribes, local governments, industry, and other stakeholders.

The Licensing Support Network (LSN) is intended to support USNRC in meeting a Congressional mandate that the USNRC reach a determination in 3 years on the USDOE application for construction authorization for a repository proposed at Yucca Mountain, Nevada. The LSN provides a single place where the parties and potential parties to the licensing hearing can search for documents from any/all of those collections in a uniform way. The LSN is codified in 10 CFR 2, Subpart J. To shorten the time spent on the exchange of documents that may be used as evidence in the USNRC licensing proceeding, the parties and potential parties to the hearing on the USDOE application will make their documents available via the LSN (an Internet-accessible system) before the USDOE license application is submitted to the USNRC.

E.2.1.3 LLW Regulation

Similarly in the Strategic Plan, the USNRC has committed itself in the LLW area to:

- Maintain a consistent national program;
- Provide support to states, as requested, to resolve specific technical issues;
- Review requests for onsite disposal; and
- Increase public confidence.

In the late 1980s and early 1990s, states were in various stages of forming compacts and siting and trying to license LLW disposal facilities in an attempt to meet the milestones of LLWPAA. To ensure that the USNRC would be able to meet its statutory requirements of reviewing a license application within 15 months after an application was received, the USNRC Commissioners directed staff to develop a plan for developing and enhancing staff ability to conduct a performance assessment of an LLW disposal facility. In response, staff proposed a plan that included developing guidance on conducting performance assessments of LLW disposal facilities.

In October 2000, the staff published a final report, "A Performance Assessment Methodology for Low-Level Radioactive Waste Disposal Facilities: Recommendations of USNRC 's Performance Assessment Working Group" (NUREG-1573). Prior to its finalization, the staff issued a preliminary draft of the report and distributed it to all Agreement States, the USNRC Advisory Committee on Nuclear Waste (ACNW), USDOE, USEPA, and the U.S. Geological Survey. The staff held public workshops with the states, other Federal agencies, and the ACNW and made revisions to the report based on comments received at those workshops. The staff also conducted a performance assessment of a "mock" LLW disposal facility to test approaches, gain additional insights in resolving key issues, and enhance staff performance assessment capabilities. No new LLW disposal facility has been licensed.

E.2.1.4 Decommissioning Regulation

Under USNRC regulations, decommissioning involves safely removing a USNRC-licensed facility from service and reducing residual radioactivity to a level that permits the property to be released for unrestricted or restricted use. This action is taken by a licensee before termination of the license. In other cases, non-licensed facilities may also be required to decontaminate and decommission the site in order to meet USNRC release limits. Table E-3 lists the performance goals for measuring results toward meeting USNRC nuclear waste safety and environmental protection goals. This activity comprises USNRC's integrated regulation of the decontamination and decommissioning of facilities and sites associated with USNRC-licensed activities, including associated research, rulemaking efforts, and the technical interface with EPA to resolve issues of mutual interest.

In July 1998, the USNRC Commissioners directed their staff to prepare various guidance documents in support of the “Final Rule on Radiological Criteria for License Termination.” As a result, the staff has completed, and is developing several other guidance documents that will help licensees prepare decommissioning documents and provide the staff with uniform criteria for reviewing licensee submittals. The staff published NUREG-1727, "NMSS Decommissioning Standard Review Plan," in September 2000. The staff conducted several workshops with stakeholders to obtain input on the development of the Standard Review Plan. A list of the major decommissioning guidance documents (completed and under development) is presented in Annex E-2.

Table E-3. USNRC Safety and Environmental Protection Performance Goals

Protection of the environment from potential hazards associated with the civilian use of source, byproduct, and special nuclear materials involves actions to mitigate environmental impacts both during licensed activities and afterward. Prior to authorizing licensed activities, the USNRC ensures that potential environmental impacts of such activities are assessed consistent with the requirements of the National Environmental Policy Act (NEPA) as implemented by applicable USNRC regulations. In its Strategic Plan, the USNRC has set the following as its goal in nuclear waste safety: "Ensure treatment, storage, and disposal of wastes produced by civilian use of nuclear material in ways that do not adversely affect this or future generations."

Performance goals for measuring results toward meeting the USNRC nuclear waste safety goal:

- No significant accidental releases of radioactive material from storage and transportation of high-level waste (including spent fuel) or LLW.
- Establish the regulatory framework for high-level waste disposal, consistent with current national policy, as required by law after the legislatively required standard is issued.
- No offsite release of radioactivity beyond regulatory limits from LLW disposal sites.
- Performance goals for measuring results toward meeting USNRC environmental protection goal.
- Zero offsite releases from operating facilities of radioactive material that may have the potential to cause adverse impact on the environment, and no increase in the number of offsite releases from operating facilities of radioactive material that exceed USNRC acceptance criteria (i.e., limits set forth in 10 CFR Part 20).
- Environmental impacts have been identified through the NEPA process before regulatory action is taken.
- No sites will be released until satisfactorily remedied in accordance with USNRC release criteria.

E.2.1.5 Advisory Committee on Nuclear Waste

The Advisory Committee on Nuclear Waste (ACNW) was established in June 1988 to provide independent technical advice to the Commissioners of the USNRC on agency activities, programs, and key technical issues associated with USNRC regulation, management, and safe disposal of radioactive waste.

The ACNW interacts with representatives of the NRC, the Advisory Committee on Reactor Safeguards, other Federal, State, and local agencies, Indian tribes, the public, and other stakeholders, as appropriate, to fulfill its responsibilities. The bases for the committee's advice include the regulations governing high-level waste disposal, LLW disposal, and other applicable regulations and legislative mandates. The ACNW examines and reports on areas of concern as requested by the USNRC Commissioners and may undertake studies and activities on its own initiative, as appropriate.

The ACNW is independent of the USNRC staff and reports directly to the Commissioners of the USNRC, which appoints its members. The provisions of the Federal Advisory Committee Act govern the operational practices of the ACNW. Advisory committees are structured to provide a forum where experts representing many technical perspectives can provide independent advice that is factored into the Commissioners' decision-making process. Most advisory committee meetings are open to the public and any member of the public may request an opportunity to make an oral statement during the committee meeting.

E.2.2 U.S. Environmental Protection Agency

The USEPA has several regulatory functions associated with radioactive waste. These areas are described in more detail below.

E.2.2.1 Waste Isolation Pilot Plant Oversight

USEPA enforces its generally applicable radiation standards and provides oversight of the USDOE WIPP disposal facility for transuranic radioactive waste. The Waste Isolation Pilot Plant Land Withdrawal Act (WIPP LWA), requires the USEPA to issue final regulations regarding the disposal of spent fuel, HLW, and TRU waste. It also gave USEPA the authority to develop the criteria that implement the final radioactive waste disposal standards specifically for the WIPP. In addition, USEPA must determine whether or not the WIPP facility continues to be in compliance with 40 CFR Part 191 every 5 years. Finally, the WIPP LWA required USEPA to determine that the WIPP complies with other Federal environmental and public health and safety regulations, such as the Clean Air Act and the Solid Waste Disposal Act.

On December 20, 1993, USEPA issued final amendments to its radioactive waste disposal standards, which were initially promulgated in 1985 (40 CFR Part 191). The amendments address the individual and ground water protection requirements of the original standards which had been remanded by the U.S. Court of Appeals. The other portions of the standards were not remanded. The final individual protection requirements require disposal systems to be designed to limit the amount of radiation to which an individual can be exposed for 10,000 years, rather than for 1,000 years as was required in the original standard. The final ground water protection requirements require disposal systems to be designed so that, for 10,000 years after waste disposal, contamination in off-site underground sources of drinking water will not exceed the maximum contaminant level for radionuclides established by the USEPA under the Safe Drinking Water Act.

On February 9, 1996, USEPA issued final compliance criteria (40 CFR Part 194) for the certification and recertification of the WIPP compliance with the final radioactive waste disposal standards (40 CFR Part 191). The compliance criteria are divided into four subparts:

- Subpart A contains definitions of terms, references, and reporting requirements for USDOE. It also describes USEPA authority to modify, suspend, or revoke certification or recertification.

- Subpart B describes the format and content of the initial compliance certification and subsequent compliance re-certifications.

- Subpart C consists of requirements that apply to activities undertaken to demonstrate compliance with USEPA disposal standards. General requirements pertain to quality assurance, the use of computer models to simulate the WIPP performance, and other areas. Containment requirements limit releases of

radionuclides to specified levels for 10,000 years after the facility accepts its final waste for disposal. Assurance requirements involve additional measures intended to provide confidence in the long-term containment of radioactive waste. Also, Subpart C implements requirements in the disposal standards for protecting individuals and ground water from exposure to radioactive contamination.

- Subpart D describes the process for public participation that USEPA will follow for certification and recertification decisions.

USDOE submitted a Compliance Certification Application (CCA) to USEPA on October 29, 1996, to demonstrate that the WIPP complies with the criteria at 40 CFR Part 194. After receiving the CCA, USEPA published an Advance Notice of Proposed Rulemaking in the Federal Register that announced receipt of the application and initiated a 120-day public comment period. Copies of the application were made available to the public. Written comments were solicited, and public hearings were held. USEPA requested additional information from USDOE related to the completeness and technical sufficiency of the CCA. USEPA announced its finding that the CCA was complete in the Federal Register on May 22, 1997. USEPA published a Notice of Proposed Rulemaking in the Federal Register on October 30, 1997, announcing the proposed certification that the WIPP will comply with USEPA disposal standards. The proposed decision was accompanied by Compliance Application Review Documents that further explained the technical basis for the USEPA decision and contained USEPA responses to comments received on the Advance Notice of Proposed Rulemaking. The announcement of the proposal initiated a 120-day period in which the public commented on the Proposed Certification. During this comment period the Agency held public hearings. The USEPA Final Rulemaking Notice on the certification decision was announced on May 18, 1998 (95 FR 27354, May 18, 1998).

The USDOE is currently preparing an application for recertification of WIPP, which by statute is required every 5 years. The USEPA will review the application and respond accordingly through the rulemaking process.

The Office of Radiation and Indoor Air coordinates most of the USEPA actions under the WIPP LWA. However, other USEPA offices also play important roles in the regulation of WIPP. The USEPA Region VI office, based in Dallas, Texas, is responsible for determining WIPP compliance with all applicable environmental laws and regulations other than the radioactive waste disposal standards. The Region VI office also coordinates with the USEPA Office of Solid Waste on hazardous waste issues. Some TRU waste intended for disposal at the WIPP also contains hazardous components, thus subjecting it to the regulations developed under the Resource Conservation and Recovery Act of 1976 (RCRA), as amended.

In addition, the State of New Mexico is authorized by USEPA to carry out the State's base RCRA and mixed waste programs in lieu of the 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.

E.2.2.2 HLW Disposal Standards

The USEPA has the responsibility for developing HLW disposal standards and has issued 2 separate standards applicable to HLW. In 1993, USEPA issued the final amendments to complete its generally applicable standards for any land disposal of spent fuel, HLW and TRU waste at 40 CFR Part 191. These standards apply to WIPP, as described in the previous section, but do not apply to the proposed Yucca Mountain repository. The U.S. Congress enacted the Energy Policy Act (EnPA) of 1992 (Public Law 102-486) and mandated a new and different process for developing the HLW disposal regulations for the proposed repository at Yucca Mountain, Nevada. EnPA directed the NAS to evaluate the scientific basis for a Yucca Mountain-specific standard (see Appendix E for detailed issues to be addressed) and directed USEPA to promulgate new public health and safety standards based on and consistent with the findings and recommendations of the NAS. The EnPA also directed the USNRC to modify its technical requirements to conform to the new USEPA standards within 1 year. In August 1995, the NAS issued its findings and recommendations on public health and safety standards for HLW specific to Yucca Mountain[i]

On June 13, 2001, USEPA issued its final standards for Yucca Mountain.[ii] As noted earlier, EnPA directs the USNRC to modify its technical requirements and criteria to be consistent with these standards. The following is a summary of these final standards, over a performance period of 10,000 years that are to be implemented by the USNRC[iii]:

- Radiation standards for storage: USEPA identifies a 0.15 mSv/year (15 mrem/year) dose limits to members of the public.

- Radiation standards for disposal: USEPA identifies a 0.15 mSv/year dose limits to a reasonably maximally exposed individual (RMEI).

- Human intrusion standards: USEPA identifies a 0.15 mSv/year dose limits to a RMEI as well as the characteristics of the human intrusion scenario itself.

- Groundwater protection standards: USEPA has a 0.04 mSv/year ground-water protection standard and associated requirements for determining compliance with the standard.

In addition, the standard requires that USDOE determine the earliest time after disposal that the waste package would degrade sufficiently that human intrusion could occur without recognition by a driller. The limit of an annual committed effective dose equivalent of 0.15 mSv to the RMEI will apply only if that time occurs at or before 10,000 years following disposal. The USDOE must also include the results of analyses beyond the 10,000 year compliance period in the environmental impact statement for Yucca Mountain as an indicator of long-term disposal system performance. The regulation

[i] National Research Council, 1995.
[ii] This activity is described in further detail at the following USEPA web site: http://www.USEPA.gov/radiation/yucca.
[iii] USEPA standards specify the characteristics of a RMEI for use in performance assessments used to demonstrate compliance with the standards for disposal. USEPA also specifies the criteria that pertain to the characteristics of the reference biosphere for use in the post-closure performance assessments. USEPA standards exclude unlikely features, events, and processes from performance assessment analyses for estimating compliance with the standards for human intrusion and ground-water protection

limits radium 0.2 Bq/liter (5 pCi/liter) and gross-alpha 0.6 Bq/liter (15 pCi/liter) activity concentrations in the representative volume of groundwater and 0.04 mSv per year combined beta and photon dosage to the whole body or any organ based on drinking 2 liters of water per day.

Additional considerations for the case of human intrusion and the protection of ground-water are also specified. These can be accessed at URL: http://www.nrc.gov/reading-rm/doc-collections/cfr/part063/index.html

E.2.2.3 Mixed Waste Regulation

A dual regulatory framework exists for mixed waste with the USEPA or authorized states regulating the hazardous component of the waste and the USNRC, the USNRC agreement states, or the USDOE regulating the radioactive component. USNRC generally regulates commercial and non-USDOE Federal facilities. USDOE orders apply to USDOE sites and contractors.

Using the AEA authority, USNRC and USDOE regulate mixed waste with regard to radiation hazards. Using the RCRA authority, USEPA regulates mixed waste with regard to chemical hazards. USNRC is authorized by the AEA to issue licenses to commercial users of radioactive materials. RCRA gives USEPA the authority to control hazardous waste from “cradle-to-grave.” Once a waste is determined to be a mixed waste, the waste handlers must comply with both AEA and RCRA statutes and regulations. The requirements of RCRA and AEA are generally consistent and compatible. However, the provisions in Section 1006(a) of RCRA allow the AEA to take precedence in the event provisions of requirements of the two acts are found to be inconsistent.

Under the 1984 Amendments to RCRA, Land Disposal Restriction regulations prohibit disposal of most mixed waste until it meets specific treatment standards. While most of the commercial mixed waste that is generated and stored can be treated to meet the Land Disposal Restriction regulations by commercially available treatment technology, there still exists a small percentage of commercial mixed waste for which no treatment or disposal capacity is available. Commercial mixed waste volumes are very small (approximately 2 percent) compared to the total volume of mixed waste being generated or stored by USDOE.

As mandated by the Federal Facilities Compliance Act, which was signed into law on October 6, 1992, USDOE has developed Site Treatment Plans to handle its mixed wastes under the purview of USEPA or its authorized states. These are being implemented by orders issued by USEPA or the state regulatory authority.

E.2.2.4 Other USEPA Radiation-Related Authorities

The USEPA has other regulatory responsibilities, which directly or indirectly are associated with a variety of man-made and naturally-occurring radioactive wastes:

- Develops general radiation protection guidance to the Federal government. Section F contains additional information about radiation protection;

- Under the Clean Air Act USEPA has established National Emission Standards for Hazardous Air Pollutants (NESHAPs) for airborne radionuclide emissions from a variety of facilities (40 CFR Part 61, 54 FR 51654, December 15, 1989). Subpart H of this regulation limits the airborne emissions of radionuclides (other than radon) from USDOE sites, which include many facilities that manage defense-related spent nuclear 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 USDOE sites are required to submit an annual report of compliance to USEPA;

- Promulgates drinking water regulations, under the Safe Drinking Water Act, as amended, including standards for radionuclides in community water systems;

- Works with state radiation protection agencies regarding protection of the environment, workers, and the public from naturally occurring radioactive materials that are exposed or concentrated by mining or processing; and

- Coordinates with USDOE, USNRC and states on orphaned sources, recycled materials, and control of imports and exports to prevent radioactively-contaminated scrap from entering the U.S.

Similar to the USNRC, the USEPA is composed of a headquarters organization and 10 regional offices. Each USEPA Regional Office is responsible within its states for the execution of the Agency's programs. The USEPA also has 17 laboratory facilities located across the nation.

E.2.3 U.S. Department of Energy

As discussed in Section A, the USDOE has prime responsibilities for U.S. Government programs involving development of nuclear technologies in the U.S. The USDOE also provides safety and health and independent oversight of its programs.

The USDOE spent fuel and radioactive waste management activities that are designated under the Joint Convention receive oversight from the USDOE Office of Environment, Safety and Health (USDOE-EH) and Office of Independent Oversight and Performance Assurance (USDOE- OA), respectively. These functions occur in addition to those specific activities within USDOE that by law are regulated by the USNRC and USEPA, such as the WIPP TRU waste repository or proposed Yucca Mountain repository.

Some of the USDOE oversight functions performed by the USDOE-EH organization:

- Ensure conformance of the USDOE activities with applicable laws and requirements governing protection of the environment, as well as the safety and health of the public and the workers at USDOE facilities;

- Conduct scientific and technical programs to enhance the USDOE ability to protect the health and safety of workers and the public;

- Develop environmental, occupational safety and health, and medical policies and rules for operation of USDOE facilities that are effective, efficient, and state-of-the-art;

- Provide technical assistance to the USDOE programs to foster the identification and resolution of environment, safety, health, safeguards, and security issues; and

- Ensure compliance with nuclear safety requirements.

The USDOE-EH organization develops, manages, and directs comprehensive programs that provide effective health and safety policy for protecting the health and safety of workers and the safety of facility and systems operations at all USDOE facilities. The office also maintains a formal liaison role with external safety and health regulators and with internal USDOE programs and line elements and with contractor organizations relating to health and safety policy and regulatory issues. The USDOE-EH organization develops and manages health and safety programs designed to improve safety performance.

The USDOE-EH organization develops, coordinates, and promulgates USDOE policy, orders, and standards relating to safety and health of workers, facilities, and working conditions. It establishes state-of-the-art programs, policies, and standards, that assure protection of the USDOE Federal and contractor personnel from occupational injury and illness, assure safety of facility design and operations, and ensure the adequacy of training related to the health and safety of USDOE and contractor employees.

The USDOE-EH organization develops policies and guidance and implementing strategies related to the specialized safety disciplines of nuclear safety, health physics, industrial hygiene, fire protection, electrical safety, high explosives, firearms safety, pressure safety, and chemical safety. It establishes policy and guidance and evaluates risk assessment processes in the USDOE regarding worker safety. It serves as the primary USDOE liaison with the Department of Labor Occupational Safety and Health Administration and the USNRC on health and safety regulation reviews and pending regulatory reform. It also maintains nuclear safety and occupational safety and health technical expertise and provides the USDOE complex with consultative services to assist workers in understanding and implementing policies, standards, and guidance, in response to compliance and program requirement issues. It develops USDOE directives and policies for radiation protection of the public and environment and guidance for environmental protection. These are promulgated as regulations or issued as USDOE Orders.

The USDOE-EH organization is also the USDOE approval authority for environmental impact statements. It coordinates with and assists in preparing adequate environmental

impact statements for major USDOE proposed actions. The USDOE-EH organization develops written orders, policies, regulations, and guidance documents that cover environmental review requirements and implementation.

The USDOE-EH organization performs independent technical reviews of facility nuclear safety authorization basis documents and the implementation process to ensure the establishment and maintenance of an adequate safety margin and the control of hazards resulting from USDOE activities during routine and upset conditions for all life cycle phases of facilities. Also, the USDOE-EH organization performs facility reviews, walk-downs, and personnel interviews to ensure actual facility conditions (including operations, where appropriate) are consistent with the authorization basis.

The USDOE-EH organization is responsible for investigations of potential violations of enforceable requirements, as well as certain nuclear safety concerns raised by workers at USDOE facilities. Where warranted, it initiates and resolves enforcement actions in accordance with the process and procedures set forth in 10 CFR Part 820.

The cornerstone of the USDOE nuclear safety enforcement program is voluntary compliance through contractor initiatives to effectively understand and implement nuclear safety requirements. As set forth in 10 CFR Part 820, Appendix A (Enforcement Rule and Policy), the primary mechanism for enforcement is contractor self-identification and reporting of potential non-compliant activities. The incentive for contractor self-reporting lies in USDOE Enforcement Policy, which provides for up to 100 percent mitigation of civil penalties when contractors promptly identify, report, and correct violations. The fundamental tenet of the enforcement policy is to focus on those violations, which, due to the actual or potential safety significance of the violations, are cause for regulatory concern. Analysis of existing information regarding nuclear safety related events was used to develop a safety significance threshold for evaluating potential violations for enforcement.

Another important oversight organization is the USDOE Office of Independent Oversight and Performance Assurance (USDOE-OA), which was formed in May 1999. This organization performs independent oversight inspections of USDOE facilities, including the functional area of environmental compliance and safety and health. The authority for USDOE-OA to conduct independent oversight was formally established through USDOE Order 470.2A, “Security and Emergency Management Independent Oversight and Performance Assurance Program.” The requirements in USDOE Order 470.2A detail the basis for independent oversight activities; the conduct of appraisals; the response to significant vulnerabilities; reporting of appraisal results; and the corrective action development, approval and closure (follow-up) process for all findings, issues, or concerns identified during appraisals. The changing mission of many USDOE facilities, as well as the aging of those facilities, increases the importance of assessing ES&H policies and programs, as well as the implementation of those programs, to evaluate their effectiveness in protecting workers, the public, and the environment. Additionally, USDOE-OA ensures that identified deficiencies and other important issues are tracked and management implements corrective actions.

E.2.4 U.S. Defense Nuclear Facilities Safety Board

The U.S. Defense Nuclear Facilities Safety Board (DNFSB) is an independent federal agency established by Congress in 1988. The Board's mandate under the Atomic Energy Act is to provide safety oversight of the nuclear weapons complex operated by the USDOE. The DNFSB has authority for oversight of most USDOE facilities—those that were or are in a defense mission. Broadly speaking, the DNFSB is responsible for independent oversight of all activities affecting nuclear safety within USDOE's nuclear weapons complex. This includes waste management facilities such as the WIPP and USDOE LLW disposal sites. Prior to the end of the nuclear arms race, the nuclear weapons complex concentrated on the design, manufacture, test, and maintenance of the nation's nuclear arsenal. The complex is now engaged in cleanup of contaminated sites and facilities, disassembly of nuclear weapons to achieve arms control objectives, maintenance of the smaller stockpile, and storage and disposition of excess fissionable materials. All of these hazardous activities must be carried out in strict observance of health and safety requirements. To ensure that these safety requirements are adequate, the Board's enabling statute, 42 U.S.C. ß 2286 et seq., requires the DNFSB to review and evaluate the content and implementation of USDOE health and safety standards applicable to the design, construction, operation, and decommissioning of defense nuclear facilities. The Board must then recommend to the Secretary of Energy any specific measures, such as changes in the content and implementation of those standards, that the DNFSB believes should be adopted to ensure that the public health and safety are adequately protected. The DNFSB also is required to review the design of new defense nuclear facilities before construction begins, as well as modifications to older facilities, and to recommend changes necessary to protect health and safety. Review and advisory responsibilities of the DNFSB continue throughout the full life cycle of facilities, including shutdown and decommissioning phases.

E.2.5 U.S. Nuclear Waste Technical Review Board

The U.S. Congress created the U.S. Nuclear Waste Technical Review Board (NWTRB) in 1987 to review the USDOE scientific and technical activities pertaining to the management and disposal of the nation’s spent fuel and HLW. The NWTRB evaluates the characterization of Yucca Mountain, Nevada, as a potential repository site, as well as the packaging and transportation of commercial spent fuel and defense HLW.

The NWTRB provides ongoing independent and expert technical review of the USDOE program. The Nuclear Waste Policy Amendments Act authorized a board of 11 part-time members who are eminent in a field of science or engineering, including environmental, and social sciences, and selected solely on the basis of distinguished service. The National Academy of Sciences recommends candidates, and the President makes the appointments.

The NWTRB makes scientific and technical recommendations to the USDOE to ensure a technically defensible site-suitability decision and disposal program. It also advises the USDOE on the organization and integration of scientific and technical work pertinent to the Yucca Mountain site. Finally, it provides an ongoing forum that fosters discussion

and understanding among the USDOE and its contractors of the complex scientific and technical issues facing the program.

The NWTRB monitors the USDOE work to ensure technically sound and scientifically credible site characterization, reports to Congress on issues involved in characterizing the potential site at Yucca Mountain, and points out concerns from a variety of outside parties that are of interest to the scientific community.

F. GENERAL SAFETY PROVISIONS

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

- General safety requirements,
- Existing facilities,
- Siting of proposed facilities,
- Design and construction of facilities,
- Assessment of safety of facilities, and
- Operation of facilities.

Sections G and H provide additional information specific to spent fuel or radioactive waste, respectively. These sections also address Article 10 and Article 17.

Section F also addresses the specific other safety provisions in Articles 21-26 of the Joint Convention. These include:

- Responsibility of license holders,
- Human and financial resources,
- Quality assurance
- Integrated safety management,
- Operational radiation protection,
- Emergency preparedness, and
- Decommissioning.

In the following sub-sections specific information is provided as suggested in the National Report preparation guidelines. Section E presents the various regulations and directives, many of which are referenced in the following sections that govern the safety requirements in the U.S, including those for spent fuel management. Most of these regulations, consisting of thousands of pages, are available electronically via the Internet (See Table A-2).

F.1 General Safety Requirements (Corresponds to Article 4 and 11)

The U.S. is fully compliant with the General Safety Requirements found in Article 4 and 11. General safety requirements addressed in the subsections below were called out specifically in the report preparation guidance. [i]

The provisions for general safety for workers and protection of the public during the operational phase of radioactive waste management are addressed in 10 CFR Part 20,

[i] 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, Vienna, Austria, December 13, 2002.

"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 include:

- Penalties for not complying with USNRC regulations, and
- Tables of individual radionuclide exposure limits.

The USDOE provides for radiation protection for workers and the public in its regulations and directives. The USDOE regulations in 10 CFR Part 835 are similar to USNRC regulations in 10 CFR Part 20. Part 835 governs radiation protection of workers at USDOE facilities and activities that are not licensed by the USNRC. The USDOE Order 5400.5 provides for radiation protection of the public and the environment. The USDOE regulates nuclear safety management in 10 CFR Part 830. The USDOE issues enforcement actions and civil penalties pursuant to 10 CFR Part 820 to enforce compliance with the regulations in Parts 830 and 835.

F.1.1 Criticality Control and Removal of Residual Heat

The U.S. has regulations and design guidance that ensure criticality control and residual heat removal from spent fuel and high-level waste. The licensing process used by USNRC reviews the designs of spent fuel management facilities in these and other areas related to safety.

The USNRC regulations for disposal of high-level waste (and spent fuel) general design criteria in 10 CFR 60.131 state:

(h) *Criticality control*. All systems for processing, transporting, handling, storage, retrieval, emplacement, and isolation of radioactive waste shall be designed to ensure that nuclear criticality is not possible unless at least two unlikely, independent, and concurrent or sequential changes have occurred in the conditions essential to nuclear criticality safety. Each system must be designed for criticality safety assuming occurrence of design basis events. The calculated effective multiplication factor must be sufficiently below unity to show at least a 5 percent margin, after allowance for the bias in the method of calculation and the uncertainty in the experiments used to validate the method of calculation.

The USNRC regulations in 10 CFR 63.112(e)(6) require preclosure safety analyses to address the means to prevent and control criticality. Provisions also exist for storage facilities for spent fuel in the general design criteria in USNRC regulations (10 CFR 72.124):

- Design for criticality safety: Spent fuel handling, packaging, transfer, and storage systems are designed to be maintained subcritical and to ensure that, before a

nuclear criticality accident is possible, at least two unlikely, independent, and concurrent or sequential changes have occurred in the conditions essential to nuclear criticality safety. The design of handling, packaging, transfer, and storage systems includes margins of safety for the nuclear criticality parameters that are commensurate with the uncertainties in the data and methods used in calculations and demonstrate safety for the handling, packaging, transfer, and storage conditions and in the nature of the immediate environment under accident conditions.

- Methods of criticality control: When practicable, the design of an ISFSI is based on favorable geometry, permanently fixed neutron absorbing materials (poisons), or both. Where solid neutron absorbing materials are used, the design must provide for positive means of verifying their continued efficacy. For dry spent fuel storage systems, the continued efficacy may be confirmed by a demonstration or analysis before use, showing that significant degradation of the neutron absorbing materials cannot occur over the life of the facility.

- Criticality monitoring: A criticality monitoring system is maintained in each area where special nuclear material is handled, used, or stored which will energize clearly audible alarm signals if accidental criticality occurs. Underwater monitoring is not required when special nuclear material is handled or stored beneath water shielding. Monitoring of dry storage areas where special nuclear material is packaged in its stored configuration is not required.

Various laws, standards and guides have been written which direct the performance of nuclear and criticality safety across the USDOE complex. The USDOE Order 420.1A, “Facility Safety,” is the directive establishing facility safety standards on nuclear safety design, criticality safety, fire protection, natural phenomena hazards mitigation, and a system engineer program. The governing regulation for Nuclear Safety Management at USDOE facilities is found in 10 CFR Part 830. Annex F-1 provides additional standards and guides used by criticality safety professionals.

The USDOE completed a review in March 2000 of all key nuclear facilities involved in fissile material operations, including spent fuel management. The review found no imminent criticality safety hazards at the facilities reviewed. The review found opportunities for improvement that have since been remedied, such as ensuring that criticality controls and their technical bases were completely understood by workers, ensuring that there was rigorous adherence to procedures and controls, and improving the feedback and communication process. Follow-up assessments continue and the USDOE continues to build expertise and maintain qualifications for its criticality safety professionals.

HLW and spent fuel storage systems are required to have reliable passive heat removal capability. USNRC regulations and USDOE Orders require that the decay heat removal system of the spent fuel storage system be capable of reliable operation so that the temperatures of materials used for systems, structures, and components (SSCs) important to safety, fuel assembly cladding material, and solidified high-level waste packages remain within the allowable limits under normal, off-normal, and accident conditions. Wet and dry fuel assembly transfer systems must have adequate decay heat removal under normal, off-normal, and accident conditions.

Decay heat removal systems may be passive (natural convection and thermal radiation) for dry storage or may include active cooling systems (motors, pumps, heat exchangers, valve actuators, and switchgear) for wet or dry storage. The design must function within the original design basis thermal limits under normal, off-normal, and accident conditions.

Technical specifications relating to 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. The following two paragraphs illustrate technical specifications related to thermal evaluations:

- Performance of the heat removal system will be verified by tests conducted upon placing the first full storage container in its storage position. These tests determine heat removal by measurement of air flow and temperatures and will be used to confirm the adequacy of the thermal analysis by comparison of the actual conditions of heat generation by the stored fuel assembly and ambient conditions.

- Periodic surveillance will be performed to ensure that there is no blockage of cooling air flow in the heat removal system. This surveillance, typically based on the minimum time for stored material cladding or other material important to safety (e.g., shielding) to reach a threshold temperature in the event of a complete blockage occurring immediately following the prior surveillance and the minimum time to repair or correct the blockage condition, shall be no less frequent than “a specified time interval”. Alternatives may link the surveillance interval to ambient temperature.

F.1.2 Waste Minimization

Waste minimization programs in the U.S. are mandated by law, regulations, and order of the President (Executive Order). The Pollution Prevention Act of 1990, 42 U.S.C. 13101 and 13102, focused industry, government, and public attention on reducing the amount of pollution through cost-effective changes in production, operation, and raw materials use. Opportunities are often not realized because existing regulations and the industrial resources required for compliance focus on treatment and disposal. Source reduction is fundamentally different and more desirable than waste management or pollution control. Pollution prevention also includes other practices that increase efficiency in the use of energy, water, or other natural resources, and protect our resource base through conservation. Practices include recycling, source reduction, and sustainable agriculture. The USEPA Waste Minimization Program works with industrial organizations, government agencies, and communities to voluntarily find ways to help individual companies reduce the amount of waste they generate, particularly if the wastes contain one or more waste minimization priority chemicals.

Federal agencies, such as the USDOE, are subject to Executive Orders mandating waste minimization and pollution prevention programs, e.g., 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". The USDOE has programs within the Office of

Environment, Safety, and Health designed to reduce environmental releases and reduce the amount of waste eventually requiring treatment, storage, and disposal at USDOE sites. Such activities include site-wide coordination, planning, reporting, employee awareness, assessments, incentives, cost-savings initiatives, recycling, and affirmative procurement programs. The USDOE produces an annual report[i] titled: "The 2001 Annual Report of Waste Generation and Pollution Prevention Progress."

USNRC licensees are encouraged to manage their activities so as to limit the amount of radioactive waste they produce. Techniques include avoiding the spread of radioactive contamination, surveying items to ensure that they are radioactive before placing them in a radioactive waste container, using care to avoid mixing contaminated waste with other trash, using radioactive materials whose radioactivity diminishes quickly and limiting radioactive material usage to the minimum necessary to establish the objective.

Licensees take steps to reduce the volume of radioactive waste after it has been produced. Common means are compaction and incineration. Approximately 59 NRC licensees are authorized to incinerate certain LLW, although most incineration is performed by a small number of commercial incinerators.

Beyond regulations, the USNRC issues orders, notices and directives which focus on specific practices and operations which either address a point of clarification or unforeseen issues which may not merit the resources and broad needs associated with a full rulemaking. An example is Information Notice 89-13, "Alternative Waste Management Procedures in Case of Denial of Access to Low-Level Waste Disposal Sites," which describes methods for minimizing the generation of radioactive waste. In addition, economics of radioactive waste disposal in the U.S. has been a major factor in reducing the amount of waste generated.

F.1.3 Interdependencies Between Different Steps in the Spent Fuel and Radioactive Waste Management Processes

Successful management of spent fuel and radioactive waste requires careful integration between power or research reactors, waste generators, storage facilities, treatment facilities, disposal sites, the geologic repository project, and their transportation interfaces. Acceptance requirements define the interfaces. The U.S. recognizes the importance of this integration and manages the interfaces between various steps, e.g. storage, transportation, and disposal.

F.1.4 National Laws/Regulations Providing Protection and Taking Into Account International Criteria and Standards

The U.S. has an extensive and comprehensive set of laws and regulations providing protection from radiation, meeting the intent of Article 4 and Article 11 of the Joint Convention. As described in Section E, the USEPA is responsible for developing

[i] USDOE , The 2001 Annual Report of Waste Generation and Pollution Prevention Progress, USDOE-EM-0630, Washington DC, June 2002. http://tis.eh.doe.gov/p2/wastemin/2001ar.pdf

national standards on radiation protection. The U.S. government works with international organizations, e.g., IAEA, and ICRP, to ensure that U.S. standards are in general harmony with recommendations from these organizations. For example, rulemaking is underway to make transportation regulations compatible with the IAEA Safety Requirement on Regulations for the Safe Transport of Radioactive Material (TS-R-1).

F.1.5 Biological, Chemical and Other Hazards

The U.S. has major environmental laws that fully take into account biological, chemical, and other hazards. Operators of facilities must abide by these laws to protect workers, the public and the environment. Laws are enforced through their implementing regulations, which are the responsibility of USEPA, which in turn delegates some regulatory authority to Agreement States. One such law is RCRA giving USEPA the authority to control hazardous waste from the "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 wastes. The 1986 amendments to RCRA enabled USEPA to address environmental problems that could result 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, which are covered by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund), 42 U.S.C. 9601, which is also regulated by USEPA. The Federal Hazardous and Solid Waste Amendments are the 1984 amendments to RCRA that required phasing out land disposal of hazardous waste. Some of the other mandates of this strict law include increased enforcement authority for USEPA, more stringent hazardous waste management standards, and a comprehensive underground storage tank program.

As part of the environmental assessment process, impacts from chemical hazards are assessed. These assessments are required prior to construction of spent fuel and radioactive waste management facilities. For example, the Environmental Impact Statement prepared for Yucca Mountain[i] examined the consequences for chemically toxic materials, which were found to be lower than identified Maximum Contaminant Level Goals. Heavy metal elements were of particular interest, including chromium, molybdenum, nickel, and vanadium contained in the metals proposed to package the waste and support the packages. The USDOE concluded that there are no impacts to water quality or human health from toxic materials that would exceed USEPA standards applicable to the proposed repository.

[i] USDOE, Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada, USDOE/EIS-0250, Washington DC, February 2002.

F.1.6 Avoidance of Undue Burden/Impacts on Future Generations

The U.S. policy to dispose of spent fuel and radioactive waste is aimed at not placing undue burdens on future generations. Performance requirements on disposal sites mandate the level of isolation.

Our experts maintain contacts with international organizations engaged on such issues. Members of the NCRP work directly with their counterparts in the international community. The NAS Board of Radioactive Waste Management considers the public policy, sociological, and ethical aspects of radioactive waste management, for example, long-term societal commitments, societal acceptability of waste management practices, and institutional capabilities to effectively and efficiently manage radioactive wastes.

F.2 Existing Facilities (Corresponds to Article 5 and Article 12)

Article 5 and Article 12 of the Joint Convention specify that each Contracting Party shall take steps to review safety of any spent fuel and radioactive waste management facility existing at the time the Convention enters into force and to ensure that, if necessary, all reasonably practicable upgrades are made.

The U.S is fully compliant with the provisions of Article 5 and Article 12 of the Joint Convention. The U.S. conducts safety reviews of both commercial and governmental spent fuel and radioactive waste management facilities under its existing regulations. 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 USDOE performs safety reviews of its nuclear facilities, including spent fuel and radioactive waste management facilities, under its safety regulations. Previous subsections in this section have detailed safety activities of the USDOE. Also, Section F.7.2 discusses the important Integrated Safety Management System used by USDOE to provide annual declarations that describe how safety is maintained, the effectiveness of the program, and changes and improvements. Re-verification by contractors and Federal organizations is part of this process, as needed. These declarations are required annually.

In addition, the USDOE also has a Voluntary Protection Program (VPP) promoting safety and health excellence through cooperative efforts among labor, management, and government at USDOE contractor sites. USDOE has also formed partnerships with other Federal agencies and the private sector for both advancing and sharing its VPP experiences and preparing for program challenges in the next century. The USDOE initiated its VPP in January 1994 to promote improved safety and health performance through public recognition of outstanding programs. The VPP is applied to a site or contractor, so it can cover multiple complex facilities and activities. It includes coverage of radiation protection/nuclear safety and emergency management. Similar to the U.S. Department of Labor (USDOL) Occupational Safety and Health Administration program for general industry, the USDOE VPP provides several proven benefits to participating sites, including improved labor/management relations, reduced workplace injuries and illnesses, increased employee involvement, improved morale, reduced absenteeism,

and public recognition. Contractors perform annual assessments and their VPP status is certified by USDOE. Contractors at USDOE sites go through this annual voluntary review process, and are certified under the USDOE VPP program. Also, as mentioned above in the sub-section on Criticality Control and Residual Heat, the USDOE recently completed a review of nuclear criticality safety at all USDOE facilities and follow-up assessments have been performed.

F.3 Siting of Proposed Facilities (Corresponds to Article 6 and Article 13)

The U.S. is fully compliant with Article 6 and Article 13 of the Joint Convention. The U.S. has in place the legal and regulatory structure described in Section E to site proposed new facilities. The process provides for evaluation of all relevant site related factors, safety impacts to workers, the public, and the environment, and socio-economic impacts.

The USNRC regulations prescribe site characterization activities required and pre-license application reviews by USNRC, the license application requirements, licensing, and construction authorization. The regulations also provide for participation in the pre-licensing (site) review and licensing review by states and affected Indian Tribes. Information is publicly available through the formal licensing docket maintained in public reading rooms by USNRC.

F.3.1 Licensing the Proposed Yucca Mountain Repository

The USDOE plans to submit a license application for the proposed Yucca Mountain repository to USNRC in 2004 for authorization to begin construction of the repository. The repository must be licensed in accordance with NRC licensing regulations in Title 10 CFR Part 63 that implement Environmental Protection Agency standards in Title 40 CFR Part 197.

The license application will contain “General Information” and a “Safety Analysis Report,” and will be accompanied by an environmental impact statement. “General Information” includes a general description of the repository system; proposed schedules for construction, receipt, and emplacement of waste; a physical protection plan; a material control and accounting program plan; and a description of site characterization work.

The “Safety Analysis Report” will include discussion of preclosure repository safety analyses; postclosure repository safety analyses; a research and development program to resolve safety questions; a performance confirmation program; and administrative and programmatic requirements. Specifically, the report shall include a description of the Yucca Mountain site. Such a description will address the GROA with respect to the boundary of the site and the geology, hydrology, geochemistry, climatology, the location of the critical group, description and discussion of the design of the engineered barrier system, field tests, in-situ tests, laboratory tests that are representative of field conditions, monitoring data, and natural analog studies, description of the quality assurance program to be applied to the structures, systems, and components important to safety and to the engineered and natural barriers important to waste isolation.

Additional details of the composition of the Safety Analysis Report can be found in 10 CFR Part 63, Section 63.21(c).

As part of the postclosure performance objectives specified at § 63.113(b) of the USNRC regulations in 10 CFR Part 63, the USDOE must also prepare and submit a performance assessment as part of the demonstration of compliance with the postclosure performance standards. The performance assessment quantitatively estimates that the expected annual dose to the RMEI will not exceed the annual dose limit of 0.15 mSv (15 mrem) from releases from the Yucca Mountain disposal system over the compliance period, as specified in § 63.311. Proof that the geologic repository will be in conformance with the objective for postclosure performance is complicated because of the uncertainties inherent in the understanding of the evolution of the geologic setting, biosphere, and engineered barrier system. For such long-term performance, what is required is reasonable expectation, making allowance for the time period, hazards, and uncertainties involved, that the outcome will be in conformance with the objective for postclosure performance of the geologic repository. Demonstrating compliance, by necessity, will involve the use of complex predictive models that are supported by limited data from field and laboratory tests, site-specific monitoring, and natural analog studies that may be supplemented with prevalent expert judgment.

F.3.2 Other Siting Considerations

Licensees select a site based on consideration of many factors. These factors include the geography, demography, meteorology, hydrology, seismology, and the geology characteristics of the site and the surrounding area. Nearby industrial, transportation and military facilities are also a consideration in the selection process. The licensee uses site characteristics to determine the influence on the facility design. The licensee will then evaluate the site characteristics from a safety viewpoint.

From the information supplied in response to the regulations, USNRC staff can determine if: (1) the applicant has properly identified the external natural and man-induced phenomena for inclusion in the design basis and whether the design basis levels are adequate; (2) the applicant has adequately characterized local land and water use and population so that important individuals and populations likely to be affected can be identified; and (3) the applicant has adequately characterized the transport process which could move any released contamination from the facility to the maximally exposed individuals and populations.

Specific requirements exist in 10 CFR 72.102 for geological and seismological characteristics. As an alternative to these requirements, an applicant may determine the design earthquake by using the criteria and level of investigations required by Appendix A of 10 CFR Part 100. From this information, the USNRC determines the acceptability of the site-derived design bases and design basis events that were incorporated into the proposed design analysis. In addition, the USNRC evaluates the applicant's determination that the maximally exposed individuals and populations and the dispersion parameters result in compliance with USNRC radiation protection requirements.

F.3.3 Assessment of Environmental Impacts Prior to Siting

The National Environmental Policy Act of 1969 (NEPA), 42 U.S.C. 4321-4347 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, e.g., USDOE (10 CFR Part 1021), USNRC (10 CFR 51), and USEPA (40 CFR 6). NEPA requires federal agencies to integrate environmental values into their decision-making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions. NEPA requirements are invoked when airports, buildings, military complexes, highways, parkland purchases, and other federal activities, such as spent fuel and radioactive management facilities, are proposed. This NEPA process is employed for any significant changes in the facility during the operating period, e.g., additional waste types are disposed or new facilities are added.

F.3.4 Public and Stakeholder Involvement

The U.S. recognizes the many benefits to be derived from public participation in its program activities, including spent fuel and radioactive waste management. Public participation is open, ongoing, two-way communication - both formal and informal - between government officials and stakeholders. Public participation provides a means for 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. Public participation benefits stakeholders by creating an opportunity to provide input and influence decisions.

Many USDOE sites have formed formal panels made up of interested citizens to advise the government on planned ongoing activities under terms in the Federal Advisory Committee Act. Site-Specific Advisory Boards provide consensus advice and recommendations to USDOE spent fuel and waste management activities at most locations where spent fuel and radioactive waste is stored. The boards provide advice and offer recommendations on USDOE activities. In addition, there are other panels formed to advice the USDOE at the program and secretarial office level, e.g. the Environmental Management Advisory Board and the Secretary of Energy Advisory Board. These groups review broader agency actions and policies, providing advice and guidance to senior governmental officials.

F.4 Design and Construction of Facilities (Corresponds to Article 7 and Article 14)

Article 7 and Article 14 of the Joint Convention require parties to take appropriate steps to ensure that design and construction of spent fuel and radioactive waste management facilities have measures to limit possible radiological impacts and discharges or uncontrolled releases; that provisions are taken into account at the design stage for

decommissioning; and technologies are supported by experience testing and analysis. The U.S. is fully compliant with Article 7 and Article 14 of the Joint Convention.

General design criteria establish the minimum requirements for the principal design criteria, which in turn establish the necessary design, fabrication, construction, testing, and performance requirements for structures, systems and components important to safety.

Quality assurance programs are an integral part of the USNRC and USDOE safety programs. Quality assurance programs are applied to design, purchase, fabrication, handling, shipping, storing, cleaning, assembly, inspection, testing, operation, maintenance, repair, modification of structures, systems and components, and decommissioning that are important to safety.

The USDOE has in 10 CFR part 830 provisions requiring design of USDOE nuclear facilities to include nuclear safety, explosives safety, fire protection, and nuclear criticality safety. In addition, USDOE Order 420.1A, "Facility Safety" requires that during operation all facilities shall be designed for protection from natural phenomena, such as earthquakes and tornadoes and that designs facilitate safe deactivation, decommissioning, and decontamination at end of their operating periods.

F.5 Assessment of Safety of Facilities (Corresponds to Article 8 and Article 15)

The Joint Convention requires that a systematic safety assessment and an environmental assessment appropriate to the hazards present at the facility be prepared to cover the entire life cycle. Before operations, updated, and detailed assessments are required. Safety and environmental assessments are performed appropriate to the hazard of the facility.

The USNRC safety oversight program is designed to prevent radiation-related deaths and illnesses, 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.

The USNRC periodically inspects the design, fabrication, and use of dry cask storage systems by sending inspectors to licensee and cask vendor and fabricator facilities. The inspectors examine whether licensees and vendors are performing activities in accordance with radiation safety requirements, licensing and certificate of compliance requirements, and quality assurance program commitments. Inspectors follow guidance in the USNRC Inspection Manual, which contains objectives and procedures to use for each type of inspection.

The USNRC issues reports to document inspection findings. These inspection reports may contain enforcement actions and follow-up inspection items. USNRC makes the Inspection Reports available for public review electronically. For example, spent fuel storage inspection reports can be located by searching for documents with a cask designer's name or docket number, or an ISFSI name or docket number.

As part of the oversight process, USNRC issues sanctions called enforcement actions to licensees who violate our regulations. These sanctions may include notices of violation, monetary fines, or orders to modify, suspend, or revoke a license or require specific actions because of a public health issue.

USDOE facilities are required to go through the process established under regulations and guidelines implementing NEPA. This process includes completion of appropriate NEPA reviews before a project can proceed. Also, these facilities must comply with applicable USDOE Orders/regulations or, if subject to USNRC licensing, USNRC licensing requirements.

F.6 Operations of Facilities (Corresponds to Article 9 and Article 16)

The USNRC regulations require operations under a safety envelope. The USNRC relies on regulations and internally developed licensing and inspection programs in granting the authorization to operate spent fuel or radioactive waste management facilities.

Operations safety data are reported to or identified by the USNRC in event reports, inspection reports, component failure reports, industry reports, safeguard and security events, reports submitted under 10 CFR Part 21, and reports of operation experience at foreign facilities. The USNRC staff screens operations safety data for safety significance, trends and generic implications and the need for further regulatory action. USNRC staff also develops, coordinates, and issues generic communications to alert industry to safety concerns and recommends the need for special inspections or event investigations.

Some examples of operational issues that have been investigated include: loose/leaking pressure switches, loose lid bolts, corrosion of outer metallic lid seals, vent and drain port cap installation problems, crane and rigging issues, pad issues, and unapproved fuel loading issues.

The USDOE facilities fall under numerous regulations and Orders mandating similar operational safety requirements. The USDOE safety regulation is found in 10 CFR Part 830. This regulation requires a comprehensive nuclear safety program at all USDOE nuclear facilities, including spent fuel management facilities. The regulation requires that a safety basis be developed including a documented safety analysis and technical safety requirements that place limits on operations as appropriate. Additional guidance on the implementation of 10 CFR Part 830 is found in USDOE G 421.1-1, “Criticality Safety Good Practices Guide for DOE Nonreactor Nuclear Facilities,” USDOE G 421.1-2, “Implementation Guide For Use in Developing Documented Safety Analyses To Meet Subpart B Of 10 CFR 830,” and USDOE G 423.1-1, “Implementation Guide For Use In Developing Technical Safety Requirements.”

Detailed safety analysis reports are developed, which include analysis of credible accident scenarios. Additional guidance on safety analysis is found in USDOE G 421.1-2, “Implementation Guide For Use in Developing Documented Safety Analyses To Meet Subpart B Of 10 CFR 830.” The safety basis is reviewed and approved by USDOE

management and documented in a Safety Evaluation Report. Safety analysis reports are updated and approved as necessary. During operations, safety issues may arise. Part 830 mandates an unreviewed safety question process that formally resolves these issues. Additional guidance on the this process is found in the USDOE G 424.1-1, "Implementation Guide For Use In Addressing Unreviewed Safety Question Requirements." The above regulations, orders and guidance ensure that safety assessments are appropriate and maintained up to date during facility operations per the Joint Convention. Annex F-3 provides additional information from USDOE Orders covering the requirements for commissioning, conduct-of-operations, maintenance, asset management, reporting, and emergency management.

F.7 Responsibilities of License Holders (Corresponds to Article 21)

The Joint Convention specifies that each Contracting Party shall ensure that the prime responsibility for safety rests with the licensee and that each such licensee meets its responsibility. If no licensee exists then the government has the responsibility. USNRC regulations ensure that licensees are responsible as described below. The USDOE Integrated Safety Management Program described in Section F.7.2 fulfills this responsibility under the Joint Convention for the U.S. government spent fuel and radioactive waste management facilities.

F.7.1 Safety Responsibility of USNRC License Holders

Storage of low-level radioactive waste requires a USNRC or Agreement State license. USNRC or Agreement State regulations require the waste to be stored in a manner that keeps radiation doses to workers and members of the public below USNRC-specified levels. Licensees must further reduce these doses to levels that are as low as reasonably achievable. Actual doses, in most cases, are a small fraction of the USNRC limits.

For spent fuel management, both pool storage and dry storage are safe methods, but there are significant differences. Pool storage requires a greater and more consistent operational vigilance on the part of utilities or other licensees and the satisfactory performance of many mechanical systems using pumps, piping and instrumentation.

USNRC requires licensees to meet USEPA standards for cleanup of uranium and thorium mill sites after the milling operations have permanently closed.
This includes requirements for long-term stability of the mill tailings piles, radon emissions control, water quality protection and cleanup, and cleanup of lands and buildings.

Although the licensee and/or operator is ultimately responsible for safe radioactive waste and spent fuel management, the USNRC and the Agreement States oversee licensees' management and disposal of radioactive waste products.

In most cases, the ultimate radioactive waste disposal site will transfer to either the Federal or the state government possession and control. The agencies within the government will be those most familiar with the hazards and risks associated with the radioactive waste, even in a stabilized and isolated disposal configuration. Eventually, the licensee or operator will transfer control and maintenance, if any is needed, to these governmental agencies, which in turn will be responsible for the short- and long-term protection of the public and the environment.

F.7.2 Integrated Safety Management at USDOE

At the pinnacle of safety programs within the USDOE is the Integrated Safety Management System (ISMS). The ISMS applies to all programs and activities within the agency, including spent fuel management. Integrated safety management is an overarching combination of all elements of environment, safety, and health into one system focused on accomplishing work safely. This is accomplished by formal processes that build in rigorous safety discipline from definition and planning of work, through performance of work, and lessons learned/feedback. The ISMS is derived from USDOE Policy 450.1, "Environment, Safety, and Health Policy for the Department of Energy Complex."

There are 7 guiding principles that form ISM:

- Line management is directly responsible for the protection of the public, the workers, and the environment;

- Clear and unambiguous lines of authority and responsibility for ensuring safety are established and maintained at all organized levels within the Department and its contractors;

- Personnel possess the experience, knowledge, skills, and abilities that are necessary to discharge their responsibilities;

- Resources are effectively allocated to address safety, programmatic, and operational considerations. Protecting the public, the workers, and the environment is a priority whenever activities are planned and performed;

- Before work is performed, the associated hazards are evaluated and an agreed-upon set of safety standards and requirements are established which, if properly implemented, provide adequate assurance that the public, the workers, and the environment are protected from adverse consequences;

- Administrative and engineering controls to prevent and mitigate hazards are tailored to the work being performed and associated hazards; and

- The conditions and requirements to be satisfied for operations to be initiated and conducted are clearly established and agreed-upon.

The core functions of integrated safety management form a continuous improvement cycle.

- Missions are translated into work, expectations are set, tasks are identified and prioritized, and resources are allocated;

- Hazards are associated with the work identified, analyzed, and categorized;

- Applicable standards and requirements are identified and agreed-upon, controls to prevent/mitigate hazards are identified, the safety envelope is established, and controls are implemented;

- Readiness is confirmed and work is performed safely; and

- Feedback information on the adequacy of controls is gathered, opportunities for improving the definition and planning of work are identified and implemented, line and independent oversight is conducted, and, if necessary, regulatory enforcement actions occur.

The ISMS promotes a complete culture. Workers recognize the value of safety and actively participate in all safety activities, such as procedure development and safety inspections. Workers understand their authority, responsibilities, accountability, and interfaces with others. All understand that safety takes precedence over production or schedule requirements. Workers follow procedures and do not knowingly work outside established limits. If an error is discovered, work is stopped and deficiencies are resolved. Workers are made aware of hazards, and if issues arise work is stopped until issues are resolved. Workers can question practices before accepting them as standard, and can make improvements. Teamwork and open communications are continually stressed to improve work processes and procedures. Needed resources and training are provided to accomplish safe work. Under these conditions, workers work safely and reliably and contribute to high levels of performance. Workers voluntarily report incidents, concerns, and other safety related information and receive timely responses. They provide useful feedback and act on issues as they arise. Peer influences reinforce, rather than undermine safety. Incident reporting is viewed as an opportunity to improve the system, rather than just report failures.

Safety at USDOE facilities is everyone's responsibility. The ISMS creates a comprehensive safety management system. However, when violations occur, the USDOE has enforcement authority to seek reparations from contractors responsible for facilities. The USDOE can apply sanctions to contractors for unsafe actions or conditions that violate nuclear safety requirements for protecting workers and the public. The USDOE statutory basis for its Enforcement Program is set forth in 42 USC 2271 et seq. Regulatory procedures to fulfill this statutory mandate are published in 10 CFR Part 820, "Procedural Rules for DOE Nuclear Activities."

F.8 Human and Financial Resources (Corresponds to Article 22)

Both commercial (USNRC regulations) and government (USDOE) sectors have requirements to ensure that necessary human and financial resources are sustained for spent fuel and radioactive waste management activities.

F.8.1 Staff Qualifications for Spent Fuel and Radioactive Waste Management Facilities

The USNRC establishes necessary qualifications for those operational employees responsible for safety and radiological health. These include the radiation safety officer and plant health physics personnel. The responsibilities of the operator specify these requirements and those for resource mechanisms such as financial assurance and any long-term institutional controls.

The USDOE has requirements for training for nuclear safety management in 10 CFR Part 830 and radiation worker protection in 10 CFR Part 835. USDOE directives impose additional training and qualification requirements for USDOE activities. The Federal Technical Capability efforts are discussed further in subsection F.8.1.4.

F.8.1.1 Low-Level Waste Facilities

The USNRC regulations (and similarly USDOE directives) provide that the applicant or licensee have qualified personnel. The requirements provide for an organizational structure of the applicant, both offsite and onsite, including a description of lines of authority and assignments of responsibilities, whether in the form of administrative directives, contract provisions, or otherwise.

The technical qualifications include training and experience so that the applicant and members of the applicant's staff are competent to engage in the proposed activities. Minimum training and experience requirements for personnel filling key positions described in response to the preceding paragraph must be provided.

In addition, a description must be provided of the applicant's personnel training program; and the plan to maintain an adequate complement of trained personnel to carry out waste receipt, handling, and disposal operations in a safe manner.

F.8.1.2 Spent Fuel and High Level Waste Management Facilities

The USNRC regulations (10 CFR Part 63) for the operational practices for disposal of spent fuel at the proposed Yucca Mountain repository require the submittal of a Safety Analysis Report and include a provision for the personnel qualifications and training requirements.

Operations of systems and components that have been identified as important to safety in the Safety Analysis Report and in the license must be performed only by trained and certified personnel or by personnel under the direct visual supervision of an individual with training and certification in such operation. Supervisory personnel who direct operations that are important to safety must also be certified in such operations. The USDOE must establish programs for training, proficiency testing, certification, and requalification of operating and supervisory personnel.

Furthermore, the physical condition and the general health of personnel certified for operations that are important to safety may not be such as might cause operational errors that could endanger the public health and safety. Any condition that might cause impaired judgment or motor coordination must be considered in the selection of personnel for activities that are important to safety. These conditions need not categorically disqualify a person, so long as appropriate provisions are made to accommodate the conditions.

F.8.1.3 Uranium Recovery Waste Management Facilities

As part of the application for a specific USNRC license under the provisions of 10 CFR Part 40, the applicant is required to demonstrate that it is qualified by reason of training and experience to use the source material for the purpose requested in such manner as to protect health and minimize danger to life or property. The provisions of 10 CFR Part 40 govern uranium recovery.

F.8.1.4 USDOE Technical Capability Efforts

As a result of a recommendation by the DNFSB in 1993, the USDOE implemented a plan requiring its managers to:

- Conduct a workforce analysis of their organization,
- Develop a staffing plan that identified critical technical capabilities and positions that are essential to safe operations at defense nuclear facilities, and
- Prepare an Annual Report for the Secretary of Energy.

These steps provide a basis to assess staffing needs and fill the technical vacancies that exist. The July 2001 Annual Report identified shortages in nuclear criticality safety skills at some defense facilities and spelled out steps being taken to address these shortages. The report also anticipated shortages in criticality safety and industrial hygiene skills at some non-defense facilities. Actions already taken involve recruitment, training, and qualifications.

The USDOE is committed to developing and maintaining a technically competent workforce to accomplish its missions in a safe and efficient manner through the Federal Technical Capability Program. Through this program, the USDOE strives to recruit and

hire technically capable personnel, continuously develop the technical expertise of its existing workforce and, within the limitations of executive policy and Federal law, retain critical technical capabilities within the USDOE at all times. Although specifically relating to the safe operation of defense nuclear facilities, the principles and intent of the Federal Technical Capability Program are applied to organizations that fall outside the purview of the Defense Nuclear Facilities Safety Board. Most of the USDOE spent fuel and radioactive waste management facilities are considered defense nuclear facilities. The USDOE is determined to continue making improvements in the capabilities of the Federal workforce and to fully utilize all of the tools at its disposal. The principles of the Federal Technical Capability Program are the following:

- As stated in the Integrated Safety Management Guiding Principles: Federal personnel possess the experience, knowledge, skills, and abilities that are necessary to discharge their safety responsibilities;

- Line managers are accountable and have the responsibility, authority, and flexibility to achieve and maintain technical excellence;

- Supporting organizations (personnel, training, contracts, finance, etc.) recognize line managers as customers and effectively support them in achieving and maintaining technical capabilities; and,

- An integrated corporate approach is required to assure that necessary technical capability and resources are available to meet the overall needs of the USDOE nuclear facility missions.

The Federal Technical Capability Program consists of the four elements described below. These elements are interrelated and use of only one or two of the elements will not ensure that an organization achieves its technical capability goals:

- Executive commitment and line management ownership;

- Recruiting and deploying technically capable personnel;

- Developing and documenting technically capable personnel; and

- Retaining critical technical skills.

F.8.2 Financial Resources for Safety at Spent Fuel and Radioactive Waste Management Facilities

Licensees in the commercial sector must meet USNRC requirements for financial surity. Spent fuel and radioactive waste management activities in the government sector (USDOE facilities) have the financial assurance of the U.S. government. Annual appropriations are made by the U.S. Congress. Special considerations are discussed below for the proposed Yucca Mountain repository, where disposal of both government and commercial spent fuel and high-level waste are proposed.

F.8.2.1 Commercial Low-Level Waste Facilities

The financial information must be sufficient to demonstrate that the financial qualifications of the applicant are adequate to carry out the activities for which the license is sought and meet other financial assurance requirements, such that each applicant shall show that it either possesses the necessary funds or has reasonable assurance of obtaining the necessary funds, or by a combination of the two, to cover the estimated costs of conducting all licensed activities over the planned operating life of the project, including costs of construction and disposal.

F.8.2.2 Spent Fuel and High-Level Waste Management

Under 10 CFR Part 72 for spent fuel storage at commercial ISFSIs, financial assurance consists of financial mechanisms including those fees assessed, which are required to ensure that the facility can be decommissioned and released for other use. These mechanisms include: prepayment, surety/insurance or other guarantee method, external sinking funds, government statement of intent, or contractual obligations on the part of the firm's customers.

Financial provisions for the Yucca Mountain proposed repository are addressed within the USDOE budgetary allotment and the Nuclear Waste Policy Act fund. The USDOE Civilian Radioactive Waste Management Program is budgeted by the U.S. Congress. However, customers who use electricity generated by nuclear power pay for the disposal of spent fuel. The Federal government collects a fee of one mil (0.001 U.S. dollar) per kilowatt-hour of nuclear-generated electricity from utilities. This money goes into the Nuclear Waste Fund from which the U.S. Congress makes an annual appropriation. The U.S. Congress also makes an annual appropriation from the General Fund of the Treasury to pay for disposal of defense-related high-level radioactive waste. The USDOE, the State of Nevada, and local governments that could be affected by the potential repository receive money from the Nuclear Waste Fund for authorized activities. The General Accounting Office, an arm of the U.S. Congress, is required by the Act to conduct annual audits of the USDOE Office of Civilian Radioactive Waste Management. Additionally, a public accounting firm conducts annual financial audits.

F.8.2.3 Uranium Recovery Waste Management

Financial surety arrangements must be established by each mill operator prior to the commencement of operations to assure that sufficient funds will be available to carry out the decontamination and decommissioning of the mill and site and for the reclamation of any tailings or waste disposal areas. The amount of funds to be ensured by such surety arrangements must be based on USNRC-approved cost estimates in an USNRC-approved plan for:

- Decontamination and decommissioning of mill buildings and the milling site to levels which allow unrestricted use of these areas upon decommissioning, and

- The reclamation of tailings and/or waste areas in accordance with technical criteria delineated in Section I of Appendix A to 10 CFR Part 40.

The licensee shall submit this plan in conjunction with an environmental report that addresses the expected environmental impacts of the milling operation, decommissioning and tailings reclamation, and evaluates alternatives for mitigating these impacts. The surety must also cover the payment of the charge for long-term surveillance and control. In establishing specific surety arrangements, the licensee's cost estimates must take into account total costs that would be incurred if an independent contractor were hired to perform the decommissioning and reclamation work. In order to avoid unnecessary duplication and expense, the USNRC may accept financial sureties that are consolidated with financial or surety arrangements established to meet requirements of other Federal or state agencies and/or local governing bodies for such decommissioning, decontamination, reclamation, and long-term site surveillance and control, provided such arrangements are considered adequate to satisfy these requirements and that the portion of the surety which covers the decommissioning and reclamation of the mill, mill tailings site, and associated areas, and the long-term funding charge is clearly identified and committed for use in accomplishing these activities. The licensee's surety mechanism is reviewed annually by the USNRC to assure, that sufficient funds would be available for completion of the reclamation plan if the work had to be performed by an independent contractor. The amount of surety liability is adjusted to recognize any increases or decreases resulting from inflation, changes in engineering plans, activities performed, and any other conditions affecting costs. Regardless of whether reclamation is phased through the life of the operation or takes place at the end of operations, an appropriate portion of surety liability is retained until final compliance with the reclamation plan is determined.

This will yield a surety that is at least sufficient at all times to cover the costs of decommissioning and reclamation of the areas that are expected to be disturbed before the next license renewal. The term of the surety mechanism is open ended, unless it can be demonstrated that another arrangement would provide an equivalent level of assurance. This assurance is provided with a surety instrument which is written for a specified period of time (e.g., 5 years) yet which must be automatically renewed unless the surety notifies the beneficiary (the USNRC or the state regulatory agency) and the principal (the licensee) some reasonable time (e.g., 90 days) prior to the renewal date of their intention not to renew. In such a situation the surety requirement still exists and the licensee is required to submit an acceptable replacement surety within a brief period of time to allow at least 60 days for the regulatory agency to collect.

Proof of forfeiture must not be necessary to collect the surety so that in the event that the licensee could not provide an acceptable replacement surety within the required time, the surety is automatically collected prior to its expiration. The conditions described above would have to be clearly stated on any surety instrument, which is not open-ended, and must be agreed to by all parties. Financial surety arrangements generally acceptable to the USNRC are: surety bonds, cash deposits, certificates of deposits, deposits of government securities, irrevocable letters or lines of credit, and combinations of the above or such other types of arrangements as may be approved by the USNRC.

However, self insurance, or any arrangement which essentially constitutes self insurance (e.g., a contract with a state or Federal agency), will not satisfy the surety requirement

since this provides no additional assurance other than that which already exists through license requirements.

F.8.3 Financial Provisions for Institutional Controls for the Closure Period and Beyond.

F.8.3.1 Low-Level Waste Facilities

USNRC regulations (10 CFR 61.62) require funding for disposal site closure and stabilization.

The applicant must provide assurance that sufficient funds are available to carry out disposal site closure and stabilization, including: (1) decontamination or dismantlement of land disposal facility structures; and (2) closure and stabilization of the disposal site so that following transfer of the disposal site to the site owner, the need for ongoing active maintenance is eliminated to the extent practicable and only minor custodial care, surveillance, and monitoring are required. These assurances shall be based on USNRC-approved cost estimates reflecting the USNRC-approved plan for disposal site closure and stabilization. The applicant's cost estimates must take into account total capital costs that would be incurred if an independent contractor were hired to perform the closure and stabilization work.

In order to avoid unnecessary duplication and expense, the USNRC accepts financial sureties that have been consolidated with earmarked financial or surety arrangements established to meet requirements of other Federal or state agencies and/or local governing bodies for such decontamination, closure and stabilization. The USNRC accepts this arrangement only if they are considered adequate to satisfy these requirements and that the portion of the surety, which covers the closure of the disposal site, is clearly identified and committed for use in accomplishing these activities.

The licensee's surety mechanism is annually reviewed by the USNRC to assure that sufficient funds are available for completion of the closure plan, assuming that the work has to be performed by an independent contractor.

The amount of surety changes in accordance with the predicted cost of future closure and stabilization. Factors affecting closure and stabilization cost estimates include: inflation; increases in the amount of disturbed land; changes in engineering plans; closure and stabilization that has already been accomplished and any other conditions affecting costs. This yields a surety that is at least sufficient at all times to cover the costs of closure of the disposal units that are expected to be used before the next license renewal.

The term of the surety mechanism is open-ended unless it can be demonstrated that another arrangement would provide an equivalent level of assurance. This assurance could be provided with a surety mechanism which is written for a specified period of time (e.g., five years) yet which must be automatically renewed unless the party who issues the surety notifies the USNRC and the beneficiary (the site owner) and the principal (the

licensee) not less than 90 days prior to the renewal date of its intention not to renew. In such a situation the licensee must submit a replacement surety within 30 days after notification of cancellation. If the licensee fails to provide a replacement surety acceptable to the USNRC, the site owner may collect on the original surety.

Proof of forfeiture is not necessary to collect the surety so that in the event that the licensee could not provide an acceptable replacement surety within the required time, the surety is automatically collected prior to its expiration. The conditions described above are clearly stated on any surety instrument, which is not open-ended, and is agreed to by all parties. Liability under the surety mechanism remains in effect until the closure and stabilization program has been completed and approved by the USNRC and the license has been transferred to the site owner.

Financial surety arrangements generally acceptable to the USNRC include: surety bonds, cash deposits, certificates of deposits, deposits of government securities, escrow accounts, irrevocable letters or lines of credit, trust funds, and combinations of the above or such other types of arrangements as may be approved by the USNRC. However, self-insurance, or any arrangement, which essentially constitutes pledging the assets of the licensee, does not satisfy the surety requirement for private sector applicants since this provides no additional assurance other than that which already exists through license requirements.

Further financial assurances for institutional controls are found in 10 CFR 61.63.

F.8.3.2 Spent Fuel and High-Level Waste Management

The Yucca Mountain repository will remain under the control of the U.S government in perpetuity. Financial provisions are addressed within the USDOE budget and the Nuclear Waste Fund.

F.8.3.3 Uranium Recovery Waste Management

A minimum charge of $250,000 (1978 U.S. dollars) to cover the costs of long-term surveillance are paid by each mill operator to the General Treasury of the United States or to an appropriate state agency prior to the termination of a uranium or thorium mill license.

If site surveillance or control requirements at a particular site are determined, on the basis of a site-specific evaluation, to be significantly greater than annual site inspections,[i] a variance in funding requirements may be specified by the USNRC. In any case, the total charge to cover the costs of long-term surveillance is such that, with an assumed 1 percent annual real interest rate, the collected funds yield interest in an amount sufficient to cover the annual costs of site surveillance. The total charge will be

[i] Conducted by the responsible 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 determined to be necessary.

adjusted annually prior to actual payment to recognize inflation. Eventual ownership of the uranium mill disposal site will be to an agency of the U.S. Government (e.g., USDOE) or an appropriate state agency for perpetuity.

F.9 Quality Assurance (Corresponds to Article 23)

The following subsections provide a summary of quality assurance (QA) requirements prescribed by the USNRC and USDOE that apply to spent fuel and waste management activities.

F.9.1 USNRC Requirements for LLW Quality Assurance Program

The applicant-supplied information includes information needed for demonstration that the performance objectives of and the applicable technical requirements of the LLW regulations in 10 CFR Part 61 will be met. This includes a description of the quality assurance 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.

F.9.2 USNRC Requirements for a HLW/Spent Fuel Quality Assurance Program

The scope of the USNRC HLW and spent fuel QA program is addressed in the 10 CFR Part 63 regulations and comprises all those planned and systematic actions necessary to provide adequate confidence that the geologic repository and its structures, systems, or components will perform satisfactorily in service. Quality assurance includes quality control, which comprises those quality assurance actions related to the physical characteristics of a material, structure, component, or system that provide a means to control the quality of the material, structure, component, or system to predetermined requirements. An entire subpart is devoted to quality assurance: 10 CFR Part 63 Subpart G and can be accessed on the Internet at URL: http://www.nrc.gov/reading-rm/doc-collections/cfr/part063/.

The USNRC staff observes audits conducted by the USDOE Office of Quality Assurance. The USDOE audits assess whether their contractors have satisfactorily implemented the USDOE Office of Civilian Radioactive Waste Management's quality assurance program. The USNRC documents its observations of the DOE audit and transmits its observations to the USDOE. The USNRC also performs independent audits on the USDOE QA program. Comments on deficiencies are recorded and transmitted to the USDOE QA program, where they are addressed. The USNRC observation audit reports are available on the Internet by accessing the URL: http://www.nrc.gov/waste/hlw-disposal/quality-audits.html.

F.9.3 Uranium Recovery Quality Assurance Requirements

Quality assurance is addressed as part of the license requirements for an operating uranium extraction operation. For the reclaimed tailings impoundment in which the tailings are buried and stabilized for the long term (200 – 1000 year design), some specific areas are addressed with respect to the disposal unit's performance; e.g., where ground-water impacts are occurring or expected, action must be taken to alleviate conditions that lead to excessive seepage impacts and restore ground-water quality. Technical specifications must be prepared to mitigate these impacts. A quality assurance, testing, and inspection program, that includes supervision by a qualified engineer or scientist, is established to assure the specifications are met.

When the operations are terminated, the site reclaimed and disposal strategy is realized, a general license is issued to the custodial agency. As part of this action a site Long-Term Surveillance Plan (LTSP) is prepared by the custodial agency and accepted by the USNRC. There is no termination of this general license. Among many safety-related provisions, the LTSP must include: a description of the long-term surveillance program, including proposed inspection frequency and the frequency and extent of ground water monitoring if required, appropriate constituent concentration limits for ground water, inspection personnel qualifications, inspection procedures, record keeping, and QA procedures.

F.9.4 USDOE Quality Assurance Requirements

USDOE quality assurance requirements are set forth by regulation in 10 CFR Part 830.120. Some portions of USDOE work are subject to regulation by quality assurance requirements from the USNRC, an Agreement State or other government agencies. In addition, USDOE elements may impose additional quality requirements and/or specific standards as necessary for certain types of work.

USDOE programs must implement the quality assurance criteria in a manner sufficient to achieve adequate protection of the workers, the public, and the environment, taking into account the work to be performed and the associated hazards. They must develop their quality assurance programs (QAP) by applying the 10 quality assurance criteria using a graded approach. The 10 quality assurance 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. The QA program plan must describe how the criteria will be satisfied and how the graded approach will be applied.

F.10 Operational Radiation Protection (Corresponds to Article 24)

The U.S. Government has access to leading experts in radiation protection through institutions such as the NAS/National Research Council and the NCRP. The NAS is a private, nonprofit institution that provides science, technology and health policy advice under a congressional charter. The NAS established a Board of Radioactive Waste Management with its prime focus on waste management and disposal.

The NCRP is a private, Congressionally-chartered organization of radiation protection experts established in 1964, but with predecessor functions back to 1928, for the purpose of formulating and disseminating information, guidance, and recommendations on radiation protection and measurements, which represent the consensus of leading scientific thinking. The recommendations of the NCRP are important to radiation users, the public, and other state, national and international groups concerned with radiation matters. Individuals and industrial organizations employing radiation sources turn to these recommendations to be sure that their equipment and practices embody the latest concepts of protection. Non-governmental groups concerned with improving protection efforts and disseminating information on radiation protection look to the NCRP for guidance. Governmental organizations, including the USNRC, USEPA, USDOE, the U.S. Public Health Service, and state governments utilize the NCRP recommendations as the scientific basis of their radiation protection activities. The NCRP also works closely with various international bodies concerned with radiation protection, such as ICRP.

F.10.1 U.S. Environmental Protection Agency

The U.S. Congress designated USEPA as the primary federal agency for protecting people and the environment from harmful and avoidable exposure to radiation. The USEPA is responsible for issuing guidance to federal agencies on radiation protection matters. The USEPA provides emergency response training and analytical support to state and local and tribal governments and works closely with other national and international radiation protection organizations to further our scientific understanding of radiation risks.

Primary radiation protection regulations pertaining to 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 radioactive waste (not spent fuel) management at the USDOE Waste Isolation Pilot Plant 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).

The "Public Health and Environmental Radiation Protection Standards for Yucca Mountain, Nevada",[i] promulgated in 40 CFR Part 197 by USEPA, became effective on July 13, 2001. The USEPA was directed to develop these standards by law in Section 801 of the Energy Policy Act of 1992 (EnPA, Public Law No. 102-486). The EnPA also required USEPA to contract with the National Academy of Sciences to conduct a study and provide findings and recommendations on reasonable standards for protection of the public health and safety. The National Academy of Sciences released its report, "Technical Bases for Yucca Mountain Standards," on August 1, 1995. This report was used by USEPA in their development of Part 197 standards.

Subpart A of 40 CFR Part 197 limits the offsite dose to any member of the public to an annual committed effective dose equivalent of 0.15 mSv (15 mrem) from the management and storage of radioactive material, including HLW, at the proposed Yucca Mountain site.

Federal guidance is a set of guidelines developed by USEPA, for use by Federal and state agencies responsible for protecting the public from the harmful effects of radiation. Guidance documents produced by USEPA are available on the Internet.[ii] Some key radiation protection guidance documents are listed in Annex F-2.

F.10.2 USNRC General Radiological Protection Limits

The USNRC promulgates safety regulations that are expressed in annual total effective dose equivalents, as well as air and liquid effluent release concentrations for restricted and unrestricted areas.

The total quantity of radioactive materials entering the general environment from the entire nuclear fuel cycle, per gigawatt-year of electrical energy produced by the fuel cycle, contains less than 1,850 TBq. (50,000 Ci.) of krypton-85, 185 MBq. (5 mCi.) of iodine-129, and 19 MBq. (0.5 mCi.) of combined plutonium-239 and other alpha-emitting transuranic radionuclides with half-lives greater than one year. The regulations have provisions for variances for temporary or unusual operation conditions.

F.10.2.1 Occupational Dose Limits

Generally, the operations shall be conducted so that the occupational dose to individual adults complies with an annual limit, which is the more limiting of: (1) The total effective dose equivalent being equal to 0.05 Sv (5 rems); or (2) The sum of the deep-dose equivalent and the committed dose equivalent to any individual organ or tissue other than the lens of the eye being equal to 0.5 Sv (50 rems).

There are other specific conditions, such as for planned special exposures and specific organ limits, as well as considerations for soluble uranium chemical toxicity intake limit of 10 milligrams in a week.

[i] USEPA Yucca Mountain Standards, http://www.epa.gov/radiation/yucca/index.html
[ii] USEPA Radiation Protection Program, http://www.epa.gov/radiation/federal/index.html

F.10.2.2 Public Dose Limits

In the case of release to unrestricted areas and protection of the public, operations shall be conducted so that the total effective dose equivalent to individual members of the public from the licensed operation does not exceed 1 mSv (0.1 rem) in a year. This dose is exclusive of the contributions from background radiation, any medical therapy contributions, and other contributions not attributable to the operation or other licensed operations.

There are provisions where an individual member of the public may be exposed to higher levels, and these provisions are addressed in the USNRC regulations for protection against radiation (10 CFR Part 20).

F.10.2.3 Radiological Criteria for License Termination of Licensed Facilities (Decommissioning)

The general public protection levels from all sources and practices are not to exceed 1 mSv/year. Upon its decommissioning and license termination, a nuclear facility or other licensed operation (e.g., medical laboratory) is held to a fraction of this limit. 10 CFR Part 20, Subpart E specifies that a site will be considered acceptable for unrestricted use, if the residual radioactivity that is distinguishable from background radiation results in a total effective dose equivalent to an average member of the critical group that does not exceed 0.25 mSv (25 mrem) per year, including that contribution from groundwater sources of drinking water, and the residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA). Determination of the ALARA levels takes into consideration any detriments, such as deaths from transportation accidents, expected to potentially result from decommissioning and waste disposal.

F.10.2.4 LLW Disposal Sites

Protection of the general population from releases of radioactivity from a LLW disposal facility is also dosed-based. The concentrations of radioactive material which may be released to the general environment in ground water, surface water, air, soil, plants, or animals must not result in an annual dose exceeding an equivalent of 0.25 mSv (25 mrem) to the whole body, 0.75 mSv (75 mrem) to the thyroid, and 0.25 mSv (25 mrem) to any other organ of any member of the public. Reasonable effort should be made to maintain releases of radioactivity in effluents to the general environment ALARA.

F.10.2.5 Uranium Mill Tailings Disposal Sites

The radiological protection limits for a reclaimed uranium mill are not in terms of doses. There is a radon (radon-222 from uranium byproduct materials and radon-220 from

thorium byproduct materials) flux limit for a stabilized mill tailings disposal site of 0.7 Bq/m^2-s (20 pCi/ m^2-s) and off-site groundwater concentration limits. The performance period is for a design providing reasonable assurance of control of radiological hazards to be effective for 1,000 years, to the extent reasonably achievable, and, in any case, for at least 200 years.

F.10.3 USDOE Radiation Protection Regulations

The USDOE has regulations for Occupational Radiation Protection promulgated in 10 CFR Part 835, dealing with workers at USDOE facilities, similar to those found in subsections F.10.1 and F.10.2 for USEPA and USNRC. Further directives are found in "Radiation Protection of the Public and the Environment," USDOE Order 5400.5.

F.10.4 Other Radiation Protection Regulations

Although USEPA has the prime role in setting U.S. radiation protection regulations, other federal agencies also promulgate regulations:

- The Occupational Health & Safety Administration of the USDOL has regulations dealing with worker protection from ionizing radiation found in Title 29, CFR;

- The U.S. Mine Safety and Health Administration of the USDOL has safety and health regulations related to underground mining in 30 CFR Part 57, subparts 4037 to 5047; and

- The U.S. Department of Transportation, Office of Hazardous Materials Safety Regulations has regulations dealing with transportation of spent fuel and radioactive waste and materials in Title 49 of the Code of Federal Regulations.

Also included here for completeness, under the authority of the Atomic Energy Act, the USNRC has transferred control of certain radioactive waste and materials to many of the states through written agreement. "Agreement States" must operate programs that are adequate to protect public health and safety from these materials. Many states have comprehensive radiation control programs. For example these programs may regulate the use of diagnostic and therapeutic x-ray equipment and certain radioactive materials or conduct environmental monitoring.

F.11 Emergency Preparedness (Corresponds to Article 25)

Article 25 specifies that spent fuel and radioactive waste management facilities shall have appropriate on-site and, if necessary, offsite emergency plans that are tested. The following subsections describe the extensive emergency preparedness and emergency management programs in place at USNRC-licensed and USDOE facilities.

F.11.1 Emergency Preparedness within the USNRC

The Following subsections provide information on emergency preparedness requirements of USNRC.

F.11.1.1 Materials Facilities, Including Waste Disposal Facilities

The USNRC 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. Those licensees' emergency plans are required to comply with the requirements of 10CFR30.32(i)(3), 10CFR40.31(j)(3), or 10CFR70.22(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.

F.11.1.2 Geological Repository for Spent Fuel and HLW

The USNRC requires that USDOE develop and be prepared to implement a plan to cope with radiological accidents that may occur at the geologic repository operations area, at any time before permanent closure and decontamination or decontamination and dismantlement of surface facilities (10 CFR Part 63, section 63.161). The emergency plan must be based on the criteria of 10CFR72.32(b). These criteria consist of a requirement for an Emergency Plan that includes the following information:

- Facility description,
- Types of accidents,
- Classification of accidents,
- Detection of accidents,
- Mitigation of consequences,
- Assessment of releases,
- Responsibilities,
- Notification and coordination,
- Information to be communicated,
- Training,
- Safe condition,
- Hazardous chemicals,
- Comments on Plan,
- Offsite assistance, and

- Arrangements made for providing information to the public.

F.11.1.3 LLW Facilities

As part of the radiation safety program required for a specific license to dispose of LLW, an applicant must provide a description of the radiation safety program for control and monitoring of radioactive effluents to ensure compliance with the performance objective in the regulation (10 CFR Part 61.41) and occupational radiation exposure to ensure compliance with the requirements of 10 CFR Part 20 and to control contamination of personnel, vehicles, equipment, buildings, and the disposal site. Both routine operations and accidents are addressed. The program description includes procedures, instrumentation, facilities, and equipment.

F.11.1.4 Uranium Recovery Waste Management Facilities

Provisions of accidental releases and emergency preparedness are addressed as part of the operational phase of uranium recovery. The perpetual disposal design is required to be robust and not need active maintenance to comply with a period of isolation and stability from 200 to 1000 years. Operational considerations for emergency planning during the operational phase is addressed in 10 CFR Part 40, Section 40.31(j)(3). The list of items to address is provided in Section F.11.1.1.

F.11.1.5 USNRC Regulatory Guide 3.67 – For General Materials Facilities[i]

The guidance on what is to be provided in the licensee's emergency planning is provided in Regulatory Guide 3.67 – "Standard Format and Content for Emergency Plans for Fuel Cycle and Materials Facilities." An acceptable emergency plan describes the licensed activities, the facility, and the types of accidents that might occur. It provides information on classifying postulated accidents and the licensee's procedures for notifying and coordinating with offsite authorities. The plan provides information on emergency response measures that might be necessary, the equipment and facilities available to respond to an emergency, and how the licensee will maintain emergency preparedness capability. It describes the records and reports that will be maintained. There is also a section on recovery after an accident, including plans for restoring the facility to a safe condition. Detailed descriptive information on processes, materials storage areas and containers, ventilation, process controls, activity locations, vessels, and confinement of radioactive or other hazardous materials may be necessary for the USNRC to evaluate the adequacy of the emergency plan. Detailed information that would help response organizations assess accident consequences and estimate releases is included in the plan. Other detailed information that is needed primarily for the licensing review may be submitted separately as a supplement to the plan or incorporated by reference to other licensing submittals.

[i] This guidance applies to materials facilities in general and does not focus specifically on radioactive waste.

An effective response to an emergency comprises WHAT is to be done (procedures), BY WHOM (response personnel), and WITH WHAT (equipment in designated locations). The emergency plan reflects, in general terms, the preplanning done in preparing to cope with an emergency, but the details of the actual response are contained in the emergency plan's implementing procedures. The implementing procedures are the heart of the emergency response. They must be clear, precise, and easily understood.

The licensee or applicant describes procedures instead of submitting them to the USNRC for approval. USNRC uses this practice to eliminate the need for a license amendment every time the procedures need to be changed. Details contained in the procedures need to be changed from time to time. The USNRC may review them during the licensing process and during inspections to ensure that the procedures are current and workable and that they conform to the descriptions in the emergency plan.

The licensee may change the emergency plan without prior USNRC approval if the changes do not decrease the effectiveness of the plan. These changes are submitted to the appropriate USNRC licensing office and to affected offsite response organizations within six months after the changes are made. The submittals include the date the changes became effective.

The licensee is encouraged to have a single emergency plan, meeting the requirements of state agencies or the Community Right-To-Know Act and complying with the regulations of the USNRC. Additional material to meet these other regulations is included in the plan or referenced in the licensee's emergency plan submitted to the USNRC.

Information to be provided in the emergency plan includes: facility description, types of accidents, classification and notification of accidents, responsibilities, emergency response measures, emergency response equipment and facilities, maintaining emergency response capability, records and reports, and recovery and plant restoration.

Finally, the licensee should certify that it is in compliance with Title III of the Superfund Amendments and Reauthorization Act of 1986, Pub. L. 99-499, entitled Emergency Planning and Community Right-to-Know Act of 1986, with respect to any hazardous materials possessed at the plant site.

Specifics of the emergency planning guidance and directives are discussed in Regulatory Guide 3.67, which can be accessed at: http://www.nrc.gov/reading-rm/doc-collections/reg-guides/fuels-materials/active/03-067/index.html

F.11.2 Emergency Preparedness and Management within the USDOE

The USDOE has implemented an emergency management system for all sites and facilities under its jurisdiction. The USDOE Order 151.1, "Comprehensive Emergency Management System," describes the USDOE emergency management system, by establishing policy; assigning roles and responsibilities; and providing the framework for development, coordination, control, and direction. This Order establishes the

requirements for emergency planning, preparedness, response, recovery, and readiness assurance activities and describes the approach for effectively integrating these activities under a comprehensive, all-emergency concept. USDOE facilities, sites, or activities and organization offices are required to develop emergency management programs as elements of the USDOE comprehensive emergency management system. The pieces of the system are integrated to ensure that the USDOE is prepared to respond promptly, efficiently, and effectively to any emergency involving USDOE, including spent fuel and radioactive waste management facilities, to protect workers, the public, the environment, and national security.

The USDOE Emergency Management Guide (USDOE Guide 151.1-1) provides an acceptable approach for implementing the requirements and expectations of Order 151.1. USDOE Order 151.1 discusses 14 emergency management programmatic elements that comprise a comprehensive system of emergency management: hazards survey and hazards assessment, emergency response organization, offsite response interfaces, categorization and classification, notifications and communications, consequence assessment, protective actions and reentry, emergency medical support, emergency public information, emergency facilities and equipment, termination and recovery, program administration, training and drills, and exercises. The Emergency Management Guide, composed of seven volumes, discusses each of these elements in detail.

The USDOE approach to emergency management is composed of a three-tiered management structure consisting of facilities and sites, the USDOE field organization office, and USDOE headquarters. The facility or site level manages the tactical response to the emergency by directing actions necessary to resolve the problem, protect the workers, the public and the environment and return the facility to a safe condition. The USDOE field organization office oversees the facility response and provides assistance and guidance to the facility management. The Headquarters organization provides strategic direction to the response, provides assistance and guidance to the field organization, evaluates impacts to the larger USDOE complex, and coordinates with other Federal governmental agencies and branches and the national media.

Because there is wide variety of hazards that must be considered, the emergency management program for a facility must be commensurate with the hazards present at that facility or site. This is often referred to as a tailored or graded approach. Each facility is required to have an operational emergency base program. The base program requirements cover aspects such as: medical support, worker evacuation plans, fire drills, worker notification systems, hazardous material responder training, hazardous material communication labeling and transport logistics, contingency planning for oil spills, environmental spill drills and exercises, and security and safeguards requirements. The objective of the base program is to achieve an effective integration of emergency planning and preparedness requirements into an emergency management program that provides capabilities for all-emergency response, through communication, coordination, and an efficient and effective use of resources. A hazards assessment is required for each facility or site where hazardous materials are present in quantities exceeding specified thresholds. The hazards assessment results determine whether an operational emergency hazardous materials program is required on top of the foundation of the base program.

Requirements in USDOE Order 151.1 specify that an operational emergency be declared when events or conditions at a USDOE facility or site require response outside the immediate/affected facility, site, or area of the event. This is the process of categorizing an event or condition as an operational emergency. Such events or conditions cause, or have the potential to cause: serious health and safety impacts to workers or the public, serious detrimental effects on the environment, direct harm to people or the environment as a result of degradation of security or safeguards conditions, or loss of control over hazardous materials.

Operational emergency events or conditions involving loss of control over hazardous materials (including radioactive materials) are classified based on the severity of potential consequences at a specific distance from the source of the release. Classes include alert, site area emergency, or general emergency, in order of increasing severity. This classification scheme facilitates early decision-making particularly with respect to response activities, offsite notifications, and protective actions, by making decisions during planning rather than during actual response.

The USDOE emergency management programs are subject to periodic independent assessments by the USDOE Office of Emergency Management Oversight. This Office conducts regular independent assessments of USDOE emergency management policies and programs at USDOE sites that have significant hazards and follow-up reviews to ensure that corrective actions are effective. The Office also conducts complex-wide studies of issues and generic weaknesses in emergency management programs.

Programs are evaluated against the requirements and guidance found in various documents, including USDOE Order 151.1, the associated emergency management guide, and appraisal process protocols. Using these guidance documents, the inspectors develop lines of inquiry applicable to their assigned program element to guide field activities. Another reference that provides information related to the evaluation of USDOE emergency management programs is USDOE Order 470.2, "Security and Emergency Management Independent Oversight and Performance Assurance Program." USDOE Order 470.2 describes the basis and purpose of oversight activities and specifies requirements for reviewing and commenting on appraisal reports and developing corrective action plans.

F.12 Decommissioning Practices (Corresponds to Article 26)

Both the USNRC and USDOE have active decommissioning programs as discussed in Section D. Their approaches are discussed in the following subsections.

F.12.1 USNRC Decommissioning Approach

The decommissioning process consists of a series of integrated activities, beginning with the facility in transition from “active” to “decommissioning” status and concluding with the termination of the license and release of the site. Depending on several factors, including the type of license, the use of radioactive material at the facility, or past management of radioactive material at the facility, the decommissioning may be

relatively simple and straightforward or complex. USNRC developed a "Decommissioning Standard Review Plan," NUREG-1727, to illustrate acceptable approaches to dose assessment and bases for determining compliance with USNRC performance-based requirements in this area. In addition, USDOE and USNRC sponsored development of the probabilistic RESRAD[i] (Version 6.0) and RESRAD-BUILD (Version 3.0) computer codes' for site-specific dose impact analysis in support of the decommissioning license termination rule (10 CFR Part 20, Subpart E). Final versions of each of the computer codes were tested and issued by Argonne National Laboratory - East (the code developer) and the USNRC. USNRC also developed the DandD (Version 2.1) computer code, a probabilistic Monte-Carlo screening code developed by the Sandia National Laboratories for the decommissioning of "simple" sites with limited site characterization data.

Currently, the USNRC is consolidating its guidance to be more risk-informed and performance based; this is being performed for over 80 decommissioning guidance documents. Upon completion in 2003, this will result in a 3-volume NUREG report that will provide the USNRC staff and licensees with a single reference guidance document addressing the USNRC decommissioning approach for materials licensees.

Once a decision is made to shut down a nuclear power plant, licensees must notify the NRC in writing within 30 days. Once the fuel is permanently removed from the reactor vessel and the USNRC staff receives a certification of this event, the licensee may no longer operate the reactor or place fuel back into the reactor vessel. Licensees must then submit a "Post-Shutdown Decommissioning Activity Report" prior to or at least 2 years following permanent cessation of operations. This report is then made available to the public and a public meeting will be held near the plant. The report provides a description of the licensee's planned decommissioning activities, a schedule of significant milestones, and an estimate of the expected costs, and documentation that environmental impacts have been considered.

A License Termination Plan is submitted at least 2 years before license termination and addresses detailed plans for final radiation release, site characterization and remediation plans, estimates of remaining costs, and any new information. Before approval of the plan, an opportunity for a hearing is published and a public meeting is held near the facility.

Reactor licensees may choose one of the following methods for decommissioning their plants: DECON, SAFSTOR or ENTOMB.

- Under DECON (immediate dismantlement), soon after the nuclear facility closes, equipment, structures, and portions of the facility containing radioactive contaminants are removed or decontaminated to a level that permits release (consistent with 10 CFR Part 20, Subpart E) of the property and termination of the NRC license.

- Under SAFSTOR, a nuclear facility is maintained and monitored in a condition that allows the radioactivity to decay, and is later dismantled.

[i] Available from the USNRC at http://www.nre.gov/RES/rescodes.htm

- Under ENTOMB, radioactive contaminants are encased in a structurally sound material such as concrete and appropriately maintained and monitored until the radioactivity decays to a level permitting release of the property.

Current regulations require that decommissioning be completed within 60 years. Additional time will be considered only when necessary to protect public health and safety. Currently, ENTOMB is not considered a viable option for reactor decommissioning because some of the long-lived radioisotopes present at the facility may not decay to acceptable levels within the 60-year period.

After components and materials are dismantled and decontaminated, wastes with relatively low concentrations of radionuclides (LLW) are sent to a licensed LLW disposal facility where they are typically buried in near-surface shallow trenches, covered with clay and gravel for drainage, and coated with a layer of topsoil. Spent fuel could remain stored in the spent fuel pool or in dry cask storage facilities until such time that a geologic repository is built and operating. The USNRC has decided that, if necessary, spent fuel generated in any reactor can be safety stored without significant impacts for at least 30 years beyond the licensed operating life of the reactor.[i]

Decommissioning is accounted in the design criteria for new facility construction. USNRC regulations contain design criteria for surface facilities in the geologic repository operations area are provided in 10 CFR Part 60.132. Surface facilities are designed to facilitate decontamination or dismantlement. Also, the regulations provide that the ISFSI is designed for decommissioning. Provisions must be made to facilitate decontamination of structures and equipment, minimize the quantity of radioactive wastes and contaminated equipment, and facilitate the removal of radioactive wastes and contaminated materials at the time the ISFSI is permanently decommissioned.

F.12.2 USDOE Decommissioning Approach

The management approach to disposing of excess USDOE facilities is set forth in USDOE Order 430.1A, “Life Cycle Asset Management.” In general, excess facility disposition phases encompass transition, deactivation, surveillance and maintenance, and decommissioning. Figure F-1 illustrates the USDOE approach, which is comprised of 5 distinct periods:

- Period 1. Operations. Operations is characterized by an operating or shut down facility that is under the control of a program other than the program responsible for decommissioning. Once the program establishes that there is no further need for the facility, it is declared excess and candidate for transfer.
- Period 2. Transition. Transition occurs between operations and disposition in a facility’s lifecycle. Transition begins once a facility has been declared or forecast to be excess to current and future needs. It includes placing the facility in stable and known conditions, identifying hazards and characterizing the facility conditions, eliminating or mitigating hazards and conducting stabilization, and transferring

[i] This is the Waste Confidence Determination; See B.10.

programmatic and financial responsibilities from the operating program to the disposition program. In preparation for the disposition phase, it is important that material, systems, and infrastructure stabilization activities be initiated prior to the end of facility operations. Where possible, materials requiring special handling (e.g., classified equipment or nuclear materials) should be removed at shutdown. During transition, a determination is made as to whether the facility will be either deactivated for reuse, deactivated in preparation for eventual decommissioning (decontamination and/or dismantling), or decommissioned immediately. The organization that will be responsible for follow on activities must be involved in this determination. For some facilities an operational campaign may be required to establish stabilized conditions before proceeding to final shutdown. Examples include: 1) a run to process a large quantity of highly radioactive or chemically reactive liquids for the purpose of cleaning a process system, and 2) removal of nuclear fuel so an area can be made accessible.

- Period 3. Deactivation. During this period surveillance and maintenance continues to assure public, environment, and worker safety. As deactivation proceeds, unneeded systems within the facility are terminated, additional hazard reduction may be conducted, and the surveillance and maintenance burden decreases commensurate with achieved risk reduction, resulting in a stable, low risk condition which is economically and technically practical to maintain for an extended period. Update of safety documentation to reduce a nuclear facility's hazard classification will be of value to post-deactivation surveillance and maintenance. Activities during this period, for example, include disposal of remaining hazardous chemicals, isolation of systems and equipment, and removal of valuable excess equipment. Appropriate characterization and documentation should be conducted for remaining contamination and waste, and for other sensitive materials that cannot be removed (chemical, hazardous, radioactive, fissile, nuclear fuel, special nuclear, and other accountable materials). This is to support safety updates, specifying deactivation end points, and planning post-deactivation surveillance and maintenance.

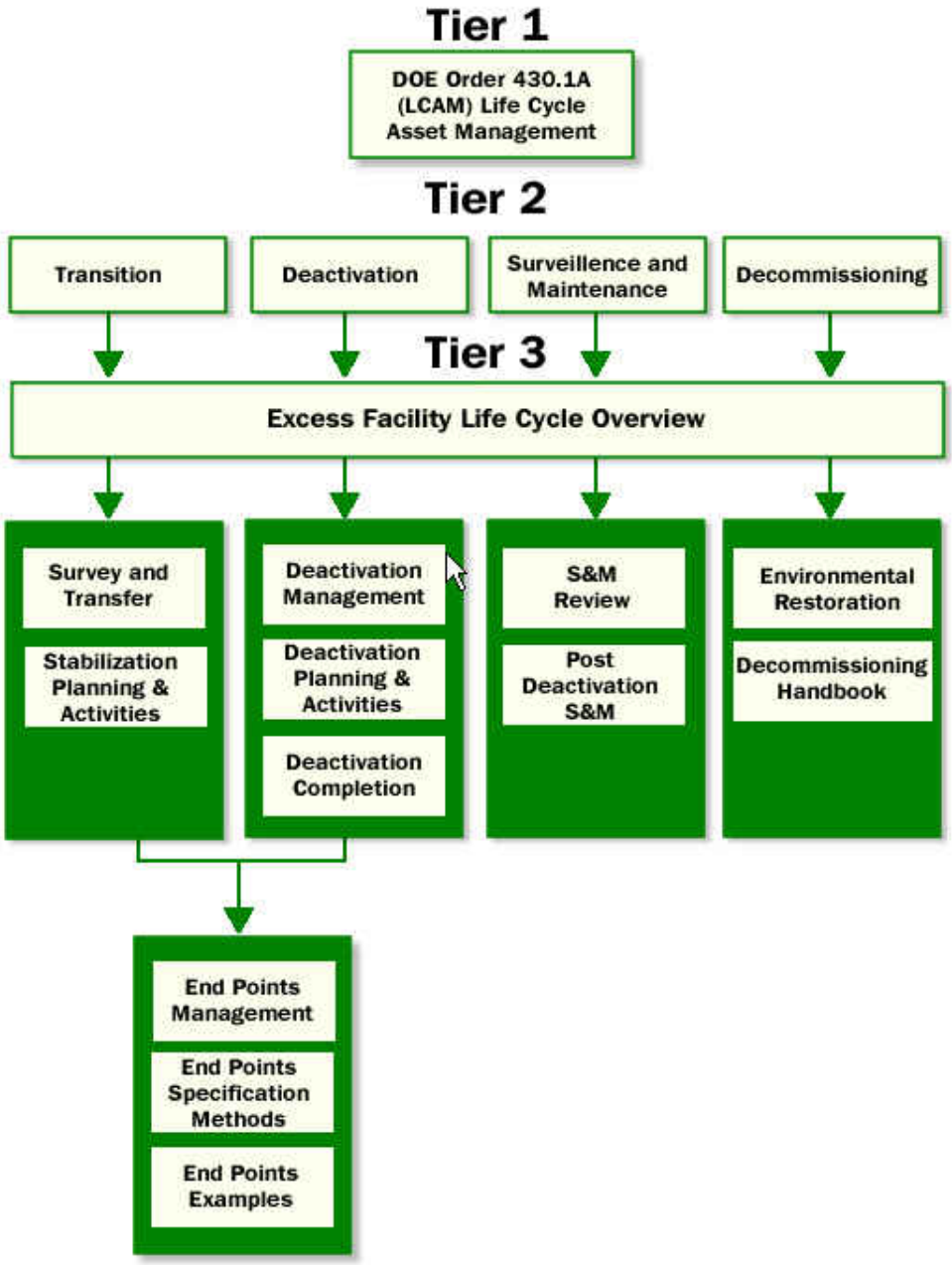
- Period 4. Post-Deactivation Surveillance and Maintenance. The facility is in a safe storage mode, with ongoing, low levels of surveillance and maintenance. Generally, the facility is unoccupied and locked except for periodic inspections. If the period between completion of deactivation and beginning of decommissioning becomes extended, an occasional need for refurbishment or repair may be needed; for example, roof repairs, exhaust fan replacement, surveillance instrumentation maintenance, etc. Radioactive and hazardous materials may remain in the facility and are subject to ongoing regulatory oversight.

- Period 5. Decommissioning. Based on resources, decommissioning and ultimate disposition of a facility will be scheduled in accordance with an overall national priority.

The regulatory process for decommissioning varies depending upon the specific activity. Additional information on waste management from cleanup of past practice sites is provided in Section H.2.1.

Additional details on this approach are provided on the USDOE website at: http://www.em.doe.gov/deact/.

Figure F-1. USDOE Decommissioning Approach



G. SAFETY OF SPENT FUEL MANAGEMENT

Section F described aspects common to spent fuel and radioactive waste safety per Articles 4-9 of the Joint Convention. 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 (Corresponds to Article 4)

In general, the licensing requirements for the independent storage of spent fuel, HLW and reactor related greater than Class C wastes are contained in 10 CFR Part 72. The licensing requirements for disposal of high-level waste, including spent fuel at a permanent geologic repository, are contained in 10 CFR Parts 60 or 63. General safety requirements are found in the National Environmental Policy Act (implemented by the USNRC through 10 CRF Part 51) and the Nuclear Waste Policy Act. Other regulations that apply are 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-2 lists key USNRC regulations.

The USNRC approves spent fuel dry storage systems by evaluating each design for resistance to normal conditions of use and accident conditions such as floods, earthquakes, tornado missiles, and temperature extremes. The heat generated from the fuel assemblies stored in each cask is different for each design. The maximum heat generated by the fuel in the highest capacity thermal cask is approximately equal to 320 100-watt light bulbs. However, the temperature of the fuel in the casks is continuously decreasing over time. The first spent fuel dry storage cask was placed in service in July 1986. No releases of spent fuel storage cask contents or other significant safety problems from the dry cask storage systems in use today have been reported.

USNRC authorizes storage of spent fuel at an ISFSI under two licensing options: site-specific licensing and general licensing. Under a site-specific license, an applicant submits a license application to USNRC and the USNRC performs a technical review of all the safety aspects of the proposed ISFSI. If the application is approved, the USNRC issues a license that is valid for 20 years. USNRC regulations also include provisions for renewal of an ISFSI license. A spent fuel storage license contains technical requirements and operating conditions (fuel specifications, cask leak testing, surveillance, and other requirements) for the ISFSI and specifies what the licensee is authorized to store at site.

A general license, authorizes a nuclear power plant licensee to store spent fuel in USNRC-approved casks at a site that is licensed to operate a power reactor under 10 CFR Part 50. Licensees are required to perform evaluations of their site to demonstrate that the site is adequate for storing spent fuel in dry casks. These evaluations must show that the cask Certificate of Compliance conditions and technical specifications can be met; including analysis of earthquake intensity and tornado missiles. The licensee must also review their security program, emergency plan, quality assurance program,

training program and radiation protection program, and make any necessary changes to incorporate the ISFSI at its reactor site.

An USNRC-approved cask is one that has undergone a technical review of its safety aspects and been found to be adequate to store spent fuel at a site that has been evaluated by the licensee to meet all of the USNRC requirements in 10 CFR Part 72. The USNRC issues a Certificate of Compliance for a cask design to a cask vendor if the review of the design finds it technically adequate. The cask certificate expires 20 years from the date of issuance with a re-approval option.

With respect to public involvement, stakeholders can and do participate in the USNRC licensing process. The Atomic Energy Act of 1954, as amended, and USNRC regulations contain provisions for public hearings and other means, such as petitions and rulemaking requests for the public to challenge USNRC decisions and licensing actions.

G.1.1 Interdependencies Between Different Steps in the Spent Fuel Management Process

The USDOE and USNRC each have roles in managing spent fuel from generation through disposition. The USDOE develops and implements policies, strategies, and programs to safely, effectively, and efficiently manage the current and future inventory of USDOE-owned spent fuel and foreign research reactor spent fuel. This is intended to ensure the integration of spent fuel management activities within USDOE, such as for the planned Yucca Mountain repository. These efforts are intended to:

- Identify and integrate spent fuel requirements to assure safe existing storage and resolution of vulnerabilities, achieve safe and secure interim storage, and prepare for eventual disposition in a geological repository;

- Manage and coordinate foreign research reactor spent fuel acceptance activities with the U.S. Department of State, foreign research reactor operators and foreign government officials, and other agencies required to plan and negotiate contracts and diplomatic understandings for participation in the program; and

- Ensure that regulatory (federal, state, and local) and safety requirements are implemented.

These efforts are responsible for bringing broader, national perspectives to individual site spent fuel management projects. Integration promotes lessons learned and sharing of issues and solutions between sites. The USDOE maintains two national spent fuel databases on spent fuel inventories for both governmental and commercial sectors.

The USNRC integrates the regulatory management of the interim storage and transportation of spent fuel with its future permanent disposal. Such integration addresses licensing, certification, safety inspections of waste packages, and quality assurance. Other considerations include interfacing on topics such as international waste management, decommissioning activities, and research.

G.1.2 Avoidance of Undue Burden/Impacts on Future Generations

The U.S. policy to dispose of spent fuel in geologic repositories is aimed at not placing undue burdens on future generations. Over the past 5 decades, leading scientists in the U.S. have advocated deep geologic repository disposal to safely manage spent fuel in perpetuity.

While promulgating disposal standards for the Yucca Mountain geologic repository, USEPA considered numerous comments from the public, some of which addressed impacts on future generations. The public comments strongly favored the position that we should not allow greater risks for future generations than are judged acceptable today. In its publication of disposal standards for Yucca Mountain, the USEPA stated that the standards ensure that future generations, for a very significant time period (10,000 years), do not have impacts greater than today. In addition, repository performance assessment models must calculate the peak dose to the reasonably maximally exposed individual beyond 10,000 years. The USDOE analyses to date indicate that the repository should be within the prescribed radiation exposure and activity concentration limits in 40 CFR Part 197 and 10 CFR Part 63 during the 10,000-year period after closure. While the individual protection standard protects those in the vicinity of the proposed Yucca Mountain repository, the groundwater standard protects those at greater distances consuming locally grown agricultural products.

To further ensure that future generations have flexibility, the planned repository may not be closed for some time after completion of emplacement. For example, repository closure, with proper maintenance, could begin 50 to 300 years after the completion of emplacement of spent fuel disposal packages. During this time, the repository will be monitored to ensure that it is performing as expected.

G.2 Existing Facilities (Corresponds to Article 5)

The ISFSIs in the U.S. use about 20 different storage cask system designs. The designs encompass the entire range of possible multi-purpose canister, vault storage system, and metal casks. These storage casks are made by about seven different vendors and have been approved or certified by the USNRC. Almost all ISFSIs are owned and operated by 10 CFR Part 50 power reactor license holders. However, two facilities owned by non-reactor entities hold a site-specific license under 10 CFR Part 72 authorizing the storage of spent fuel. These two facilities are located offsite from a nuclear power plant.

An ISFSI operated by the USDOE represents a substantial spent fuel management facility upgrade, which was completed before ratification of the Joint Convention The ISFSI stores core debris and spent fuel from the Three-Mile Island Unit-2 (TMI-2) reactor accident in Pennsylvania in 1979. In the mid-1980's the debris and spent fuel were taken to the USDOE Idaho National Engineering and Environmental Laboratory (INEEL) for investigation of the accident and resulting fuel damage. Since that time, the core debris and spent fuel were stored in a water-filled storage pool at INEEL. The USDOE received a license from the USNRC allowing stored canisters to be removed from the aging pool facility, dried in a heated vacuum furnace, repackaged in welded steel

containers, transported, and stored in an ISFSI constructed specifically for the TMI-2 fuel debris. Between 1999 and 2001 the TMI-2 spent fuel and debris were repackaged and moved to the ISFSI.

G.3 Siting of Proposed Facilities (Corresponds to Article 6)

The NWPA, as amended, provides for the siting of a deep geologic repository that could be used to dispose of spent fuel and HLW. Any such repository would be licensed by the USNRC. Pursuant to the NWPA, the Secretary of Energy, the President, and the U.S. Congress have acted to designate Yucca Mountain as the site of the first such repository. The USDOE is preparing a license application for submission to the USNRC to receive authorization to begin construction of a repository at Yucca Mountain. Specific licensing provisions, for the proposed Yucca Mountain geologic repository, are codified in 10 CFR Part 63

If other repositories for HLW and spent fuel disposal become necessary in the future, siting would be governed by USNRC regulations published in 10 CFR Part 60. These regulations prescribe site characterization activities required and pre-license application reviews by USNRC. The regulations also provide for participation in the pre-licensing (site) review and licensing review by states and affected Indian Tribes. Information will be publicly available through the formal licensing docket maintained in public reading rooms by USNRC.

The USNRC regulations, governing licensing of independent storage facilities for spent fuel and high-level radioactive waste, are published in 10 CFR Part 72. These regulations establish requirements, procedures, and criteria for the issuance of licenses to receive, transfer, and possess power reactor spent fuel, power reactor-related GTCC waste, and other radioactive materials associated with spent fuel storage in an ISFSI. These regulations provide the terms and conditions under which the USNRC will issue these licenses. In addition 10 CFR Part 72 establishes requirements, procedures, and criteria for the issuance of licenses to the USDOE to receive, transfer, package, and possess power reactor spent fuel, HLW waste, power reactor-related GTCC waste, and other radioactive materials for storage in a monitored retrievable storage installation. The U.S. does not have plans at this time to site or construct a monitored retrievable storage installation. The regulations in this part also establish requirements, procedures, and criteria for the issuance of Certificates of Compliance approving spent fuel storage cask designs. The regulations prescribe the license application requirements and licensing process, among other requirements. The regulations also provide for public inspection of licensing applications and documents. Information is publicly available through the formal licensing docket maintained in public reading rooms by USNRC.

If the proposed ISFSI will be located at or in the vicinity of an existing licensed site such as a nuclear power plant, much of the existing siting information may be used. The USNRC responsibilities for siting are from the Atomic Energy Act of 1954, as amended, and the Energy Reorganization Act of 1974. These statutes give broad regulatory powers to the USNRC, and specifically authorize the USNRC to promulgate regulations that it deems necessary to fulfill its responsibilities. USNRC regulations are integral to protecting public health and safety and the environment. 10 CFR Part 72 Subpart E

contains both general considerations and specific requirements to ensure that site characteristics that may directly affect the safety or the environmental impact of the ISFSI are to be investigated and assessed.

G.4 Design and Construction of Spent Fuel Storage Facilities (Corresponding to Article 7)

As discussed in the Section G.3, USNRC has 3 primary regulations that apply to spent fuel management facilities, 10 CFR Part 60 and 10 CFR Part 63 for geologic disposal facilities and 10 CFR 72 for storage facilities and storage casks.

G.4.1 Facilities

The design criteria contained in 10 CFR Part 72 Subpart G establish the design, fabrication, construction, testing, maintenance and performance requirements for structures, systems, and components important to safety as defined in 10 CFR 72.3. These are minimum requirements for the design criteria for an ISFSI.

G.4.2 Spent Fuel Storage Casks

The requirements contained in 10 CFR Part 72 Subpart L, establish requirements for spent fuel storage cask design approval and fabrication for use by general licensees. This subpart also contains requirements/ conditions for re-approval of designs for which a certificate of compliance (USNRC approval) has been issued, record keeping and report requirements, process for amending a certificate of compliance and for periodic updating of safety analysis reports. Quality assurance requirements apply to both the facility and certificate of compliance holder. These requirements can be found in 10 CFR Part 72, Subpart G.

The USNRC staff review applications (safety analysis reports) according to NUREG-1536, “Standard Review Plan for Dry Cask Storage Systems,” and NUREG-1567, “Standard Review Plan for Spent Fuel Dry Storage Facilities.” These plans assure the quality and uniformity of staff reviews of applications. NUREG-1613 “Standard Review Plan for Transportation Packages for Spent fuel” is used to review and approve transportation applications.

G.5 Assessment of Safety of Facilities (Corresponds to Article 8)

For spent fuel disposal facilities, by law the USDOE utilizes the USNRC licensing process. The “Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada,” was issued in February 2002 and accompanied the site recommendation sent to the President. This life cycle environmental assessment

includes public comments received on a 1999 Draft Environmental Impact Statement prepared for the Yucca Mountain Site and Supplement to the Draft issued in 2001.

Other recent assessments prepared by the USDOE for the Yucca Mountain Project include:

- "Yucca Mountain Science and Engineering Report," (S&ER) Revision 1, was issued in February 2002 when the site recommendation was sent to the President. It describes the reference design of the repository considered in the site recommendation.

- *"*Preliminary Site Suitability Evaluation*"* and "Site Suitability Evaluation,*"* (SSE) respectively, provided preliminary and final evaluations of the site's performance against the USDOE proposed and final site suitability guidelines (10 CFR Part 963).

- "Technical Update Report" updated potential impacts on results of total system performance assessment referenced in the S&ER and SSE based on updated information.

G.6 Operations of Facilities (Corresponds to Article 9)

The USNRC relies on regulations and internally developed licensing and inspection programs in granting the authorization to store spent fuel or reactor related GTCC waste at an ISFSI or to approve storage cask design and in ensuring the operation of the ISFSI. Since the first ISFSI went operational in 1985, no releases from any cask leakage or radiation safety problems have occurred.

Effective April 5, 2001, 10 CFR Part 72.48 was revised to better define the changes in the cask design or procedures that can be made without a license amendment request. In implementing this rule change, some control of the operational limits could be shifted from the technical specifications to the Final Safety Analysis Report. The objective of this effort was to replace the current detailed technical specifications with more general standard technical specifications that concentrate on controlling the parameters that are most important to maintaining safety. The remaining parameters/conditions of lesser importance would be handled under the 10 CFR Part 72.48 process. The licensee or certificate holder would notify USNRC of the safety analysis report updates but no review or approval by USNRC would be required. The 10 CFR Part 72.48 analysis would be audited during routine USNRC inspections.

Working closely with industry, the USNRC issued guidance regarding the standard format and content for technical specifications and recommendation 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."

Requirements for incident reporting are specified in 10 CFR Part 72.74, Part 72.75, and Part 72.80. The rules require reporting to the USNRC of significant events for which the USNRC may need to act to maintain or improve safety or to respond to public concerns.

G.7 Examples of Improvements to Existing Spent Fuel Management Facilities

The USDOE has two significant projects underway to improve the safety at USDOE spent fuel storage facilities. These include:

Spent Fuel Dry Storage Privatization Project at INEEL. This project includes packaging and upgraded storage (from pool storage to dry storage) of selected spent fuel at INEEL. The four-phased project includes design, licensing by the USNRC, construction of the facility, spent fuel packaging, and spent fuel storage. Completion of construction and beginning of the movement of fuel loading is planned for late 2004. The dry storage project will be designed to accommodate spent fuel elements currently at INEEL, which originated from the Peach Bottom and Shippingport nuclear power plants and various training and research reactors.

Hanford Spent Nuclear Fuel Project. The Hanford Spent Nuclear Fuel Project was begun in 1994 to move metallic spent fuel, which originated in USDOE defense production reactors, from degraded pool storage conditions in the 105K East and 105K West Basins along the banks of the Columbia River to safe, dry interim storage in the 200 Area on the Central Plateau at Hanford until the planned federal repository is available. The project will also remove sludge and debris from the basins and provide treatment to reduce tritium levels in the basin water. Spent fuel is currently being removed, dried, repackaged into multi-canister overpacks, transported, and placed in the interim storage facility. Additionally, other spent fuel stored at various locations on the Hanford Site will be consolidated in the 200 Area interim storage facility for eventual shipment offsite for disposition.

G.8 Disposal of Spent Fuel (Corresponds to Article 10)

Until a geologic repository is licensed and operational, the spent fuel is being stored. The storage of spent fuel in an ISFSI is considered to be an interim action and not a final disposal solution. The U.S. government has clearly distinguished between permanent disposal and interim storage. While the licensing decision and possible construction of the geological repository for spent fuel and HLW proceeds, nuclear power plants will continue to operate, produce power and generate more spent fuel. Most reactors need to maintain the capability of discharging a full core into the storage pool. Reactor plants have achieved expansion of the storage capacity by reracking the spent fuel storage pools. However, increases in spent fuel storage capacity will occur through the period required to license, construct and operate a geologic repository. This will result in a need for continued interim dry storage of spent fuel.

H. SAFETY OF RADIOACTIVE WASTE MANAGEMENT

Section F described aspects common to spent fuel and radioactive waste safety per Articles 11-16 of the Joint Convention. This section provides additional information relative to the same Articles pertaining solely to radioactive waste management. This section also addresses Article 17 of the Joint Convention.

As in most of the activities and sites associated with the generation, predisposal and disposal management of radioactive waste, the fundamental legal basis is provided in the U.S. Atomic Energy Act. Under this general authority and other subsequent legislation (see Table E-1), the USEPA has general and broad authority to promulgate standards in the areas of management of radioactive waste and more broadly in areas that could affect human health, safety and the protection of the environment. The USNRC issues regulations pertinent to the activities and facilities that it regulates (nuclear fuel cycle facilities, medical and research activities, etc.). Likewise the USDOE issues Orders to manage its activities and operations for those facilities outside of the commercial applications. These Orders tend to be compatible with the corresponding regulations that the USNRC issues. This process is discussed in greater detail in Section E.

For the safe management of radioactive waste (or any licensed activity dealing with radioactive materials), the USNRC establishes the fundamental radiological protection limits in the 10 CFR Part 20, "Standards for Protection Against Radiation." Likewise, the USDOE Order that applies specifically to radioactive waste management is USDOE Order 435.1, “Radioactive Waste Management.” Through this Order and its implementing guide and manual, the USDOE ensures that all radioactive waste is managed in a manner that is protective of worker public health and safety and the environment. USDOE Order 435.1 applies to all USDOE radioactive waste classes, including HLW, TRU waste, and LLW. The requirements span the life cycle of waste management facilities from planning through decommissioning and closure. The Order references other USDOE requirements on radiation protection, environmental protection, and occupational safety discussed in Section F.

For the commercial sector, radioactive waste is regulated as HLW, LLW, and uranium mill tailings. However, the types of radioactive materials are categorized as source, special nuclear and byproduct material. The USNRC regulatory program for disposal and radioactive waste management of commercial spent fuel is addressed in sections F and G. This section will address USNRC radioactive waste management safety requirements for LLW and uranium recovery programs. The categorization of different kinds of regulated commercial radioactive waste is addressed in detailed in section C.6.

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

The commercial sector’s LLW is typically stored on-site by licensees, 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 in containers approved by the U.S. Department

of Transportation.[i] LLW disposal occurs at commercially operated LLW disposal facilities that must be licensed by either the USNRC or Agreement States in accordance with health and safety requirements. The facilities must be designed, constructed, and operated to meet safety standards. The operator of the facility must also extensively characterize the site on which the facility is located and analyze how the facility will perform for thousands of years into the future.

The Low-level Radioactive Waste Policy Amendments Act of 1985 gave states responsibility for the disposal of LLW generated within their borders. Currently, 32 of the 50 states have entered into Agreements with USNRC, and others are currently being evaluated. The Act encouraged the states to enter into compacts that would allow them to dispose of waste at a common disposal facility and exclude waste from states outside the compact. Most states have entered into compacts; however, no new disposal facilities have been built since the Act was passed. Figure H-1 shows the makeup of U.S. regional compacts for LLW disposal.

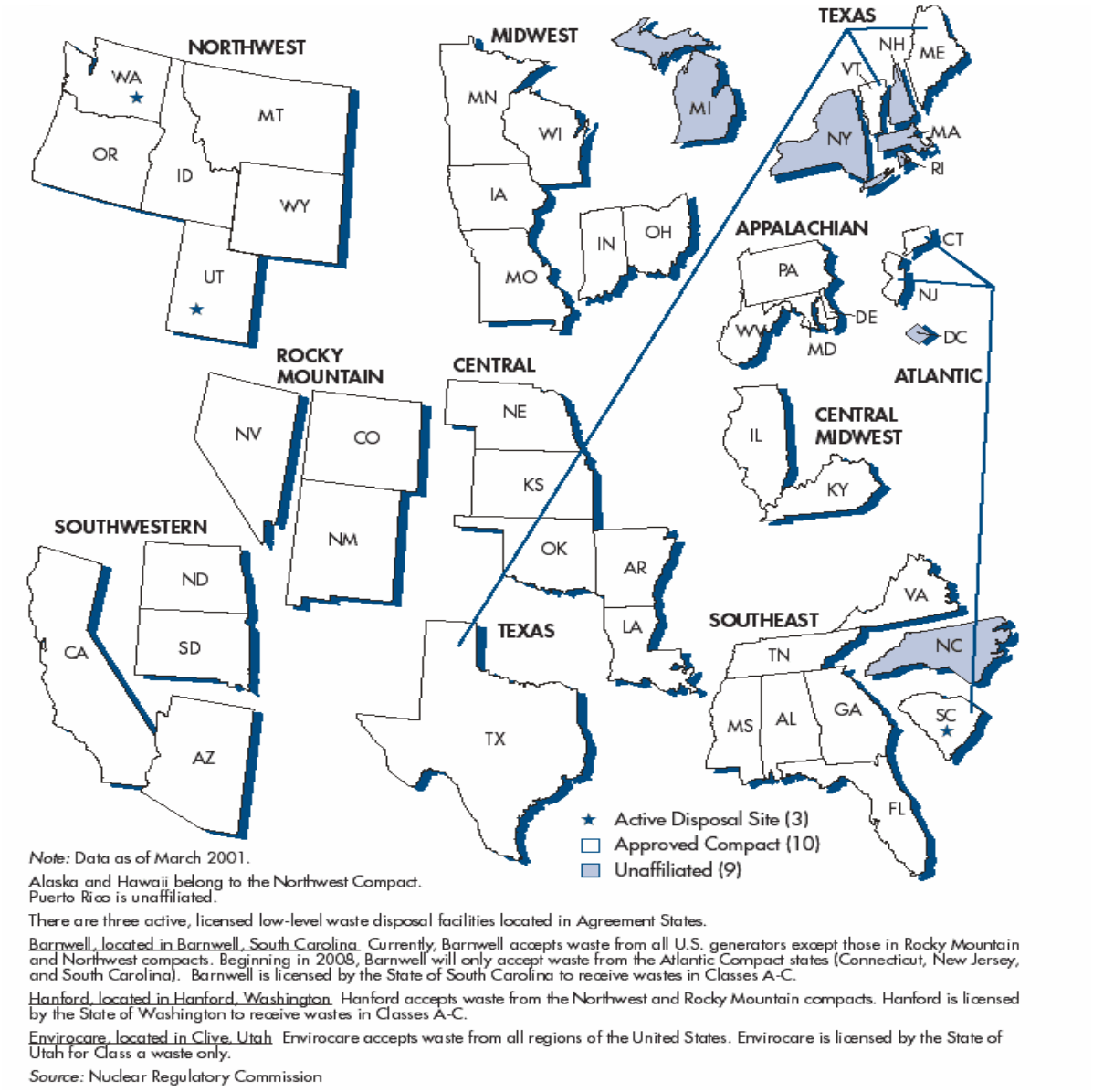
The concept of regional compacts was to discourage the propagation of LLW disposal sites throughout the U.S. Unaffiliated states have opposed the concept, because of the LLWPAA provision that compact states could exclude LLW from outside of the compact. Currently, no facility has been solely licensed as a regional compact disposal facility.

USNRC provides assistance to states expressing interest in establishing programs to assume USNRC regulatory authority (Agreement States) under the Atomic Energy Act of 1954, as amended, which provides a statutory basis under which USNRC relinquishes to the states portions of its regulatory authority to license and regulate byproduct materials (radioisotopes); source materials (uranium and thorium); and certain quantities of special nuclear materials. The mechanism for the transfer of USNRC authority to a state is an agreement signed by the Governor of the state and the Chairman of the USNRC.

USNRC 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 USNRC review comments, and recommendations for USNRC approval of proposed agreements. Additionally, USNRC conducts training courses, workshops; evaluates technical licensing and inspection issues from Agreement States; evaluates state rule changes; participates in activities conducted by the Conference of Radiation Control Program Directors, Inc.; and provides early and substantive involvement of the states in USNRC rule making and other regulatory efforts. The USNRC also coordinates with Agreement States the reporting of event information and responses to allegations reported to USNRC involving Agreement States.

The 3 existing commercial LLW disposal sites in the U.S. that accept various types of LLW are discussed in section D. All are in Agreement States.

[i] For more detailed information on LLW, see USNRC brochure “Radioactive Waste: Production, Storage, Disposal,” (NUREG/BR-0216) and USNRC fact sheet on “Low-Level Radioactive Waste”.



Note: Data as of March 2001.

Alaska and Hawaii belong to the Northwest Compact.
Puerto Rico is unaffiliated.

There are three active, licensed low-level waste disposal facilities located in Agreement States.

Barnwell, located in Barnwell, South Carolina. Currently, Barnwell accepts waste from all U.S. generators except those in Rocky Mountain and Northwest compacts. Beginning in 2008, Barnwell will only accept waste from the Atlantic Compact states (Connecticut, New Jersey, and South Carolina). Barnwell is licensed by the State of South Carolina to receive wastes in Classes A-C.

Hanford, located in Hanford, Washington. Hanford accepts waste from the Northwest and Rocky Mountain compacts. Hanford is licensed by the State of Washington to receive wastes in Classes A-C.

Envirocare, located in Clive, Utah. Envirocare accepts waste from all regions of the United States. Envirocare is licensed by the State of Utah for Class a waste only.

Source: Nuclear Regulatory Commission

Figure H-1. U.S. Low-Level Waste Compacts

H.2 USDOE Waste Management Facilities

General safety requirements for USDOE facilities were discussed in Section F (pertaining to Article 11 of the Joint Convention). The following subsections contain additional information specific to the safety of radioactive waste management at USDOE facilities.

The USDOE manages radioactive waste from government-sponsored programs including waste resulting from defense activities and cleanup of former defense waste sites. The USDOE Order 435.1 is implemented through a manual that catalogs

procedural requirements and existing practices to ensure that (Manual 435.1-1) all waste is managed in manner that is protective of the public and the environment. This manual has separate chapters that delineate requirements for each class of radioactive waste managed: HLW, TRU waste, and LLW. Chapters in the manual have diverse subsections that address general and specific waste classification requirements. Topics include complex-wide waste management programs, site-wide waste management programs, waste management basis, quality assurance program, contingency actions, corrective actions, waste acceptance, waste generation planning, waste characterization, waste certification, waste transfer, packaging and transportation, site evaluation and facility design, storage, treatment, disposal, monitoring, and closure. The manual is very extensive and serves as the basis for safe radioactive waste management practices at USDOE facilities. Compliance with Order 435.1 requires a comprehensive waste management program by operators of government facilities and projects, under USDOE oversight.

H.2.1 Past Practices (Corresponds to Article 12)

The USDOE ensures the management and disposal of radioactive waste resulting from environmental restoration activities, including decommissioning, meet the substantive requirements of USDOE Order 435.1, “Radioactive Waste Management.” Environmental restoration activities using the CERCLA (See Section F.1.5) process may demonstrate compliance with the substantive requirements of USDOE Order 435.1, including the performance assessment and performance objectives, as well as the composite analysis described below) through the CERCLA process. However, compliance with all substantive requirements of USDOE Order 435.1 not met through the CERCLA process must be demonstrated. Environmental restoration activities which will result in the off-site management and disposal of radioactive waste must meet the applicable requirements of USDOE Order 435.1 for the management and disposal of those off-site wastes. Organizations performing environmental restoration activities, involving development and management of radioactive waste disposal facilities under the CERCLA process, submit certification that compliance with the substantive requirements of USDOE Order 435.1 have been met through application of the CERCLA process. They also submit the decision document, such as the Record of Decision, or any other document that serves as the authorization to dispose for approval.

Section H.2.4 provides additional requirements related to closure of waste management facilities, some of which may be attributed to past practices.

H.2.2 Siting of Proposed Facilities (Corresponds to Article 13)

New radioactive waste management facilities, operations, and activities are sited and designed in accordance with USDOE Order 420.1A, “Facility Safety,” and USDOE Order 430.1A, “Life- Cycle Asset Management.” Proposed locations for radioactive waste management facilities are evaluated to identify relevant features that should be avoided or must be considered in facility design and analyses. Each site proposed for a new facility or expansion of an existing facility is evaluated considering environmental

characteristics, geotechnical characteristics, and human activities, including for a LLW disposal facility, the capability of the site to demonstrate, at a minimum, whether it is:

- Located to accommodate the projected volume of waste to be received;
- Located in a flood plain, a tectonically active area, or in the zone of water table fluctuation; and
- Located where radionuclide migration pathways are predictable and erosion and surface runoff can be controlled.

Proposed sites with environmental characteristics, geotechnical characteristics, and human activities for which adequate protection cannot be provided through facility design shall be deemed unsuitable for the location of the facility. Low-level waste disposal facilities are sited to achieve long-term stability and to minimize, to the extent practical, the need for active maintenance following final closure.

H.2.3 Design and Construction (Corresponds to Article 14)

Safety structures, systems, and components for high-level waste storage, pretreatment, and treatment facilities are designated and designed consistent with the provisions of USDOE Order 420.1A, and nuclear safety regulations (10 CFR 830). The following requirements apply to new or modifications to existing high-level waste systems, ancillary systems, and components:

- Secondary confinement systems are designed to prevent any migration of wastes or accumulated liquid out of the waste system; are capable of detecting, collecting, and retrieving releases into the secondary confinement; and are constructed of, or lined with, materials that are compatible with the waste(s) to be placed in the waste system; and
- Tank and piping systems used for high-level waste collection, pretreatment, treatment, and storage are welded construction, except where remote configurations or periodic rerouting of high-level waste streams require non-welded construction.

The design of hoisting and rigging devices complies with the following specific requirements. Lifting devices that are designated as safety class or safety significant are designed to prevent free fall of loads. Loading and unloading systems for lifting devices that are designated as safety class or safety significant are designed with a reliable system of interlocks that will fail safely upon malfunction. Remote maintenance features, and other appropriate techniques to maintain as low as is reasonably achievable (ALARA) personnel exposures, are incorporated into each HLW facility.

Designs for HLW storage facilities incorporate features to facilitate retrieval capability. High-level waste receipt and retrieval systems are designed to complement the existing storage facilities for safe storage and transfer of high-level waste. Designs for new tanks incorporate features to avoid critical degradation modes at the proposed site where

practicable, or minimize degradation rates for the critical modes; and incorporate features to facilitate execution of a structural integrity program

Engineering controls are incorporated in the design and engineering of radioactive waste treatment storage, pretreatment, and treatment facilities to provide volume inventory data and to prevent spills, leaks and overflows from tanks or confinement systems. Monitoring and/or leak detection capabilities are incorporated in the design and engineering of high-level waste storage, pretreatment, and treatment facilities to provide rapid detection of failed confinement and/or other abnormal conditions.

All radioactive waste management systems and components are designed to maintain waste confinement. Design of pretreatment, treatment, storage, and disposal facilities include ventilation, if applicable, through an appropriate filtration system to maintain the release of radioactive material in airborne effluents within the requirements and guidelines specified in applicable requirements. When conditions exist for generating gases in flammable or explosive concentrations, ventilation systems or other measures are provided to keep the gases in a non-flammable and non-explosive condition. Where concentrations of explosive or flammable gases are expected to approach the lower flammability limit, measures are taken to prevent deflagration or detonation. Areas in new and modifications to existing radioactive waste management facilities that are subject to contamination with radioactive or other hazardous materials are designed to facilitate decontamination. For such facilities a proposed decommissioning method or a conversion method leading to reuse is described.

Low-level waste disposal facilities are designed to achieve long-term stability and to minimize to the extent practical, the need for active maintenance following final closure and the contact of waste with water during and after disposal.

H.2.4 Assessment of Safety of Facilities (Corresponds to Article 15)

Radioactive waste facilities, operations, and activities shall have a radioactive waste management basis consisting of physical and administrative controls to ensure the protection of workers, the public, and the environment. Specific waste management controls are part of the radioactive waste management basis:

- For waste generators, the waste certification program;
- For pretreatment and treatment facilities, the waste acceptance requirements and the waste certification program;
- For storage facilities, the waste acceptance requirements and the waste certification program; and
- For LLW and TRU Waste Disposal Facilities. The performance assessment, composite analysis, disposal authorization statement, closure plan, waste acceptance requirements, and monitoring plan.

USDOE LLW disposal facilities are sited, designed, operated, maintained, and closed so that a reasonable expectation exists that the following performance objectives are met for waste disposed of after September 26, 1988:

- Dose[i] to representative members of the public does not exceed 0.25 mSv (25 mrem) in a year from all exposure pathways, excluding the dose from radon and its progeny in air;

- Dose to representative members of the public via the air pathway does not exceed 0.10 mSv (10 mrem) in a year total effective dose equivalent, excluding the dose from radon and its progeny; and

- Release of radon is less than an average flux of 0.74 Bq/m^2/s (20 pCi/m^2/s) at the surface of the disposal facility; alternatively, a limit of 0.0185 Bq/l (of 0.5 pCi/l) in air may be applied at the boundary of the facility.

A site-specific radiological performance assessment was prepared and is maintained for DOE LLW disposed of after September 26, 1988. The performance assessment includes calculations for a 1,000-year period after closure of potential doses to representative future members of the public and potential releases from the facility to provide a reasonable expectation that the performance objectives above are not exceeded as a result of operation and closure of the facility.

Analyses performed to demonstrate compliance with the performance objectives, and to establish limits on concentrations of radionuclides for disposal based on the performance measures for inadvertent intruders are based on reasonable activities in the critical group of exposed individuals. Unless otherwise specified, the assumption of average living habits and exposure conditions in representative critical groups of individuals projected to receive the highest doses is appropriate. The likelihood of inadvertent intruder scenarios may be considered in interpreting the results of the analyses and establishing radionuclide concentrations, if adequate justification is provided.

The point of compliance corresponds to the point of highest projected dose or concentration beyond a 100 meter buffer zone surrounding the disposed waste. A larger or smaller buffer zone may be used if adequate justification is provided.

Performance assessments address reasonably foreseeable natural processes that might disrupt barriers against release and transport of radioactive materials. Performance assessments use USDOE-approved dose coefficients (dose conversion factors) for internal and external exposure of reference adults. The performance assessment includes a sensitivity/uncertainty analysis. Performance assessments include a demonstration that projected releases of radionuclides to the environment are maintained ALARA. For purposes of establishing limits on radionuclides that may be disposed of near the surface, the performance assessment includes an assessment of impacts to water resources. For purposes of establishing limits on the concentration of radionuclides that may be disposed of near-surface, the performance assessment includes an assessment of impacts calculated for a hypothetical person assumed to

[i] 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.

inadvertently intrude for a temporary period into the LLW disposal facility. For intruder analyses, institutional controls are assumed to be effective in deterring intrusion for at least 100 years following closure. The intruder analyses use performance measures for chronic and acute exposure scenarios, respectively, of 1 mSv (100 mrem) in a year and 5 mSv (500 mrem) total effective dose equivalent excluding radon in air.

For LLW disposal facilities that received waste after September 26, 1988, a site-specific radiological composite analysis was prepared and is maintained. The composite analysis accounts for all sources of radioactive material that are left at the USDOE site and may interact with the LLW waste disposal facility, contributing to the dose projected to a hypothetical member of the public from the existing or future disposal facilities. Performance measures are consistent with USDOE requirements for protection of the public and environment and evaluated for a 1,000-year period following disposal facility closure. The composite analysis results are used for planning, radiation protection activities, and future use commitments to minimize the likelihood that current LLW disposal activities will result in the need for future corrective or remedial actions to adequately protect the public and the environment.

The performance assessment and composite analysis are maintained to evaluate changes that could affect the performance, design, and operating bases for the facility. Performance assessment and composite analysis maintenance includes research, field studies, and monitoring needed to address uncertainties or gaps in existing data. The performance assessment is updated to support the final facility closure. Additional iterations of the performance assessment and composite analysis are conducted as necessary during the post-closure period. Performance assessments and composite analyses are reviewed and revised when changes in waste forms or containers, radionuclide inventories, facility design and operations, closure concepts, or the improved understanding of the performance of the waste disposal facility in combination with the features of the site on which it is located alter the conclusions or the conceptual model(s) of the existing performance assessment or composite analysis. A determination of the continued adequacy of the performance assessment and composite analysis is made on an annual basis, and considers the results of data collection and analysis from research, field studies, and monitoring. Annual summaries of LLW disposal operations are prepared with respect to the conclusions and recommendations of the performance assessment and composite analysis and a determination of the need to revise the performance assessment or composite analysis.

A disposal authorization statement is obtained prior to construction of a new LLW disposal facility. USDOE sites with existing LLW disposal facilities obtained a disposal authorization statement in accordance with the schedule in the “Complex-Wide Low-Level Waste Management Program Plan.” The disposal authorization statement is issued based on a review of the facility's performance assessment, composite analysis, performance assessment and composite analysis maintenance, preliminary closure plan, and preliminary monitoring plan. The disposal authorization statement specifies the limits and conditions on construction, design, operations, and closure of the LLW facility based on these reviews. A disposal authorization statement is a part of the radioactive waste management basis for a disposal facility.

LLW disposal sites develop Disposal Facility Closure Plans. A preliminary closure plan is developed for review with the performance assessment and composite analysis. The closure plan is updated following issuance of 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. They include a description of how the disposal facility will be closed to achieve long-term stability and minimize the need for active maintenance following closure and to ensure compliance with the requirements of USDOE Order 5400.5, "Radiation Protection of the Public and the Environment." Closure plans also include the total expected inventory of wastes to be disposed of at the facility over the operational life of the facility.

Closure of a USDOE LLW disposal facility occurs within a five-year period after it is filled to capacity, or after a determination is made that the facility is no longer needed. Prior to facility closure, the final inventory of the LLW disposed in the facility is prepared and incorporated in the performance assessment and composite analysis, which is updated to support the closure of the facility. A final closure plan is prepared based on the final inventory of waste disposed in the facility, the plan implemented, and the updated performance assessment and composite analysis prepared in support of the facility closure.

Deactivated USDOE HLW facilities/sites are closed in accordance with: (1) the requirements of USDOE Order 430.1A, "Life-Cycle Asset Management" and requirements of USDOE Order 5400.5, "Radiation Protection of the Public and the Environment", for free release; (2) the CERCLA process; and/or (3) an approved closure plan. Under USDOE Order 435.1, "Radioactive Waste Management," a closure plan is developed for each HLW facility/site being closed that defines the approach and plans by which closure of each facility within the site is to be accomplished. This plan is completed and approved prior to the initiation of physical closure activities, and updated periodically to reflect current analysis and status of individual facility closure actions. The plan includes, at a minimum, the following elements:

- Identification of the closure standards/performance objectives;

- A strategy for allocating waste disposal facility performance objectives from the closure standards identified in the closure plan among the facilities/units to be closed at the site;

- An assessment of the projected performance of each unit to be closed relative to the performance objectives allocated to each unit under the closure plan;

- An assessment of the projected composite performance of all units to be closed at the site relative to the performance objectives and closure standards identified in the closure plan; and

- Any other relevant closure controls including a monitoring plan, institutional controls, and land use limitations to be maintained in the closure activity.

H.2.5 Operation of Facilities

It is the policy of the USDOE that radioactive waste shall be treated, stored, and in the case of LLW, disposed of at the site where the waste is generated, if practical; or at

another USDOE facility. If USDOE capabilities are not practical or cost effective, commercial treatment and storage are available options. Disposal of USDOE LLW at non-USDOE sites requires an exemption based on the requirements that non-USDOE facilities comply with such provisions as:

- Adherence to applicable Federal, State, and local requirements;
- Annual audits by USDOE approved personnel;
- Protection of public health and the environment; and
- Demonstration of performance objectives as detailed in Annex F-3.

TRU waste is disposed at WIPP in accordance with the requirements of 40 CFR Part 191, "Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes." Plans for the removal of TRU waste from retrievable earthen-covered storage facilities prior to shipment for disposal are established and maintained. Prior to commencing waste retrieval activities, each waste storage site is evaluated to determine relevant information on types, quantities, and location of radioactive and hazardous chemicals as necessary to protect workers during the retrieval process

Pertaining to stored liquid HLW, confinement systems in the form of partially buried steel storage tanks are operated and maintained so as to preserve the design basis. Secondary confinement systems, where provided, are operated to prevent any migration of wastes or accumulated liquid out of the waste confinement systems. A structural integrity program is developed for each HLW storage tank site to verify the structural integrity and service life of each tank to meet operational requirements for storage capacity. The program is capable of verifying and or identifying robustness, chemical and physical integrity, and detecting any failure of tank performance. Specific indicators are addressed in Annex F-3. The structural integrity of other storage components is verified to assure leak tightness and structural strength.

HLW treatment facilities are designed and implemented in a manner that will ultimately comply with DOE/EM 0093, "Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms," or DOE/RW-0351P, "Waste Acceptance System Requirements Document" for non-vitrified, immobilized HLW.

The requirements of RW-0333P, "Quality Assurance Requirements and Description," apply to those HLW items and activities important to waste acceptance/product quality. The evaluation and assessment requirements of RW-0333P and associated implementing procedures apply for HLW acceptance and product quality activities, in addition to the assessment requirements of other DOE directives.

Canisters of immobilized high-level waste awaiting shipment to a repository are:

- Stored in a suitable facility;
- Segregated and clearly identified to avoid commingling with LLW and TRU waste;

- Monitored to ensure that storage conditions are consistent with DOE/EM 0093, "Waste Acceptance Product Specifications for Vitrified High-level Waste Forms," or DOE/RW-0351, "Waste Acceptance System Requirements Document," for non-vitrified immobilized high-level waste.

Facilities and operating procedures for storage of vitrified high-level waste maintain the integrity of the canistered waste form.

H.2.6 Institutional Measures After Closure

Institutional control measures are integrated into land use and stewardship plans and programs, and shall continue until the facility can be released pursuant to USDOE Order 5400.5, "Radiation Protection of the Public and the Environment." The location and use of the facility is filed with the local authorities responsible for land use and zoning.

Monitoring occurs to ensure that radioactive waste management facilities are in compliance with the conditions in their authorization statement. Parameters sampled or monitored, at a minimum, include temperature, pressure (for closed systems), radioactivity in ventilation exhaust and liquid effluent streams, and flammable or explosive mixtures of gases. Facility monitoring programs include verification that passive and active control systems have not failed. For facilities storing liquid waste, liquid level and/or waste volume, and significant waste chemistry parameters are monitored. Monitoring programs also include physical inspections to verify that control systems have not failed

A preliminary monitoring plan for a LLW disposal facility is prepared and submitted to USDOE for review with the performance assessment and composite analysis. The monitoring plan is updated within one year following issuance of the disposal authorization statement to incorporate and implement conditions specified in the disposal authorization statement. The site-specific performance assessment and composite analysis are used to determine the media, locations, radionuclides, and other substances to be monitored. The environmental monitoring programs are designed to include measuring and evaluating releases, migration of radionuclides, disposal unit subsidence, and changes in disposal facility and disposal site parameters, which may affect long-term performance. The environmental monitoring programs are capable of detecting changing trends in performance to allow application of any necessary corrective action prior to exceeding the performance objectives.

At the WIPP repository for disposal of TRU waste (see Section B.4.2 and Section D.3.4), the USDOE will utilize 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. Groundwater monitoring will continue for at least 30 years after closure, and subsidence monitoring will continue for at least 100 years after closure. After the active institutional control period, passive institutional controls are required to inform and warn future generations about the location and purpose of this repository.

Regulations require that the TRU waste disposal site use markers and controls. These passive controls are expected to communicate the location, design, and contents of the disposal system for at least 10,000 years. Planned components include: a large earthen berm, perimeter monuments, buried warning markers, magnets and metal radiation symbols, an information center using graphics and various languages, and information storage rooms. In addition, archives will be stored in various locations around the world. A summary report is planned, written in multiple languages on archival-quality paper to preserve it for 10,000 years.

H.3 Uranium Recovery Wastes

As defined in the USNRC regulations of 10 CFR Part 40, uranium milling is any activity that results in the production of byproduct material as defined in this part. 10 CFR Part 40 defines byproduct material the same as Section 11e(2) of the Atomic Energy Act, "...the tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content," but adds "...including discrete surface wastes resulting from uranium solution extraction processes." While this section deals with safety practices, Section D.3.3 provides a thorough discussion of uranium recovery facilities in the U.S.

H.3.1 General Safety Requirements (Corresponds to 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, "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." The criteria in Appendix A cover the siting and design of tailings impoundments, disposal of tailings or wastes, decommissioning of land and structures, groundwater protection standards, testing of the radon emission rate from the impoundment cover, monitoring programs, airborne effluent and offsite exposure limits, inspection of retention systems, financial surety requirements for decommissioning and long-term surveillance and control of the tailings impoundment, and eventual government ownership of the tailings site under a USNRC general license.

The Office of Surface Mining, U.S. Department of Interior and individual states regulate mining. USNRC regulates milling and the disposal of tailings in non-Agreement States; although state agencies regulate these activities in Agreement States when the agreement specifically includes tailings. USNRC requires licensees to meet USEPA standards for cleanup of uranium and thorium mill sites after the milling operations have permanently closed. This includes requirements for long-term stability of the mill tailings piles, radon emissions control, water quality protection and cleanup, and cleanup of lands and buildings.

H.3.2 Existing Facilities/Past Practices (Corresponds to Article 12)

Only one USNRC-licensed conventional uranium mill is operating. Three other mills are still on stand-by status and may resume commercial operation in the future. Most of the conventional uranium mill sites have completed, or are completing, reclamation activities to provide long-term stabilization and closure of the tailings impoundments and the sites. Three of the six ISL facilities are presently operating, one is in stand-by status, one is decommissioning, and the other facility has not been built yet. The USNRC inspects these sites at semiannual to 3-year intervals depending on the operational (or stand-by) and reclamation status.

The USNRC-licensed sites are located in Nebraska, New Mexico, Utah, and Wyoming. There also are seven conventional uranium mills in Agreement States that have similar non-operational tailings impoundments. One mill in Colorado is operating. Texas also has ISL facilities, but most are in, or have completed, decommissioning. (See Section D.3.3 and Annex D-5)

A separate 11e(2) waste disposal facility, operated by Envirocare of Utah at South Clive, Utah, was licensed as a commercial facility in November 1993 to receive and dispose of 11e(2) byproduct material, including radioactive waste from conventional and other milling operations. The site also has disposal cells licensed under Utah Agreement State authority, for the disposal of low-level radioactive waste and mixed waste.

H.3.3 Uranium Recovery Radioactive Waste Management Facilities: Siting, Design and Construction (Corresponds to Articles 13 and 14)

As discussed previously, 10 CFR Part 40 addresses domestic licensing of source material. However, 11e(2) byproduct material, essentially radioactive wastes from uranium recovery, is addressed in this part of the U.S. Code of Federal Regulations. Specifically, Appendix A to 10 CFR Part 40, “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,” stipulates siting, design, construction, maintenance and surveillance of reclaimed tailings disposal piles, and many other regulatory aspects of management of uranium milling wastes. Specifically, the criteria in Appendix A cover the siting and design of tailings impoundments, disposal of tailings or wastes, decommissioning of land and structures, groundwater protection standards, testing of the radon emission rate from the impoundment cover, monitoring programs, airborne effluent and offsite exposure limits, inspection of retention systems, financial surety requirements for decommissioning and long-term surveillance and control of the tailings impoundment, and eventual government ownership of the tailings site under a NRC general license.

Appendix A to 10 CFR Part 40 Technical Criterion 1 stipulates that the broad objective in siting and design decisions is permanent isolation of tailings and associated contaminants by minimizing disturbance and dispersion by natural forces, and to do so without ongoing maintenance. Other criteria specify that specific siting decisions and design standards must involve finite times (e.g., the longevity design standard in Criterion 6). Additional considerations such as site features that will contribute to such a

goal or objective must be considered in selecting among alternative tailings disposal sites (e.g., remoteness).

Construction considerations include the preference for below grade disposal and reliance on a full self-sustaining vegetative cover or rock cover employed to reduce wind and water erosion to negligible levels.

In all there are 13 criteria for the siting, design, construction, operation, termination and post-closure provisions. These criteria can be accessed at the URL: http://www.nrc.gov/reading-rm/doc-collections/cfr/part040/part040-appa.html

H.3.4 Uranium Recovery Radioactive Waste Management Facilities: Safety Assessment (Corresponds to Article 15)

Safety assessment is performed as part of the application review process for a uranium recovery operation. As significant changes occur during the life of the facility, e.g., expansion of the tailings pile or increasing the number of ISL well fields, the licensee needs to provide an environmental report with sufficient information for USNRC to prepare an environmental assessment (under the provisions of NEPA – See Table E-1). Should the environmental assessment result in potential significant environmental impacts, a more complete EIS is prepared by USNRC. As a result of such an EIS, the licensee may have to revise the design and/or increase the financial assurance mechanism, which provides a measure of guarantee that there will be adequate funding for closure and disposal.

H.3.5 Uranium Recovery Radioactive Waste Management Facilities: Institutional Measures After Closure (Corresponds to Article 17)

Appendix A, Criterion 12 stipulates that the final design of the waste impoundment, i.e., the final disposition of tailings, residual radioactive material, or wastes at milling sites, should be such that ongoing active maintenance is not necessary to preserve isolation. A monetary mechanism is specified to ensure that surveillance and monitoring continue, but that active ongoing maintenance should not be needed, because of the robust impoundment design required by the other criteria.

I. TRANSBOUNDARY MOVEMENT

I.1 U.S. Policy Regarding Transboundary Movement of Spent Fuel and Radioactive Waste

As prospects for international transactions involving transboundary movements of various low-level and other types of radioactive waste increased and concern about illicit transfers of such wastes to lesser developed countries materialized, the importance of ensuring that transfers involving transboundary movement are undertaken in a manner consistent with internationally endorsed safety standards and practices was underscored. In the 1980s, the U.S. government actively supported the development and adoption of the "IAEA Code of Practice on the International Transboundary Movement of Radioactive Waste" as well as the subsequent development and adoption of the more formal international commitments regarding transboundary movement set forth in the Joint Convention. The U.S. Government strongly endorsed and promoted international adoption of the Joint Convention and Contracting Parties' acceptance of obligations to consider internationally accepted standards and criteria in the establishment and/or modification of their own national requirements for safely transferring spent fuel and radioactive waste whether they were exporting or importing such materials.

I.2 Governing Documents

The Atomic Energy Act of 1954, as amended, designates USNRC as the responsible regulatory and oversight authority for exports and imports of nuclear equipment and byproduct, source, and special nuclear materials out of and into the U.S. USNRC regulations for imports and exports of these materials, which were originally adopted by the USAEC under the "Atoms for Peace" program and which have evolved over time, can now be found at 10 CFR Part 110 (Part 110). Until 1995, these regulations were primarily designed to control exports and imports of radioactive materials, which, if used improperly, could significantly increase the risk of nuclear weapons proliferation.

I.3 Regulatory Controls for Exports/Imports of Nuclear Materials and Equipment Under USNRC Jurisdiction

NRC utilizes two types of export/import licenses – general and specific – in order to exercise specific controls over exports/imports of proliferation-sensitive nuclear materials and equipment and, at the same time, to provide for greater flexibility for exports/imports of the less sensitive nuclear materials and equipment.

I.3.1 General Licenses.

Although this is sometimes confused with the concept of license exemption, USNRC's general license authority is effective without filing an application with the USNRC, so long as the responsible company or person has an office located in the U.S. and nuclear material or equipment to be exported or imported falls into one of the categories described in 10 CFR Part 110, §§ 110.21 through §§ 110.30. The export/import transactions described in those sections of USNRC regulations can proceed without USNRC issuance of specific licensing documents though special reporting, record-keeping and other requirements may apply depending on the material, equipment or foreign country involved. USNRC's general export/import license authority does not relieve a person from complying with relevant domestic regulations, if the nuclear materials or equipment involved are subject to USNRC, Agreement State or other U.S. government agencies.

Prior to 1995, exporters/importers of radioactive materials not considered a nuclear weapons proliferation risk, such as LLW, were not required to obtain specific licenses from USNRC. Rather, radioactive waste was allowed to leave the U.S. under USNRC general export license authority pursuant to the general regulatory requirements set forth in 10 CFR Part 110, §§ 110.21-110.23, and to enter the U.S. under similar general regulatory authority set forth in § 110.27.

I.3.2 Specific Licenses

USNRC 10 CFR Part 110 regulations require that if exports/imports of nuclear materials and equipment are not subject to USNRC general license authority, then they are subject to specific export/import license authority. USNRC requires that specific licensing documentation be issued to a named person, who is a responsible authority at an established office in the U.S., where papers may be served and where records required by the USNRC will be maintained.

To obtain a specific license, a formal application (either an USNRC Form 7 for specific export license applications or a letter for specific import licenses and for all license amendments) must be submitted to the USNRC for review and approval. USNRC's 10 CFR Part 110 regulations describe the information that must be provided in specific license applications, the procedures for appropriate levels of review and consultations within USNRC and with other U.S. federal agencies, whether assurances and/or consents from foreign governments are required, and the criteria that will be evaluated to determine whether the license should be approved, for example, whether foreign countries are authorized recipients of such exports.

After considering information and/or recommendations that may be provided on specific export/import license applications, USNRC as the independent export/import licensing authority decides whether to issue a specific export or import license. USNRC's decision is based on the determination that the action would not be inimical to the common defense and security of the U.S. An applicant for an export/import license cannot proceed until USNRC issues a formal specific license at which time the applicant becomes an USNRC licensee subject to all relevant domestic requirements and

enforcement actions if they do not adhere to the terms and conditions of the specific license.

I.4 Issues Considered in Amending USNRC Regulations to Address for Exports and Imports of Radioactive Waste

At the same time U.S. officials were actively involved in efforts encouraging IAEA member states to seek and provide assurances that international transfers of radioactive wastes are effectively regulated, and public health and safety within a country's borders and in neighboring countries is protected, USNRC was also evaluating options to establish U.S. national policy for international transfers of radioactive wastes. Although it was clear that the U.S. needed to establish better controls over and greater accountability for U.S. companies involved in the export and import of radioactive wastes, USNRC did not wish to establish and apply controls that would also unnecessarily restrict transfers of radioactive materials that were not associated with nuclear weapons proliferation or as potentially endangering public health and safety if improperly handled. The process to develop and finalize U.S. regulations for the export and import of radioactive waste involved extensive review, consultation and revision.

In February 1990, USNRC took the first step by issuing an advance notice of proposed rulemaking describing the various options under consideration for regulating the export and import of radioactive waste and seeking public comments on these or other options. After reviewing the comments provided by interested parties including state and Federal government agencies, USNRC issued revised regulations in July 1995, which incorporated additional regulatory requirements into 10 CFR Part 110 for the export and import of radioactive wastes.

After considering various methods of providing advance notice and obtaining consent, USNRC concluded that the best approach for controlling exports or imports of "radioactive waste" out of or into the U.S. and holding exporters and importers accountable for their actions, would be to require them to first file an application with the USNRC and obtain a specific license for this purpose. In USNRC's view, this would be the most appropriate step the U.S. could take to ensure that the international transboundary movement of radioactive waste is managed safely. To effectively protect public health and safety without unnecessarily curtailing international trade, the U.S. developed the rationale for and clearly defined what additional exports and imports of nuclear materials should be controlled from a public health and safety standpoint as radioactive waste. At the same time, it was understood that a certain amount of flexibility needed to be preserved to facilitate continuation of useful practices.

The most difficult part of establishing new regulations governing the U.S. export and import of radioactive wastes was developing appropriate definitions to distinguish what additional materials needed to be controlled from those that did not need special controls. The USNRC's approach was to establish two new categories of materials: radioactive waste and incidental radioactive material. For the purposes of transboundary movement, the USNRC defined radioactive waste (See Glossary) in 10 CFR Part 110 to include, among other considerations, mixtures involving hazardous

wastes.[i] *Incidental radioactive material (See Glossary) was also defined to address any radioactive material not otherwise subject to specific licensing under Part 110 that is incidentally contained in or a contaminant of any non-radioactive material; again within specific conditions.* Because USNRC's regulations establish different categories of general licenses authorizing the export of special nuclear, source or byproduct materials, new requirements had to be added to each of the general export license categories to exclude "radioactive waste" and provide guidance on "incidental radioactive material". The changes to 10 CFR Part 110 general export license provisions are provided in Annex I-1. These deal with such issues as total weight limitations and restrictions on exports of special nuclear material.

Because a general export license could no longer be used for radioactive waste, a specific export license was required. For exports of incidental radioactive material, although an USNRC Form 7 must be submitted to USNRC before such an export takes place, the USNRC does not process this application and issue a specific export license. The information is reviewed to ensure that a specific export license is not required and records are maintained as necessary.

I.5 USNRC Regulatory Regime Relevant to Radioactive Waste Transboundary Movement Provisions of the Joint Convention

The following provides the USNRC regulatory status with regard to the Joint Convention's Article 27 provisions on transboundary movement involving radioactive waste and disused sealed sources:

1.(i) A State of origin shall take the appropriate steps to ensure that transboundary movement is authorized and takes place only with the prior notification and consent of the State of destination.

USNRC 10 CFR Part 110 regulations require prospective U.S. exporters of any material designated as radioactive waste to submit a formal application to and obtain a specific license from USNRC. USNRC performs an initial review of all applications to determine that required information is provided and, if so, forwards the application to the U.S. Department of State, which coordinates the review by interested U.S. Government agencies. The U.S. Department of State takes the lead for notifying and obtaining consent from the nation of destination.

(ii) Transboundary movement through States of transit shall be subject to those international obligations, which are relevant to the particular modes of transport utilized.

USNRC regulations assign responsibility for ensuring that nuclear materials are transported in accordance with established international requirements for packaging and

[i] Section 1004(5) of the Solid Waste Disposal Act, 42 U.S.C. 6903(5) defines hazardous wastes as "…a solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may - (A) cause, or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or (B) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed material for the purposes of USEPA standards for controlling chemical and toxic wastes that may or may not be mixed with radioactive components.

mode of transport to U.S. licensees. U.S. licensees are subject to enforcement and penalties if they do not comply with these requirements. In addition for all proposed export and import cases, USNRC relies on the U.S. Department of State to consult with foreign governments of transit countries as that agency deems appropriate, to obtain any necessary approvals to satisfy obligations undertaken pursuant to this principle of the Joint Convention.

(iii) A State of destination shall consent to a transboundary movement only if it has the administrative and technical capacity, as well as the regulatory structure, needed to manage the spent fuel or radioactive waste in a manner consistent with this Convention.

The U.S. Department of State contacts a prospective nation of destination regarding a proposed export of radioactive waste from the U.S. and seeks that nation's government's consent to accept the proposed import of U.S. material under the terms and conditions of a bilateral Agreement between the U.S. and that nation. (Note that the term "nation" is used here instead of "state" to avoid confusion with the "states" that make up the U.S.) Based on the assurances provided by the nation of destination including acknowledgement and consent that the designated consignee is authorized to receive the radioactive waste, the U.S. accepts such statement as a confirmation that the nation of destination believes it has the administrative and technical capacity and regulatory structure to manage and dispose of the waste.

(iv) A State of origin shall authorize a transboundary movement only if it can satisfy itself in accordance with the consent of the State of destination that the requirements of paragraph iii [above] are met prior to transboundary movement.

NRC regulations do not require performance of independent and specific assessments and findings and an opportunity for adjudication regarding the adequacy of the receiving nation's administrative and technical capacity and regulatory structure for managing and disposing of a proposed export of radioactive waste. The Joint Convention does not specify how the nation of origin should satisfy itself the nation of destination meets the requirements and does not require the performance of an independent assessment. USNRC concluded in 1980 that it was not necessary to consider extraterritorial impacts of any nuclear material or equipment exports because the regulation of economic and industrial activities taking place within a nation's territorial boundaries is a function of the territorial sovereignty. Nevertheless, USNRC does not contemplate any circumstances for which it would issue a license authorizing the export radioactive waste to a country without a regulated waste disposal program. By obtaining the views of the U.S. Government before approving an application for export of radioactive waste and based on USNRC's interactions with regulatory authorities from various countries for example in the context of bilateral agreements on public health and safety issues, USNRC is confident that appropriate actions can be taken.

(v) A State of origin shall take the appropriate steps to permit re-entry into its territory, if a transboundary movement is not or cannot be completed in conformity with the relevant principles, unless an alternative safe arrangement can be made.

NRC requires its licensees to agree to accept returns of materials they have exported, if they do not meet international standards or the terms of the export license. In practice and depending on the circumstances, when issuing a license authorizing the import of radioactive wastes, USNRC may also require the concurrent issuance of a

corresponding export license to provide for return of non-conforming radioactive wastes or materials that are not to be disposed of within the U.S. Such licenses involved consultation with relevant foreign government authorities to allow for such exchanges, should they be necessary.

2. A Contracting Party shall not license the shipment of its spent fuel or radioactive waste to a destination south of latitude 60 degrees South for storage or disposal.

Although this principle has not been formally adopted in USNRC regulations, the USNRC does not expect to deviate from this policy and will consider adding it to 10 CFR Part 110 regulations at a future date.

3. Nothing in this Convention prejudices or affects:

(i) the exercise, by ships and aircraft of all States, of maritime, river and air navigation rights and freedoms, as provided for in international law;

Although this principle has not been formally adopted in USNRC regulations, the USNRC does not expect to deviate from this policy and will consider adding it to 10 CFR Part 110 regulations at a future date.

(ii) rights of a Contracting Party to which radioactive waste is exported for processing to return, or provide for the return of, the radioactive waste and other products after treatment to the nation of origin;

As a matter of practice, USNRC provides for the return of radioactive waste exported or imported for processing.

(iii) the right of a Contracting Party to export its spent fuel for reprocessing;

Under the terms and conditions of U.S. bilateral cooperation agreements and the assurances provided by recipient countries for exports from the U.S., such export is subject to U.S. prior consent for any proposed retransfer to a third party, whether for reprocessing or any other use. Requests for U.S. approvals of such retransfers must be filed with the USDOE /National Nuclear Security Administration, which coordinates U.S. interagency review to determine whether U.S. legal and regulatory criteria would be met. Some U.S. agreements contain programmatic approvals for envisioned retransfers including for reprocessing of spent fuel derived from U.S.-origin materials.

(iv) rights of a Contracting Party to which spent fuel is exported for reprocessing to return, or provide for the return of, radioactive waste and other products resulting from reprocessing operations to the State of origin.

This would also be considered a retransfer subject to U.S. prior consent, which would be reviewed and accommodated if the transaction meets U.S. criteria for such a retransfer. The U.S. has been consulted and has not objected to the return of radioactive waste and other products resulting from reprocessing operations to the nation of origin, i.e., where the U.S.-origin (or obligated) material was used to produce the spent fuel.

I.6 Additional USNRC Regulatory Requirements Governing Radioactive Waste Imports and Exports

The USNRC has exclusive jurisdiction, vis-à-vis the states and U.S. territories, for granting or denying specific radioactive waste import licenses. However, in the case of a proposed import of radioactive waste, the USNRC recognizes the authority of state LLW compacts to decide whether or not to accept an import of LLW for disposal in the compact region. The USNRC will consult with interested states and LLW compacts prior to issuing an import license for LLW. The USNRC will not grant an import license for waste intended for disposal unless it is clear that the waste will be accepted by a disposal facility, host state, and compact (where applicable). This will be part of the determination regarding the appropriateness of the facility that has agreed to accept the waste for management or disposal.

Following review by the USNRC staff, a determination will be made whether to approve or deny the application for a specific license for the import or export of radioactive waste. An import or export license issued by the USNRC only authorizes the radioactive waste to enter or exit the U.S. This license alone does not authorize possession of the waste material nor does it guarantee access to a waste management facility or a disposal site in the U.S. or another country.

Specific licenses are also required for exports and imports of radioactive mixed waste. Mixed waste is waste that consists of both hazardous waste and radioactive waste. In addition to meeting USNRC requirements, exporters and importers of mixed waste must also meet USEPA requirements applicable to the hazardous component of the waste. The burden is on the exporter or importer to comply with USEPA requirements, though in practice USNRC provides copies of all relevant documentation to ensure that USEPA is aware of the transaction.

Export or import of naturally-occurring or radioactive material (other than source or byproduct material) under section 11 e(2) of the AEA and accelerator-produced radioactive material lie outside of USNRC regulatory authority and are subject to health and safety regulations of the individual states and other Federal agencies. The regulations also distinguish a separate category of “incidental radioactive material”, which is not subject to the specific licensing controls of 10 CFR Part 110, though as noted above those engaging in this practice must file an NRC Form 7 with USNRC prior to a shipment.

I.7 Applicable Regulations Governing Review of Waste Import/Export Applications

Annex I-1 provides a summary of the relevant provisions of 10 CFR Part 110 that apply specifically to exports and imports of radioactive waste, as well as other USNRC criteria for reviewing applications for export/import of radioactive waste.

J. DISUSED SEALED SOURCES

J.1 Safety of Disused Sealed Sources

The regulations embodied in 10 CFR 30.32(g) and 32.210 codify the current and long-standing practice whereby vendors of sealed sources of radioactive material and devices containing sealed sources submit radiation safety information necessary to perform an independent, technical safety evaluation, and to obtain registration of radiation safety information on certain sealed sources and devices. The practice has been used by the USAEC/USNRC since the 1950's and by the Agreement States starting in 1962.

The specific provisions in 10 CFR 30.32(g) require 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. Section 32.210 outlines the USNRC safety evaluation and registration criteria and clarifies the regulatory responsibility of registration certificate holders of products for which the USNRC evaluates and registers radiation safety information.

Current regulations only require that products used under a specific license issued in accordance with 10 CFR Part 30 be registered with the USNRC. However, if registration of a product design is deemed necessary by USNRC, the applicant needs to provide the information contained in 10 CFR 32.210 and the application will be evaluated in the same manner as all registration applications.

In addition to the preceding requirements for proper registration of sources, the possession, use, packaging, handling, transfer and disposition of radioactive sealed sources are required to comply with the general occupational and public radiological protection regulations, which are listed in Table E-2. Annex J-1 identifies those NRC regulations that apply to sealed sources.

J.2 Policy Regarding Reentry From Abroad Into the U.S. of Disused Sealed Sources for Return to Manufacturer

The safe use of sealed sources is addressed in USNRC byproduct regulation in 10 CFR Part 30, which provides licensing procedures and requirements for all byproduct materials, including sealed sources; these topics include licensing, financial assurance and record keeping for decommissioning, and expiration and termination of licenses and decommissioning.

It should be noted that U.S. regulations do not bar the return of sealed sources. In fact, to facilitate these returns, sealed sources are not required to be licensed for import as radioactive waste, which is provided for in the 10 CFR Part 110.2 definition of waste.

Radiation safety programs for use of byproduct material as a sealed source or device are structured on the presumption that the byproduct material will not breach its

containment and contaminate the environment or unnecessarily expose individuals to radiation. This presumption depends largely upon the adequacy of the containment properties of the sealed sources or devices in withstanding the stresses imposed by the environment in which they are possessed and used.

USNRC regulations in 10 CFR Part 30.32(g) require an applicant for a specific license to use a sealed source or device to identify the sealed source or device as registered with USNRC in accordance with 10 CFR Part 32.210 or to provide the information contained in 10 CFR Part 32.210, which requires registration of a product and provides a means for having a single safety evaluation of the product performed. This process allows applicants and license reviewers to reference the evaluation when licensing the product for use or distribution without having to perform a complete evaluation of the product for each licensing action.

The USNRC maintains a registry of radiation safety information on sealed sources and devices containing byproduct material.[i] Agreement States also provide information on their radiation safety evaluations to the USNRC for the registry. Thus a vendor needs to provide detailed information about its sealed source or device only to a single agency. The results of the radiation safety evaluation are available to the USNRC during licensing approval to users of the devices throughout the U.S. The USNRC estimates that there are approximately 12,000,000 of these devices in existence at the present time.

J.3 Disposition of Sealed Sources

Sealed source retrieval efforts have recently become a priority to reduce the risk from both accidental and intentional dispersal of radioactive materials. Once sources are retrieved they are managed in accordance with the objectives of the Joint Convention found in Article 1. However, the disused sources are not declared as waste, and managed accordingly, until they are accepted for disposal at commercial or governmental facilities. Because the volume of disposed disused sealed sources is small in comparison to the larger volumes of commercial and government waste, the contribution to total volume disposed is negligible.

The primary regulatory statues and authorities relating to disposal are:

- The Low-Level Radioactive Waste Policy Amendments Act of 1985 (LLWPA) assigns to the Federal government the responsibility for disposal of all commercial radioactive waste that exceeds the regulatory limit for shallow land burial (commonly referred to as GTCC waste). While the Act can be read to assign responsibility within the Federal government to USDOE, it also contemplates that licensees will bear all costs of disposal of the waste. The ultimate disposition path for these materials is not yet determined, but currently USDOE provides long term storage of some GTCC sources at Los Alamos National Laboratory (LANL), see Section J.4. Legislation would be needed to allow USDOE to retain and use any funds collected

[i] URL: http://www.hsrd.ornl.gov/nrc/sources/index.cfm

from licensees for GTCC disposal. The LLWPA has not established a deadline for GTCC disposal to take place;

- A USNRC- USDOE Memorandum of Understanding defines the roles and responsibilities between the USNRC and USDOE in situations where the USNRC is responsible for the Federal response to a radiological emergency and transfer to USDOE is determined to be necessary to protect the public health and safety and the environment;

- The Atomic Energy Act of 1954, as amended, defines byproduct material and provides basic regulation for processing and utilization;

- 10 CFR Part 835, "Sealed Radioactive Source Control," establishes radiological protection requirements which specify that sealed radioactive sources shall be used, handled, and stored in a manner commensurate with the hazards associated with operations involving the sources;

- 10 CFR Part 31, "General Domestic Licenses for Byproduct Material," establishes general licenses for possession and use of byproduct material and a general license for ownership of byproduct material; specific provisions of 10 CFR Part 30 are applicable to general licenses established by this part; and

- 10 CFR Part 61, "Licensing Requirements for Land Disposal of Radioactive Waste," establishes the disposal requirements for LLW.

J.4 U.S. Department of Energy Off-Site Source Recovery Project

Many sealed sources are excess, unwanted, and orphaned in the U.S. industrial, medical, academic, and government sectors. The Off-Site Source Recovery (OSR) Project, managed by the USDOE, collects sources from commercial licensees and stores them at LANL. Long-lived sealed sources consist mainly of americium neutron sources, other americium-241 sources, plutonium-238 heat sources, plutonium-239 neutron sources, and large strontium-90 sources. Large cesium-137 sources also typically exceed the U.S. regulatory criteria for shallow LLW disposal, but are largely recycled and remanufactured into new sources. The U.S. government recognizes that public health and safety risks are posed by unwanted long-lived sealed sources. One of the most common isotopes used is americium-241. Many of these are used in oil and gas well-logging activities. Small firms lacking the physical capability and financial resources to provide safe storage commonly own these neutron sources. This presents a growing problem because these sources are not suitable for disposal in shallow land burial facilities. Other appropriate disposal options are not yet available.

Considerable numbers of heat sources containing plutonium-238 once were used in manufacturing cardiac pacemakers. These pacemakers and plutonium-238 batteries became obsolete in the 1970s with the onset of long-life chemical battery technology. The OSR Project has recovered approximately 2,000 excess and unwanted pacemakers to date.

The most prolific use of long-lived sealed sources in the U.S. is in portable and fixed industrial gauges. Approximately 9,000 such sources, chiefly containing americium-241, are found in manufacturing and general commerce. Recovering these sources is particularly important because many are excess and unwanted, and commonly are lost, stolen or inadvertently discarded.

Beginning in the late 1990s, the USDOE greatly expanded the sealed source handling capacity at LANL to accommodate thousands of excess sealed sources from the commercial sector. Initially, neutron sources were chemically processed to eliminate neutron generation. However, this was determined to be unnecessary. Instead, excess and unwanted sealed sources are simply stored as radioactive waste at government nuclear facilities. This strategy required developing new nuclear material containers specifically for long-lived neutron sources. The first of these is a special-form overpack capsule for individual sources. The second is a multi-function container capable of providing safe storage, transportation, and ultimately disposal.

The special-form capsule has been designed, tested, and certified in several configurations. Composed of thick-walled stainless steel, it is used to safely store and ship damaged sealed sources, or sources that for other reasons cannot be certified for transportation. Once closed, a special-form capsule cannot be reopened. The USDOE continues to modify and fabricate these capsules to accommodate unique sources as they appear, especially from government nuclear research and development laboratories. These capsules are available for both government and commercial radioactive waste management activities.

The multi-function container evolved from containers used by USDOE for transportation and disposal of TRU waste. This container incorporates neutron shielding and accommodates considerable quantities of neutron sources without special handling requirements. The pipe overpack concept was modified to provide a narrow diameter (15 cm.) inner payload container, within a standard 200-liter (55-gallon) drum. The annular space is filled by neutron shielding material. This multi-function container has been evaluated and approved by the government's TRU waste certification program, and is now acceptable for field recovery, transportation, long-term storage, and eventual disposal in a government waste repository.

The OSR Project expects to store more than 14,000 long-lived sealed sources (GTCC LLW sealed sources) by 2010 if the U.S Congress appropriates adequate funds. A large share of waste from the OSR Project will be generated by the commercial and academic sector. More than 4,000 sealed sources are already in storage at LANL. Another 5,000 sealed sources are known to be excess and unwanted, and are slated for recovery by 2005. Subsequent sealed source recovery will occur at a pace depending upon numbers of sources declared excess and upon funding levels. The U.S. has not established a disposition path for GTCC LLW, including most long-lived sealed sources. This is discussed in Section D.3.5. Therefore, the OSR Project will develop and provide storage capacity until a disposal pathway is developed. OSR Project projections indicate less than 500 cubic meters of waste in shielded containers will require indefinite storage. The next step for the U.S. government is to examine final disposal options.

K. PLANNED ACTIVITIES TO INCREASE SAFETY

This report has described many existing and ongoing activities in the U.S. that ensure the safe management of spent fuel and radioactive waste. The U.S. is already in compliance with the conditions set forth in the Joint Convention. However, there are several key areas that are important to safety and continue to receive significant attention.

K.1 Spent Fuel and High-Level Waste Disposal

The development of disposal capability for spent fuel and high level waste is a key activity for long-term safety of spent fuel and HLW management. This is manifest in the USDOE site characterization and licensing efforts for the proposed repository at Yucca Mountain.

During 2001 and early 2002, the USDOE completed the investigations needed to support a determination of site suitability, made that information available to the public, and invited public comment. On January 11, 2002, the Secretary of Energy, as required by the Nuclear Waste Policy Act, notified the Governor of the State of Nevada of his intent to recommend the Yucca Mountain site for development of a geologic repository. Citing compelling national interests that warrant this decision, the Secretary of Energy stated that a repository was vital to ensure America's national security, support energy security, secure disposal of nuclear wastes, and provide for a cleaner environment. On February 14, 2002, the Secretary of Energy, after a comprehensive review of the science, testing, and analyses conducted over 20 years, recommended to the President that the Yucca Mountain site be developed as a repository for spent fuel and high-level waste. On February 15, 2002 the President, in turn, recommended the site to the U.S. Congress for site designation. In April 2002, the Governor of the State of Nevada submitted a letter of disapproval to Congress. In July 2002, the U.S. Congress passed a joint resolution of repository approval and the resolution became law with the President's signature making the site designation effective. Scientific and engineering investigations are continuing in support of a license application.

The USDOE is currently planning to submit a license application to the USNRC in late 2004 for repository construction authorization. The license review by the USNRC is expected to take about three years. If approved, the USDOE will then spend approximately 2 years constructing the repository and subsequently apply to the USNRC for a license amendment to allow receipt and possession of waste. Given adequate funding by the U.S. Congress and successful completion of the licensing process, the spent fuel shipments could begin arriving at the repository by late 2010.

Until repository disposal for spent fuel and HLW becomes available, the USNRC will continue to authorize licensees to store spent fuel in dry casks using USNRC approved dry cask designs. The use of ISFSIs for the storage of spent fuel in the U.S will continue until repository disposal is available.

The USDOE has projects underway to move spent fuel into dry storage facilities at the Hanford Site, Washington, and INEEL, Idaho. These activities are designed to increase safety of stored spent fuel until a repository becomes operational.

K.2 Commercial Low-Level Waste Disposal

As described in Section H-1, under Federal law the 50 states are responsible for providing for the disposal of commercial LLW generated within their borders. The law encourages states to enter into regional compacts that allow several states to dispose of waste at a regional disposal facility. Most of the states have entered into compacts as shown in Figure H-1. At one time, a dozen new sites were being planned by the states, and a number of activities to evaluate designs and locate sites were implemented. However, at the present time, no new regional disposal facilities have been opened and no states have plans for a new facility. Currently all LLW generators have access to a commercial LLW site, but access to the Barnwell, South Carolina, is currently planned to be restricted to waste generators in the Atlantic Compact in 2008. All waste generators have access to the Envirocare of Utah site, but this site currently is not licensed to dispose of Class B and Class C LLW that can be disposed currently at the Barnwell site. Some commercial firms may be considering options to expand or create new disposal sites to meet future needs, although opposition to new disposal sites for nuclear waste continues to make these efforts difficult.

K.3 Disused Sealed Sources and Greater than Class C LLW Disposal

As described in Section J, the U.S. Government has an aggressive program in place to collect thousands of disused sealed sources from the commercial sector for safe storage and eventual disposal. This activity decreases the likelihood for accidents or misuse of this material across the nation. Many of these sources fall into the GTCC LLW classification (see Table B-1). Until an adequate disposition policy is determined, GTCC LLW is being stored, e.g., at nuclear power plants and other facilities. Under Federal law (Low-Level Radioactive Waste Policy Act of 1980, as amended) GTCC LLW must be disposed in an NRC-licensed facility. The U.S. Government is analyzing the environmental impacts of various options for GTCC disposal.

K.4 Accelerated Cleanup of the Former Nuclear Weapons Complex

The U.S. Government is spending billions of dollars per year on USDOE activities to clean-up government sites and facilities throughout the nation. Recently USDOE has accelerated cleanup efforts and is making great progress at sites like the Rocky Flats Environmental Technology Site, Colorado. Other Federal agencies and the private sector are similarly cleaning up sites and facilities, as described in Section D.5. The U.S. will continue to reduce risks, increase safety and eliminate the liability from past

practices by the commitment to accelerate cleanup of the remaining contaminated facilities and sites across the nation.

ANNEXES

Annex D-1. Spent Fuel Management Facilities[i]

State	Installation	Licensee	Regulator	Facility Name	Features	Purpose
Government Installations						
California	General Atomic	USDOE	USDOE	Hot Cell Facility	SNF Storage	Defense
Idaho	Idaho National Engineering and Environmental Lab	USDOE	USDOE	Power Burst Reactor Facility	SNF Storage	Defense
	Argonne National Lab - West	USDOE	USDOE	ANL-W SF Storage	SNF Storage	Defense
	Idaho National Engineering and Environmental Lab	USDOE	USDOE	Test Reactor Area	SNF Storage	Defense/Other
		USDOE	USNRC	Test Area North	SNF Storage	Defense
		USDOE	USDOE	ID Nuclear Tech & Eng. Center	SNF Storage	Defense
Illinois	Argonne National Lab - East	USDOE	USDOE	ANL-E SF Storage	SNF Storage	Defense
Nevada	Yucca Mountain Site	USDOE	USNRC	Geologic Repository (proposed at Yucca Mountain, Nevada)	SNF/HLW Disposal	Commercial/ Defense
New Mexico	Sandia National Lab - NM	USDOE	USDOE	Tech Area 5	SNF Storage	Defense
		USDOE	USDOE	Kirkland AFB - Manzano Storage Fac	SNF Storage	Defense
New York	West Valley Demonstration Project	USDOE	USDOE	Fuel Receiving and Storage Facility	SNF Storage	Commercial
South Carolina	Savannah River Site	USDOE	USDOE	Receiving Basin for Off-Site Fuels	SNF Storage	Defense
Tennessee	Oak Ridge Reservation	USDOE	USDOE	Oak Ridge Reservation SF Storage	SNF Storage	Defense
Washington	Hanford Site	USDOE	USDOE	100 Area	SNF Storage	Defense
		USDOE	USDOE	300 Area	SNF Storage	Defense
		USDOE	USDOE	400 Area	SNF Storage	Defense
		USDOE	USDOE	200 Area	SNF Storage	Defense
Commercial Facilities						
Arkansas	Arkansas Nuclear One	Entergy	USNRC	Independent Spent Fuel Storage Installation	SNF Dry Storage	Commercial
Arizona	Palo Verde	Arizona Public Service	USNRC	Independent Spent Fuel Storage Installation	SNF Dry Storage	Commercial
California	Rancho Seco	Sacramento Municipal Utility District	USNRC	Independent Spent Fuel Storage Installation	SNF Dry Storage	Commercial
Colorado	Fort St. Vrain	USDOE	USNRC	Independent Spent Fuel Storage (Storage Well)	SNF Dry Storage	Commercial
Georgia	Hatch	Southern Company	USNRC	Independent Spent Fuel Storage Installation	SNF Dry Storage	Commercial
Illinois	Dresden	Exelon Generation	USNRC	Independent Spent Fuel Storage Installation	SNF Dry Storage	Commercial

[i] Note: Blanks in the table indicate values are not readily available.
NA: Not applicable

Annex D-1. Spent Fuel Management Facilities[i]

State	Installation	Licensee	Regulator	Facility Name	Features	Purpose
	GE Morris	General Electric Co.	USNRC	Independent Spent Fuel Storage Installation	SNF Wet Storage	Commercial
Maine	Maine Yankee	Maine Yankee Atomic Power	USNRC	Independent Spent Fuel Storage Installation	SNF Dry Storage	Commercial
Maryland	Calvert Cliffs	Constellation Nuclear	USNRC	Independent Spent Fuel Storage Installation	SNF Dry Storage	Commercial
Massachusetts	Yankee Rowe	Yankee Atomic Power	USNRC	Independent Spent Fuel Storage Installation	SNF Dry Storage	Commercial
Michigan	Big Rock Point	Consumers Power	USNRC	Independent Spent Fuel Storage Installation	SNF Dry Storage	Commercial
	Palisades	Consumers Power	USNRC	Independent Spent Fuel Storage Installation	SNF Dry Storage	Commercial
Minnesota	Prairie Island	Northern States Power	USNRC	Independent Spent Fuel Storage Installation	SNF Dry Storage	Commercial
New Jersey	Oyster Creek	AmerGen	USNRC	Independent Spent Fuel Storage Installation	SNF Dry Storage	Commercial
New York	Fitzpatrick	Entergy Nuclear	USNRC	Independent Spent Fuel Storage Installation	SNF Dry Storage	Commercial
North Carolina	McGuire	Duke Power	USNRC	Independent Spent Fuel Storage Installation	SNF Dry Storage	Commercial
Ohio	Davis-Besse	First Energy	USNRC	Independent Spent Fuel Storage Installation	SNF Dry Storage	Commercial
Oregon	Trojan	Portland General Electric	USNRC	Independent Spent Fuel Storage Installation	SNF Dry Storage	Commercial
Pennsylvania	Peach Bottom	Exelon Generation	USNRC	Independent Spent Fuel Storage Installation	SNF Dry Storage	Commercial
	Susquehanna	Pennsylvania Power & Light	USNRC	Independent Spent Fuel Storage Installation	SNF Dry Storage	Commercial
South Carolina	H.B. Robinson	Progress Energy - Carolina	USNRC	Independent Spent Fuel Storage Installation	SNF Dry Storage	Commercial
	Oconee	Duke Power	USNRC	Independent Spent Fuel Storage Installation	SNF Dry Storage	Commercial
Virginia	North Anna	Dominion Virginia Power	USNRC	Independent Spent Fuel Storage Installation	SNF Dry Storage	Commercial
	Surry	Dominion Virginia Power	USNRC	Independent Spent Fuel Storage Installation	SNF Dry Storage	Commercial
Washington	Columbia	Energy Northwest	USNRC	Independent Spent Fuel Storage Installation	SNF Dry Storage	Commercial
Wisconsin	Point Beach	Wisconsin Electric Power	USNRC	Independent Spent Fuel Storage Installation	SNF Dry Storage	Commercial

Annex D-2. Inventory of Spent Fuel[i]

State	Installation	Facility	Inventory	Units	Activity (Bq)	Activity (Ci)	Description
Government Installations							
California	General Atomic	Hot Cell Facility	0.005	MTHM	2.43E+14	6.56E+03	SNF from USDOE experimental reactors
Idaho	Argonne National Lab - West	ANL-W SF Storage	27.962	MTHM	9.11E+17	2.46E+07	SNF from USDOE experimental reactors
	Idaho National Engineering and Environmental Lab	ID Nuclear Tech & Eng. Center	178.91	MTHM	1.13E+18	3.04E+07	SNF from defense applications
		Test Reactor Area	0.897	MTHM	9.22E+16	2.49E+06	SNF from defense applications
		Power Burst Reactor Fac	0.563	MTHM	5.45E+14	1.47E+04	SNF from defense applications
		Test Area North	75.47	MTHM	3.41E+17	9.21E+06	SNF from defense applications
Illinois	Argonne National Lab - East	ANL-E SF Storage	0.114	MTHM	3.22E+15	8.71E+04	SNF from USDOE experimental reactors
New Mexico	Sandia National Lab - NM	Tech Area 5	0.279	MTHM	9.51E+15	2.57E+05	SNF from USDOE experimental reactors
		Kirkland AFB - Manzano Storage Fac	0.009	MTHM	2.18E+14	5.90E+03	SNF from defense applications
New York	West Valley Demonstration Project	Fuel Receiving and Storage Facility	26.315	MTHM	1.77E+17	4.78E+06	Awaiting shipment to INEEL
South Carolina	Savannah River Site	Receiving Basin for Off-Site Fuels	30.12	MTHM	6.54E+17	1.77E+07	SNF from various USDOE applications (foreign research reactors)
Tennessee	Oak Ridge Reservation	Oak Ridge Reservation SF Storage	0.635	MTHM	2.15E+16	5.81E+05	SNF from various DOE applications
Washington	Hanford Site	200 Area	16.335	MTHM	2.25E+17	6.07E+06	SNF from defense applications
		400 Area	10.999	MTHM	5.25E+18	1.42E+08	SNF from defense applications
		300 Area	2.305	MTHM	3.03E+16	8.18E+05	SNF from defense applications
		100 Area	2102.808	MTHM	8.31E+17	2.24E+07	SNF from defense applications
Commercial Facilities[ii]							
Arkansas	Arkansas Nuclear One	Independent Spent Fuel Storage Installation (ISFSI)	244	MTU			SNF from nuclear power plant
California	Rancho Seco	ISFSI	228	MTU			SNF from nuclear power plant
Colorado	Fort St. Vrain	ISFSI (Storage Well)	14.729	MTHM	1.07E+17	2.90E+06	SNF from nuclear power plant
Georgia	Hatch	ISFSI	147	MTU			SNF from nuclear power plant
Illinois	Dresden	ISFSI	195	MTU			SNF from nuclear power plant
	GE Morris	ISFSI	674	MTU			SNF from nuclear power plants
Maine	Maine Yankee	ISFSI	100	MTU			SNF from nuclear power plant

[i] Sources: EIS for Disposal of Spent Fuel and High Level Radioactive Waste, 2002 (DOE/EIS-0250); DOE National Spent Fuel Database (Version 4.2.0, March 2002); EIA Form RW-859 Spent Fuel Data (1998), DOE's Current, Planned, and Projected Dry Storage Facilities Table (January 2003)
Note: Blanks in the table indicate values art not readily available.

[ii] Source: Office of Civilian Radioactive Waste Management

Annex D-2. Inventory of Spent Fuel[i]

State	Installation	Facility	Inventory	Units	Activity (Bq)	Activity (Ci)	Description
Maryland	Calvert Cliffs	ISFSI	335	MTU			SNF from nuclear power plant
Massachusetts	Yankee Rowe	ISFSI	62	MTU			SNF from nuclear power plant
Michigan	Big Rock Point	ISFSI	19	MTU			SNF from nuclear power plant
	Palisades	ISFSI	177	MTU			SNF from nuclear power plant
Minnesota	Prairie Island	ISFSI	248	MTU			SNF from nuclear power plant
New Jersey	Oyster Creek	ISFSI	43	MTU			SNF from nuclear power plant
New York	Fitzpatrick	ISFSI	37	MTU			SNF from nuclear power plant
North Carolina	McGuire	ISFSI	72	MTU			SNF from nuclear power plant
Ohio	Davis-Besse	ISFSI	34	MTU			SNF from nuclear power plant
Oregon	Trojan	ISFSI	11	MTU			SNF from nuclear power plant
Pennsylvania	Peach Bottom	ISFSI	181	MTU			SNF from nuclear power plant
	Susquehanna	ISFSI	230	MTU			SNF from nuclear power plant
South Carolina	H.B. Robinson	ISFSI	24	MTU			SNF from nuclear power plant
	Oconee	ISFSI	832	MTU			SNF from nuclear power plant
Virginia	North Anna	ISFSI	222	MTU			SNF from nuclear power plant
	Surry	ISFSI	524	MTU			SNF from nuclear power plant
Washington	Columbia	ISFSI	58	MTU			SNF from nuclear power plant
Wisconsin	Point Beach	ISFSI	136	MTU			SNF from nuclear power plant

Annex D-3. Radioactive Waste Management Facilities[i]

State	Installation	Licensee	Regulator	Facility Name	Features	Purpose
Government Installations						
California	Energy Technology Engineering Center	USDOE	USDOE	TRU Waste Facilities	TRU Storage	Defense
		USDOE	USDOE/CA	M/LLW Facilities	M/LLW Storage, packaging	Defense
	Laboratory for Energy-Related Health Research	USDOE	USDOE	LLW Facilities	LLW Storage, characterization, treatment, packaging	Nuclear Applications
	Lawrence Berkeley National Laboratory	USDOE	USDOE	TRU Waste Facilities	TRU Storage	Nuclear Applications
		USDOE	USDOE/CA	M/LLW Facilities	M/LLW Storage, characterization, treatment, packaging	Nuclear Applications
		USDOE	USDOE/CA	M/LLW Facilities	M/LLW Storage, characterization, treatment, packaging	Defense
		USDOE	USDOE	TRU Waste Facilities	TRU Storage, characterization, packaging	Defense
Colorado	Rocky Flats Environmental Technology Site	USDOE	USDOE/CO	M/LLW Facilities	M/LLW Storage, characterization, treatment, packaging	Defense
		USDOE	USDOE	TRU Waste Facilities	TRU Storage, characterization, packaging	Defense
Idaho	Idaho National Engineering and Environmental Laboratory	USDOE	USDOE	Calcined Solids Storage Facility	Calcined HLW Storage in underground tanks/bins	Defense
		USDOE	USDOE	Radioactive Waste Management Complex	LLW Disposal in shallow land disposal facility	Defense
		USDOE	USDOE	Idaho CERCLA Disposal Facility	LLW Disposal in engineered surface disposal cell for D&D wastes (under construction)	Defense
		USDOE	USDOE	Calciner	HLW Treatment (evaporation and calcination)	Defense
		USDOE	USDOE	TRU Waste Storage Facilities	TRU Storage	Defense
		BNFL, Inc.	USDOE	Advanced Mixed Waste Treatment Plant	TRU characterization, treatment, and packaging	Defense
		USDOE	USDOE/ID	M/LLW Facilities	M/LLW Storage, characterization, treatment, packaging	Defense
		USDOE	USDOE	HLW Tank Farm	HLW Liquid Storage in underground tanks	Defense
Illinois	Argonne National Laboratory – East	USDOE	USDOE/IL	M/LLW Facilities	M/LLW Storage, characterization, treatment, packaging	Defense
		USDOE	USDOE	TRU Waste Facilities	TRU Storage, characterization, packaging	Defense
Kentucky	Paducah Gaseous Diffusion Plant	USDOE	USDOE/KY	M/LLW Facilities	M/LLW Storage, characterization, treatment, packaging	Defense
		USDOE	USDOE	TRU Waste Facilities	TRU Storage	Defense
Missouri	Weldon Spring Site Rem. Action Project	USDOE	USDOE	On-Site Disposal Cell	11e(2) Disposal in engineered, surface disposal cell	Defense
Multiple States	Other USDOE	USDOE	USDOE/	M/LLW Facilities (small)	M/LLW Storage, characterization, treatment,	Defense

[i] Note: Blanks in the Licensee column indicate Licensee and Installation name are the same.
NA: Not applicable

Annex D-3. Radioactive Waste Management Facilities[i]

State	Installation	Licensee	Regulator	Facility Name	Features	Purpose
			Other states		packaging	
Multiple States	Other USDOE	USDOE	USDOE	TRU Waste Facilities (small)	TRU Storage	Defense
Nevada	Nevada Test Site	USDOE	USDOE	Greater Confinement Disposal	TRU Disposal in boreholes	Defense
		USDOE	USDOE/NV	MW Disposal Unit	MLLW Disposal in shallow trenches	Defense
		USDOE	USDOE	Area 3/Area 5 RWMS	LLW Disposal in trenches and subsidence craters	Defense
		USDOE	USDOE	TRU Waste Facilities	TRU Storage, characterization, packaging	Defense
	Yucca Mountain Site	USDOE	NRC	Geologic Repository (planned at Yucca Mountain, Nevada)	SNF/HLW Disposal	Commercial/ Defense
New Mexico	Inhalation Toxicology Laboratory	USDOE	USDOE	LLW Facilities	LLW Storage, characterization, packaging	Defense
		USDOE	USDOE	TRU Waste Facilities	TRU Storage	Defense
	Los Alamos National Laboratory	USDOE	USDOE/NM	M/LLW Facilities	M/LLW Storage, characterization, treatment, packaging	Defense
		USDOE	USDOE	TRU Waste Facilities	TRU Storage, characterization, packaging	Defense
		USDOE	USDOE	Technical Area 54/Area G	LLW Disposal in shallow land disposal facility	Defense
		USDOE	USDOE	Technical Area 54	Disused Sealed Source Storage	Defense
		USDOE	USDOE	Chemical and Metallurgy Research Bldg.	Disused Sealed Source Consolidation	Defense
	Sandia National Laboratory - NM	USDOE	USDOE	TRU Waste Facilities	TRU Storage, characterization, packaging	Defense
		USDOE	USDOE/NM	M/LLW Facilities	M/LLW Storage, characterization, treatment, packaging	Defense
	Waste Isolation Pilot Plant	USDOE	NMED/ USEPA	WIPP Disposal	TRU Disposal in deep salt formation	Defense
New York	Niagara Falls Storage Site (FUSRAP)	USACE	NY	Niagara Falls Storage Facility	Restoration Waste Storage	
	West Valley Demonstration Project	USDOE	USDOE	HLW Tanks	HLW Liquid Storage in stainless steel tanks	Commercial
		USDOE	USDOE	TRU Waste Facilities	TRU Storage	Commercial
		USDOE	USDOE	HLW Glass Storage Cell	Interim storage of Vitrified HLW in a former process cell	Commercial
		USDOE	USDOE	HLW Vitrification Plant	HLW Liquid Treatment (Vitrification)	Commercial
		USDOE	USDOE/NY	M/LLW Facilities	M/LLW Storage, characterization, treatment, packaging	Commercial
Ohio	Ashtabula Environ. Management Project	USDOE	USDOE/OH	M/LLW Facilities	M/LLW Storage, characterization, treatment, packaging	Defense
	Fernald Environmental Management Project	USDOE	USDOE	On-Site Disposal Facility	LLW (from D&D) Disposal in engineered surface disposal cell	Defense
		USDOE	USDOE/OH	M/LLW Facilities	M/LLW Storage, characterization, treatment, packaging	Defense
	Miamisburg Environmental Management Project	USDOE	USDOE	TRU Waste Facilities	TRU Storage, characterization, packaging	Defense
		USDOE	USDOE	LLW Facilities	LLW Characterization, treatment, packaging	Defense
	Portsmouth Gaseous Diffusion Plant	USDOE	USDOE/OH	M/LLW Facilities	M/LLW Storage, treatment, packaging	Defense
South Carolina	Savannah River Site	USDOE	USDOE	E-Area Low Activity Vault	Disposal of low-activity LLW in aboveground vaults	Defense

Annex D-3. Radioactive Waste Management Facilities[i]

State	Installation	Licensee	Regulator	Facility Name	Features	Purpose
		USDOE	USDOE	TRU Waste Facilities	TRU Storage, characterization, packaging	Defense
		USDOE	USDOE	Glass Waste Storage Building	Interim Storage of Vitrified HLW	Defense
		USDOE	USDOE	HLW Tank Farm	HLW Liquid Storage in underground double-shell, stainless steel tanks	Defense
		USDOE	USDOE	Defense Waste Processing Fac.	HLW Liquid Treatment (Vitrification)	Defense
		USDOE	USDOE/SC	M/LLW Facilities	M/LLW Storage, characterization, treatment, packaging	Defense
		USDOE	USDOE	E-Area Intermediate Level Vault	Disposal of intermediate-activity LLW in underground vaults	Defense
		USDOE	USDOE	E-Area Trenches	Disposal of LLW in trenches	Defense
		USDOE	USDOE	Saltstone Vaults	Disposal of low-activity fraction of HLW	Defense
Tennessee	Oak Ridge Reservation	USDOE	USDOE	TRU Waste Tanks	TRU Liquid Storage	Defense
		USDOE	USDOE	TRU Waste Facilities	TRU Storage, characterization, packaging	Defense
		USDOE	USDOE/TN	M/LLW Facilities	M/LLW Storage (in building and on concrete pad), characterization, treatment, packaging	Defense
		USDOE	USDOE	Environmental Management Waste Management Facility	LLW Disposal in engineered surface disposal cell for D&D wastes (under construction)	Defense
		Foster-Wheeler Corp.	USDOE	Oak Ridge TRU Waste Treatment Facility	Private facility for USDOE TRU waste treatment (under construction); also for liquid LLW supernate treatment and packaging	Defense
		USDOE	USDOE	Interim Waste Management Fac.	LLW Disposal in engineered aboveground facility	Defense
Texas	Pantex Plant	USDOE	USDOE/TX	M/LLW Facilities	M/LLW Storage, characterization, treatment, packaging	Defense
Utah	Cheney Site	USDOE	USDOE	Cheney Disposal Cell	11e(2) Disposal in engineered, surface disposal cell	Defense
	Monticello Remedial Action Project	USDOE	USDOE	Monticello Disposal Cell	11e(2) Disposal in engineered, surface disposal cell	Defense
Washington	Hanford Site	USDOE	USDOE	Decommissioned Submarine Hulls Disposal Area	Navy submarine hulls disposal in trenches	Defense
		USDOE	USDOE	HLW Tank Farm	HLW Liquid Storage in underground single- and double-shell tanks	Defense
		USDOE	USDOE	Waste Encapsulation and Storage Facility	Cs-Sr Storage in hot cells and storage pool	Defense
		USDOE	USDOE	TRU Waste Facilities	TRU Storage, characterization, packaging	Defense
		USDOE	USDOE/WA	RMW Trenches	MLLW Disposal in lined trenches	Defense
		USDOE	USDOE	Environmental Restoration Disposal Facility	LLW (from D&D) Disposal in engineered surface disposal unit	Defense
		USDOE	USDOE	200 Area Burial Grounds	LLW Disposal in trenches	Defense
		USDOE	USDOE/WA	M/LLW Facilities	M/LLW Storage, characterization, treatment, packaging	Defense
Commercial Facilities						
California	New World Technology		USNRC	New World Technology	Broker – Waste Treatment Service (Other than compactio3333n)	Commercial
	Thomas Grey Associates		USNRC	Thomas Grey Associates	Broker – Processing of liquids and radium	Commercial

Annex D-3. Radioactive Waste Management Facilities[i]

State	Installation	Licensee	Regulator	Facility Name	Features	Purpose
Connecticut	Cabrera Services, Inc.		USNRC	Cabrera Services, Inc.	Broker – Decontamination Services	Commercial
	Radiation Safety Associates		USNRC	Radiation Safety Associates	Broker	Commercial
	Yale Univ. Radiation Safety Section		USNRC	Yale Univ. Radiation Safety Section	Broker – Academic Type A Broad	Commercial
Illinois	ADCO Services Inc.		USNRC	ADCO Services Inc.	Broker – Processing of uranium and thorium	Commercial
	Dept. Of The Army Rock Island Arsenal		USNRC	Dept. Of The Army	Broker – Waste Disposal Service Processing and/or Repackaging.	Commercial
	Closed Commercial Disposal at Sheffield		IL	Closed Commercial Disposal	LLW Disposal	Commercial
Kentucky	Closed Commercial Disposal at Maxey Flats		KY/ USNRC	Closed Commercial Disposal	LLW Disposal	Commercial
Maryland	Dept. Of The Army Ft. Detrick		USNRC	Dept. Of The Army	Broker – Waste Disposal Service Processing and/or Repackaging.	Commercial
	Ecology Services		MD	Ecology Services	Broker – Mixed waste processing	Commercial
	RSO, Inc.		MD	RSO, Inc.	Broker – Organics processing	Commercial
Michigan	Pharmacia & Upjohn Company		USNRC	Pharmacia & Upjohn Company	Broker – Manufacturing and Distribution Type A Broad	Commercial
Minnesota	University of Minnesota		USNRC	University of Minnesota	Broker – Waste Disposal Service Processing and/or Repackaging.	Commercial
Missouri	Pharmacia Corporation		USNRC	Pharmacia Corporation	Broker – Waste Disposal Service Processing and/or Repackaging.	Commercial
	R.M. Wester		USNRC	R.M. Wester	Broker	Commercial
	Westinghouse Electric Company, LLC		USNRC	Westinghouse Electric Company, LLC	Broker – Decommissioning of Uranium Fuel Fabrication Plants	Commercial
Montana	HHS, Dept. Of USPHS, NIH, Rocky Mountain Laboratories		USNRC	HHS, Dept. Of USPHS, NIH, NIAID	Broker – Research and Development Type A Broad	Commercial
Nevada	Closed Commercial Disposal at Beatty		NV	Closed Commercial Disposal	LLW Disposal	Commercial
New Jersey	BASF Corporation		USNRC	BASF Corporation	Broker – Research and Development Type A Broad	Commercial
	Radiation Science, Inc.		USNRC	Radiation Science, Inc.	Broker – Waste Disposal Service Prepackaged only.	Commercial
	Teledyne Brown Engineering, Inc.		USNRC	Teledyne Brown Engineering, Inc.	Broker – Waste Disposal Service Prepackaged only.	Commercial
New York	Radiac Research Corp.		USNRC	Radiac Research Corp.	Broker – Waste Disposal Service Prepackaged only.	Commercial
	Closed Commercial Disposal at West Valley		NY/ USNRC	Closed Commercial Disposal	LLW Disposal	Commercial
North Carolina	HHS, Dept. Of Public Health Service		USNRC	HHS, Dept. Of Public Health Service	Broker – Research and Development Type A Broad	Commercial
	V.A. Medical Center		USNRC	V.A. Medical Center	Broker – Medical Institution Broad	Commercial
Pennsylvania	Alaron Corporation		USNRC	Alaron Corporation	Broker – Waste Disposal Service Processing and/or Repackaging.	Commercial

Annex D-3. Radioactive Waste Management Facilities[i]

State	Installation	Licensee	Regulator	Facility Name	Features	Purpose
	Applied Health Physics, Inc.		USNRC	Applied Health Physics, Inc.	Broker – Waste Disposal Service Prepackaged only.	Commercial
	BWX Technologies, Inc. B&W Nuclear Environmental Services		USNRC	BWX Technologies, Inc. B&W Nuclear Environmental Services	Broker – Decommissioning of Advanced Fuel R&D and Pilot Plants	Commercial
	Fox Chase Cancer Cntr.		USNRC	Fox Chase Cancer Center	Broker – Medical Institution Broad	Commercial
	Solutient Technologies		USNRC	Solutient Technologies	Broker – Processing	Commercial
South Carolina	GTS-Duratek/Chem-Nuclear Systems, Inc.	GTS-Duratek, Inc	USNRC	GTS-Duratek/ Chem-Nuclear Systems, Inc.	Broker – Decommissioning of Byproduct Material Facilities	Commercial
	Barnwell Disposal Facility	GTS-Duratek, Inc	SC	Barnwell Commercial Disposal	LLW Disposal	Commercial
Tennessee	Bionomics		TN	Bionomics	Broker	Commercial
	Chase Environmental		TN	Chase Environmental	Broker	Commercial
	Diversified Technologies		TN	Diversified Technologies	Processing of resins, sludges, and liquids	Commercial
	Duratek		TN	Duratek	Broker – Processing of uranium, thorium, other	Commercial
	Permafix		TN	Permafix	Processing/treatment of mixed wastes	Commercial
	Philotechnics		TN	Philotechnics	Broker -- Processing of uranium and thorium salts	Commercial
	RACE		TN	RACE	Broker – Processing of large equipment	Commercial
	V.A. Medical Center		USNRC	V.A. Medical Center	Broker – High Dose Rate Remote Afterloader	Commercial
Texas	MKM Engineers, Inc.		USNRC	MKM Engineers, Inc.	Broker – Waste Disposal Service Processing and/or Repackaging.	Commercial
	NSSI		TX	NSSI	Mixed waste processing	Commercial
	Specpro, Inc.		USNRC	Specpro, Inc.	Broker – Waste Disposal Service Processing and/or Repackaging.	Commercial
	Waste Control Specialists (WCS)	WCS	TX	Waste Control Specialists	MLLW Treatment	Commercial
Utah	Envirocare of Utah	Envirocare of Utah	UT/USNRC	Envirocare	Treatment of mixed wastes; Disposal of LLW, MLLW, and 11e(2)	Commercial
Washington	Allied Technology Group (ATG)		WA	Allied Technology Group	Mixed waste treatment and processing	Commercial
	U.S. Ecology - Richland	US Ecology	WA	US Ecology	LLW Disposal	Commercial
Wisconsin	Covance Laboratories		USNRC	Covance Laboratories	Broker – Research and Development Other	Commercial
	William S. Middleton Memorial V.A. Hospital		USNRC	William S. Middleton Memorial Veterans Hospital	Broker – Medical Institution Broad	Commercial

Annex D-4. Uranium Mill Tailings Radiation Control Act Title I Sites[i]

Site Name/Location	Licensee	Regulator License Number		Quantity of contaminated material (dry metric tonnes except as noted)	Total Ra-226 Activity
Ambrosia Lake, New Mexico	USDOE	USNRC	General	6,300,000	68 TBq (1850 Ci)
Burrell, Pennsylvania	USDOE	USNRC	General	78,000	0.15 TBq (4 Ci)
Canonsburg, Pennsylvania	USDOE	USNRC	General	200,000	4 TBq (100 Ci)
Durango, Colorado	USDOE	USNRC	General	3,100,000	52 TBq (1400 Ci)
Falls City, Texas	USDOE	USNRC	General	6,400,000	47 TBq (1280 Ci)
Grand Junction, Colorado	USDOE		Not yet under LTSP* Program	3,100,000 m3, with capacity for an additional 190,000 m3 more.	
Green River, Utah	USDOE	USNRC	General	450,000	1.1 TBq (30 Ci)
Gunnison, Colorado	USDOE	USNRC	General	1,000,000	6.5 TBq (175 Ci)
Lakeview, Oregon	USDOE	USNRC	General	670,000	1.6 TBq (42 Ci)
Lowman, Idaho	USDOE	USNRC	General	200,000	0.4 TBq (12 Ci)
Maybell, Colorado	USDOE	USNRC	General	3,900,000	17 TBq (455 Ci)
Mexican Hat, Utah	USDOE	USNRC	General	4,000,000	67 TBq (1800 Ci)
Moab, Utah	USDOE		Not yet under LTSP[ii] Program	10,800,000	
Naturita, Colorado	USDOE	USNRC	General	880,000	2.9 TBq (79 Ci)
Rifle, Colorado	USDOE	USNRC	General	4,500,000	101 TBq (2740 Ci)
Salt Lake City, Utah, Processing Site	USDOE	USNRC	General	Residual Ra-226- and Th-230-contaminated material.	
Salt Lake (South Clive), Utah, Disposal Site	USDOE	USNRC	General	2,500,000	57 TBq (1550 Ci)
Shiprock, New Mexico	USDOE	USNRC	General	2,300,000 wet metric tonnes	28 TBq (750 Ci)
Slick Rock, Colorado	USDOE	USNRC	General	1,000,000	71 TBq (175 Ci)
Spook, Wyoming	USDOE	USNRC	General	1,500,000 m3	
Tuba City, Arizona	USDOE	USNRC	General	2,000,000	35 TBq (940 Ci)

[i] Source: USDOE Grand Junction web site
Note: Blanks in the Licensee column indicate Licensee and Installation name are the same.
NA: Not applicable

[ii] Long-Term Surveillance Plan

Annex D-5. Uranium Mill Tailings Radiation Control Act Title II Sites[i]

Site Name/Location	Licensee	Regulator	License Number	Status	Quantity of contaminated material (metric tonnes)	Total Ra-226 Activity
Sites Regulated by USNRC[ii]						
Bluewater, New Mexico	USDOE	USNRC	General	Under general NRC license, in USDOE LTSP program	22,000,000	460 TBq (12,300 Ci)
Edgemont, South Dakota	USDOE	USNRC	General	Under general NRC license, in USDOE LTSP program	3,600,000	19 TBq (530 Ci)
Sherwood, Washington	USDOE	USNRC	General	Under general NRC license, in USDOE LTSP program	2,600,000	17 TBq (470 Ci)
White Mesa, Utah	International Uranium Corp	USNRC	SUA-1358	Not yet on LTSP	3,200,000	
Gas Hills, Wyoming	Umetco Minerals Corp	USNRC	SUA-0648	Not yet on LTSP	7,300,000	
Split Rock, Wyoming	Western Nuclear Inc.	USNRC	SUA-0056	Not yet on LTSP	7,000,000	
Lucky Mc, Wyoming	Pathfinder Mines Corp	USNRC	SUA-0672	Not yet on LTSP	10,600,000	
ANC, Wyoming	American Nuclear Corp	USNRC	SUA-0667	Not yet on LTSP	5,300,000	
Shirley Basin, Wyoming	Pathfinder Mines Corp	USNRC	SUA-0442	Not yet on LTSP	7,400,000	
Shirley Basin, Wyoming	Petrotomics Co	USNRC	SUA-0551	Not yet on LTSP		
Lisbon, Utah	Rio Algom Mining Corp	USNRC	SUA-1119	Not yet on LTSP	3,500,000	
Highland, Wyoming	Exxon Mobil Corp	USNRC	SUA-1139	Not yet on LTSP	10,300,000	
Bear Creek, Wyoming	Bear Creek Uranium Co	USNRC	SUA-1310	Not yet on LTSP	4,300,000	
Sweetwater, Wyoming	Kennecott Uranium Co	USNRC	SUA-1350	Not yet on LTSP	2,100,000	
Shootaring, Utah	Plateau Resources Ltd	USNRC	SUA-1371	Not yet on LTSP		
Grants, New Mexico	Homestake Mining Co	USNRC	SUA-1471	Not yet on LTSP	20,300,000	
L-Bar, New Mexico	Kennecott Energy Co.	USNRC	SUA-1472	Not yet on LTSP	1,900,000	
Ambrosia Lake, New Mexico	Rio Algom Mining LLC	USNRC	SUA-1473	Not yet on LTSP	30,100,000	
Church Rock, New Mexico	UNC Mining and Milling	USNRC	SUA-1475	Not yet on LTSP	3,200,000	
Sites Regulated by Agreement States						
Cotter, Colorado		Colorado		Standby		
Uravan, Colorado		Colorado		Reclamation/decommissioning	9,500,000	
Sweeney, Colorado		Colorado		No activity. Colorado is trying to get it on the FUSRAP list.		

[i] *Sources: USDOE Grand Junction web site, ADAMS, and Decommissioning of U.S. Uranium Production Facilities. U.S. USDOE Energy Information Administration, Report No. USDOE/EIA-0592, February 1995.*

Note: Blanks in the Licensee column indicate Licensee and Installation name are the same.
NA: Not applicable

[ii] Sequoyah Fuels Corporation in Gore, Oklahoma was a uranium conversion facility, but the USNRC decided in July 2002 that the front-end waste was 11(e)2 material. The Sequoyah Fuels site is listed in Annex D-12.

Annex D-5. Uranium Mill Tailings Radiation Control Act Title II Sites[i]

Site Name/Location	Licensee	Regulator	License Number	Status	Quantity of contaminated material (metric tonnes)	Total Ra-226 Activity
Kerr-McGee, Illinois		Illinois		Decommissioning. The West Chicago site is being decommissioned for unrestricted use.		
Conoco Conquista, Texas		Texas		Reclamation/Stability monitoring		
Exxon Felder, Texas		Texas		Reclamation/Stability monitoring	400,000	
RGR/Chevron, Texas		Texas		Reclamation/Stability monitoring	5,900,000	
Dawn Mining, Washington		WA		Reclamation/Residue Disposal		
WNI Sherwood, Washington		WA/USNRC		State License Terminated (April 2001); Disposal area is under 40.28 General License by USNRC	2,800,000	
Maybell, Colorado		Colorado		Reclamation/Stability monitoring	NA – Heap Leach Site	
Durita, Colorado		Colorado		Reclamation/Stability monitoring	NA – Heap Leach Site	
Cogema, Texas		Texas		Restoration/Closure	NA – In Situ Site	
Everest Minerals, Texas		Texas		Restoration/Closure	NA – In Situ Site	
IEC, Texas		Texas		Restoration/Closure	NA – In Situ Site	
URI, Texas		Texas		Standby, Restoration of some satellite well fields	NA – In Situ Site	
USX, Texas		Texas		License has been terminated.	NA – In Situ Site	
Mestena, Texas		Texas		New license, pre-operational work only.	NA – In Situ Site	

Annex D-6. Inventory of Stored Radioactive Waste[i]

State	Installation	Waste Type	Inventory	Units	Activity (Bq)	Activity (Ci)	Radionuclides/Category (ies)
Government Installations							
California	Energy Technology Engineering Center	TRU	11	m3	1.11E+10	3.00E-01	Transuranic Isotopes
		MLLW	2	m3			Activation Products, Mixed Fission Products, Transuranic Isotopes, Naturally-Occurring Isotopes
		LLW	1,816	m3			Activation Products, Mixed Fission Products, Transuranic Isotopes, Naturally-Occurring Isotopes
	Laboratory for Energy-Related Health Research	LLW	2,012	m3			Mixed Fission Products, Naturally-Occurring Isotopes
	Lawrence Berkeley National Lab	TRU	2	m3			Various
		MLLW	4	m3			Various
		LLW	77	m3			Various
	Lawrence Livermore National Lab	TRU	295	m3			Transuranic Isotopes, H-3
		MLLW	405	m3			Activation Products, Mixed Fission Products, Transuranic Isotopes, Naturally-Occurring Isotopes, H3
		LLW	1,256	m3			Activation Products, Mixed Fission Products, Transuranic Isotopes, Naturally-Occurring Isotopes
Colorado	Rocky Flats Environmental Technology Site	TRU	5,309	m3			Transuranic Isotopes, Naturally-Occurring Isotopes
		MLLW	5,954	m3			Transuranic Isotopes, Naturally-Occurring Isotopes
		LLW	13,344	m3			Transuranic Isotopes, Naturally-Occurring Isotopes
Idaho	Idaho National Engineering and Environmental Lab	TRU	64,871	m3			Transuranic Isotopes
		MLLW	3,711	m3	9.31E+10	2.52E+00	Activation Products, Mixed Fission Products, Transuranic Isotopes, Naturally-Occurring Isotopes, H3
		LLW	1,352	m3			Activation Products, Mixed Fission Products, Transuranic Isotopes, Naturally-Occurring Isotopes
		HLW	9,394	m3	1.11E+18	2.99E+07	Activation Products, Mixed Fission Products, Transuranic Isotopes, Naturally-Occurring Isotopes
Illinois	Argonne National Lab - East	TRU	99	m3			Various
		MLLW	84	m3			Various
		LLW	76	m3			Various
Kentucky	Paducah Gaseous Diffusion Plant	TRU	5	m3	1.03E+12	2.79E+01	Transuranic Isotopes, Naturally-Occurring Isotopes
		MLLW	4,305	m3			Transuranic Isotopes, Naturally-Occurring Isotopes
		LLW	6,452	m3			Transuranic Isotopes, Naturally-Occurring Isotopes
	Other USDOE	TRU	61	m3			Various

[i] Sources: DOE Environmental Management Stream Disposition Data (IPABS, 8/28/01); DOE LLW Disposal Capacity Report (2000)
Note: Blanks in the Licensee column indicate Licensee and Installation name are the same.
NA: Not applicable

Annex D-6. Inventory of Stored Radioactive Waste[i]

State	Installation	Waste Type	Inventory	Units	Activity (Bq)	Activity (Ci)	Radionuclides/Category (ies)
Multiple States	Other USDOE	TRU	61	m3			Various
	Other USDOE	LLW	233	m3			Various
Nevada	Nevada Test Site	TRU	615	m3			Mixed Fission Products, Transuranic Isotopes, H-3
		MLLW	<1	m3	1.03E+08	2.79E-03	Mixed Fission Products, Transuranic Isotopes, H-3
New Mexico	Inhalation Toxicology Laboratory	TRU	<1	m3	7.76E+05	2.10E-05	Various
		LLW	72	m3	4.53E+08	1.22E-02	Various
	Los Alamos National Lab	TRU	9,443	m3			Transuranic Isotopes
		MLLW	152	m3			Mixed Fission Products, Transuranic Isotopes, Naturally-Occurring Isotopes, H-3
	Sandia National Lab - NM	TRU	38	m3			Various
		MLLW	83	m3	6.14E+11	1.66E+01	Mixed Fission Products, Transuranic Isotopes, H-3
		LLW	565	m3			Activation Products, Mixed Fission Products, Transuranic Isotopes, Naturally-Occurring Isotopes, H-3
New York	Brookhaven National Lab	MLLW	12	m3			Activation Products, Mixed Fission Products, Transuranic Isotopes, Naturally-Occurring Isotopes, H3
		LLW	11,493	m3			Activation Products, Mixed Fission Products, Transuranic Isotopes, Naturally-Occurring Isotopes, H3
	Niagara Falls Storage Site (FUSRAP)	LLW	195,000	m3			Naturally-Occurring Isotopes
	West Valley Demonstration Project	TRU	548	m3			Activation Products, Mixed Fission Products, Transuranic Isotopes, Naturally-Occurring Isotopes
		MLLW	80	m3			Activation Products, Mixed Fission Products, Transuranic Isotopes, Naturally-Occurring Isotopes, H3
		LLW	16,410	m3			
		HLW	229	m3			Mixed Fission Products, Transuranic Isotopes
Ohio	Ashtabula Environmental Management Project	MLLW	433	m3			Naturally-Occurring Isotopes
		LLW	2,916	m3			Naturally-Occurring Isotopes
	Fernald Environmental Management Project	MLLW	1,477	m3	1.18E+11	3.18E+00	Naturally-Occurring Isotopes
		LLW	38,896	m3	2.36E+12	6.38E+01	Naturally-Occurring Isotopes
	Miamisburg Environmental Management Project	TRU	247	m3			Transuranic Isotopes, Naturally-Occurring Isotopes
	Portsmouth Gaseous Diffusion Plant	MLLW	10,805	m3			Naturally-Occurring Isotopes
		LLW	13,259	m3			Naturally-Occurring Isotopes
South Carolina	Savannah River Site	TRU	10,849	m3			Transuranic Isotopes
		MLLW	2,241	m3	2.74E+13	7.39E+02	Activation Products, Mixed Fission Products, Transuranic Isotopes, Naturally-Occurring Isotopes, H3
		LLW	12,828	m3			Activation Products, Mixed Fission Products, Transuranic Isotopes, Naturally-Occurring Isotopes, H3
		HLW	137,806	m3			Activation Products, Mixed Fission Products, Transuranic Isotopes, Naturally-Occurring Isotopes, H3

Annex D-6. Inventory of Stored Radioactive Waste[i]

State	Installation	Waste Type	Inventory	Units	Activity (Bq)	Activity (Ci)	Radionuclides/Category (ies)
Tennessee	Oak Ridge Reservation	TRU	2,438	m3			Activation Products, Mixed Fission Products, Transuranic Isotopes, Naturally-Occurring Isotopes
		MLLW	8,877	m3			Activation Products, Mixed Fission Products, Transuranic Isotopes, Naturally-Occurring Isotopes, H3
		LLW	34,473	m3			Activation Products, Mixed Fission Products, Transuranic Isotopes, Naturally-Occurring Isotopes, H3
Texas	Pantex Plant	MLLW	8	m3			Mixed Fission Products, Transuranic Isotopes, Naturally-Occurring Isotopes, H-3
		LLW	101	m3			Transuranic Isotopes, Naturally-Occurring Isotopes, H-3
Washington	Hanford Site	TRU	16,408	m3			Activation Products, Mixed Fission Products, Transuranic Isotopes, Naturally-Occurring Isotopes, H3
		MLLW	7,677	m3			Activation Products, Mixed Fission Products, Transuranic Isotopes, Naturally-Occurring Isotopes, H3
		LLW	299	m3			Activation Products, Mixed Fission Products, Transuranic Isotopes, Naturally-Occurring Isotopes, H3
		HLW	206,832	m3			Activation Products, Mixed Fission Products, Transuranic Isotopes, Naturally-Occurring Isotopes, H3

Radionuclide Category Key	
General Category	Key Isotopes
Activation Products	Primarily Cl-36, Fe-55, Mn-54, Zn-65, Co-58, Co-60, Ni-63,
Mixed Fission Products	Radioactive isotopes and daughters from Zn-72 to Gd-158; primary loner-lived isotopes are Kr-85, Sr-89, Sr-90/Y-90,Y-91, Zr-95, Nb-95, Ru-103/Rh103, Ru-106/Rh-106, Sb-125/Te-125, Cs-137/Ba-137, Ce-141, Ce-144/Pr-144, Pm-147, S-m151,and Eu-155
Transuranic Isotopes	Isotopes of Cf, Bk, Cm, Am, Pu, and Np, and their respective decay products.
Naturally-Occurring Isotopes	U-238 , U-235, U-234, Th-232, and their respective decay products (*Pa-231, Th-227, Th-228, Th-230, Th-231, Th-234, Ac-227, Ac-228, Ra-223, Ra-224, Ra-226, Ra-228, Fr-223, Rn-219, Rn-220, Rn-222, At-215, At-218, At-219, Po-210, Po-211, Po-212, Po-214, Po-215, Po-216, Po-218, Bi-210, Bi-211, Bi-212, Bi-214, Pb-210, Pb-211, Pb-212, Pb-214, Tl-206, Tl-207, Tl-208, and Tl-210*), C-14, K-40, V-40, Rb-87, In-115, Te-123, La-138, Ce-142, Nd-144, Sm-147, Sm-148, Sm-149, Gd-152,Dy-156, Lu-176, Hf-174, Ta-180, Re-187, Pt-190, Pb-204, Bi-215
Tritium	H-3

Annex D-7. Inventory of Disposed Radioactive Waste[i]

State	Installation	Disposal Facility	Waste Type	Inventory	Units	Activity (Bq)	Activity (Ci)	Radionuclides
Government Installations								
Idaho	Idaho National Engineering and Environmental Lab	Radioactive Waste Management Complex	LLW	22,169	m3	9.08E+16	2.45E+06	Activation Products, Mixed Fission Products, Transuranic Isotopes, Naturally-Occurring Isotopes, H3
Missouri	Weldon Spring Site Rem. Action Proj.	On-Site Disposal Cell	11e(2)	1,120,000	m3			Naturally-Occurring Isotopes
Nevada	Nevada Test Site	Greater Confinement Disposal	TRU	200	m3	2.11E+15	5.70E+04	Activation Products, Mixed Fission Products, Transuranic Isotopes, Naturally-Occurring Isotopes, H3
		MW Disposal Unit	MLLW	82	m3	3.92E+13	1.06E+03	Activation Products, Mixed Fission Products, Transuranic Isotopes, Naturally-Occurring Isotopes, H3
		Area 3/Area 5 RWMS	LLW	378,103	m3	1.81E+17	4.89E+06	Activation Products, Mixed Fission Products, Transuranic Isotopes, Naturally-Occurring Isotopes, H-3
New Mexico	Los Alamos National Lab	Technical Area 54/Area G	LLW	47,414	m3	1.61E+16	4.35E+05	Activation Products, Mixed Fission Products, Transuranic Isotopes, Naturally-Occurring Isotopes, H-3
	Waste Isolation Pilot Plant	WIPP Disposal	TRU	9,293	m3	1.13E+16	3.02E+05	Activation Products, Mixed Fission Products, Transuranic Isotopes, Naturally-Occurring Isotopes, H3
Ohio	Fernald Environmental Management Project	On-Site Disposal Facility	MLLW	90	m3			Naturally-Occurring Isotopes
		On-Site Disposal Facility	LLW	426,036	m3			Naturally-Occurring Isotopes
South Carolina	Savannah River Site	Saltstone Vaults	LLW	28,317	m3			Activation Products, Mixed Fission Products, Transuranic Isotopes, Naturally-Occurring Isotopes, H3
		E-Area Low Activity Vault	LLW	15,143	m3	2.32E+15	6.27E+04	Activation Products, Mixed Fission Products, Transuranic Isotopes, Naturally-Occurring Isotopes, H-3
		E-Area Trenches	LLW	4,186	m3	2.57E+11	7.00E+00	Activation Products, Mixed Fission Products, Transuranic Isotopes, Naturally-Occurring Isotopes, H-3
		E-Area Intermediate Level Vault	LLW	1,966	m3	1.67E+16	4.51E+05	Activation Products, Mixed Fission Products, Transuranic Isotopes, Naturally-Occurring Isotopes, H-3
Tennessee	Oak Ridge Reservation	Interim Waste Management Facility	LLW	3,700	m3	1.18E+13	3.19E+02	Activation Products, Mixed Fission Products, Transuranic Isotopes, Naturally-Occurring Isotopes, H-3
Utah	Cheney Site	Cheney Disposal Cell	11e(2)	2,850,000	m3			Naturally-Occurring Isotopes
	Monticello Remedial Action Project	Monticello Disposal Cell	11e(2)	2,000,000	m3			Naturally-Occurring Isotopes

[i] Sources: DOE Environmental Management Stream Disposition Data (IPABS, 8/28/01); DOE LLW Disposal Capacity Report (2000); Verbal update from Carlsbad Field Office (2003)
Note: Blanks in the Licensee column indicate Licensee and Installation name are the same.
NA: Not applicable

Annex D-7. Inventory of Disposed Radioactive Waste[i]

State	Installation	Disposal Facility	Waste Type	Inventory	Units	Activity (Bq)	Activity (Ci)	Radionuclides
Washington	Hanford Site	Environmental Restoration Disposal Facility	MLLW	135	m3			Activation Products, Mixed Fission Products, Transuranic Isotopes, Naturally-Occurring Isotopes, H3
		RMW Trenches	MLLW	846	m3	4.54E+14	1.23E+04	Activation Products, Mixed Fission Products, Transuranic Isotopes, Naturally-Occurring Isotopes, H-3
		Environmental Restoration Disposal Facility	LLW	1,079,066	m3			Activation Products, Mixed Fission Products, Transuranic Isotopes, Naturally-Occurring Isotopes, H3
		200 Area Burial Grounds	LLW	258,079	m3	1.39E+17	3.76E+06	Activation Products, Mixed Fission Products, Transuranic Isotopes, Naturally-Occurring Isotopes, H-3
		Decommissioned Submarine Hulls Disposal Area	LLW	110	Reactor Compart-ments			
Commercial Facilities								
South Carolina	Barnwell Disposal Facility	Barnwell Commercial Disposal	LLW	769,226	m3	7.17E+17	1.94E+07	Activation Products, Mixed Fission Products, Transuranic Isotopes, Naturally-Occurring Isotopes, H-3
Utah	Envirocare of Utah	Envirocare LLW Disposal	LLW	142,918	m3	8.03E+13	2.17E+03	Activation Products, Mixed Fission Products, Transuranic Isotopes, Naturally-Occurring Isotopes, H-3
Washington	U.S. Ecology - Richland	US Ecology	LLW	384,101	m3	2.70E+17	7.30E+06	Activation Products, Mixed Fission Products, Transuranic Isotopes, Naturally-Occurring Isotopes, H-3
Multiple States	Closed Commercial Disposal: Beatty, NV; Maxey Flats, KY; Sheffield, IL; West Valley, NY	Closed Commercial Disposal	LLW	438,143	m3	7.81E+16	2.11E+06	Activation Products, Mixed Fission Products, Transuranic Isotopes, Naturally-Occurring Isotopes, H-3

Radionuclide Category Key	
General Category	Key Isotopes
Activation Products	Primarily Cl-36, Fe-55, Mn-54, Zn-65, Co-58, Co-60, Ni-63,
Mixed Fission Products	Radioactive isotopes and daughters from Zn-72 to Gd-158; primary longer-lived isotopes are Kr-85, Sr-89, Sr-90/Y-90,Y-91, Zr-95, Nb-95, Ru-103/Rh103, Ru-106/Rh-106, Sb-125/Te-125, Cs-137/Ba-137, Ce-141, Ce-144/Pr-144, Pm-147, S-m151,and Eu-155
Transuranic Isotopes	Isotopes of Cf, Bk, Cm, Am, Pu, and Np, and their respective decay products.
Naturally-Occurring Isotopes	U-238 , U-235, U-234, Th-232, and their respective decay products (*Pa-231, Th-227, Th-228, Th-230, Th-231, Th-234, Ac-227, Ac-228, Ra-223, Ra-224, Ra-226, Ra-228, Fr-223, Rn-219, Rn-220, Rn-222, At-215, At-218, At-219, Po-210, Po-211, Po-212, Po-214, Po-215, Po-216, Po-218, Bi-210, Bi-211, Bi-212, Bi-214, Pb-210, Pb-211, Pb-212, Pb-214, Tl-206, Tl-207, Tl-208, and Tl-210*), C-14, K-40, V-40, Rb-87, In-115, Te-123, La-138, Ce-142, Nd-144, Sm-147, Sm-148, Sm-149, Gd-152,Dy-156, Lu-176, Hf-174, Ta-180, Re-187, Pt-190, Pb-204, Bi-215
Tritium	H-3

Annex D-8. Commercial Nuclear Power Facilities Being Decommissioned

State	Facility Name	Purpose
California	Vallecitos BWR	5 MWe BWR Experimental Power Reactor
	Humboldt Bay 3	63 MWe BWR Commercial Power Reactor
	Rancho Seco	913 MWe PWR Commercial Power Reactor
	San Onofre 1	437 MWe PWR Commercial Power Reactor
Colorado	Fort St. Vrain	330 MWe HTGR Commercial Power Reactor
Connecticut	Haddam Neck	590 MWe PWR Commercial Power Reactor
	Millstone 1	660 MWe BWR Commercial Power Reactor
Illinois	Dresden 1	200 MWe BWR Commercial Power Reactor
	Zion 1	1040 MWe PWR Commercial Power Reactor
	Zion 2	1040 MWe PWR Commercial Power Reactor
Maine	Maine Yankee	860 MWe PWR Commercial Power Reactor
Massachusetts	Yankee Rowe	167 MWe PWRCommercial Power Reactor
Michigan	Big Rock Point	67 MWe BWR Commercial Power Reactor
	Fermi 1	61 MWe LMFBR Commercial Power Reactor
New York	Indian Point 1	257 MWe PWR Commercial Power Reactor
	Shoreham	809 MWe BWR Commercial Power Reactor
Oregon	Trojan	1095 MWe PWR Commercial Power Reactor
Pennsylvania	Peach Bottom 1	40 MWe HTGR Commercial Power Reactor
	Saxton	35 MWe PWR Experimental Power Reactor
	Three Mile Island 2	792 MWe PWR Commercial Power Reactor
South Carolina	Carolinas-Virginia Tube Reactor	17 MWe PTHWR Experimental Power Reactor
South Dakota	Pathfinder	66 MWe Superheat BWR Commercial Power Reactor
Wisconsin	LaCrosse	50 MWe BWR Commercial Power Reactor

BWR= Boiling light-water reactor
HTGR = High temperature gas reactor
LMFBR = Liquid metal fast breeder reactor
PT HWR = Pressure Tube Heavy water reactor
PWR = Pressurized light-water reactor

Annex D-9. Ongoing USDOE Decommissioning and Remediation Projects

Geographic Site Name	State	Historic Mission	Nuclear / Radioactive Facilities With Decommissioning Ongoing or Pending	Release Sites With Remediation Ongoing or Pending
Energy Technology Engineering Center	CA	Research, Development & Testing	3	6
Lab. for Energy-Related Health Research	CA	Research, Development & Testing	0	4
Lawrence Berkeley National Laboratory	CA	Research, Development & Testing	0	43
Lawrence Livermore National Laboratory - Main Site	CA	Defense, Research, Development & Testing	0	16
Lawrence Livermore National Laboratory - Site 300	CA	Defense, Research, Development & Testing	0	15
Stanford Linear Accelerator Center	CA	Research, Development & Testing	0	4
Rocky Flats Environmental Technology Site	CO	Defense	59	63
Idaho National Engineering and Environmental Laboratory	ID	Defense, Research, Development & Testing	105	171
Argonne National Laboratory - East	IL	Research, Development & Testing	15	4
Paducah Gaseous Diffusion Plant	KY	Enrichment	2	152
Kansas City Plant	MO	Defense	0	1
Los Alamos National Laboratory	NM	Defense, Research, Development & Testing	1	812
Sandia National Laboratories-New Mexico	NM	Defense, Research, Development & Testing	0	19
Nevada Test Site and offsite test locations	NV, AK, NM, CO, MS	Defense (Weapons Testing)	0	1422
Brookhaven National Laboratory	NY	Research, Development & Testing	7	8
Separations Process Research Unit	NY	Research, Development & Testing	4	6
West Valley Demonstration Project	NY	Commercial Reprocessing	0	1
Ashtabula Env. Management Project	OH	Defense	10	3
Columbus Environmental Management Project - West Jefferson	OH	Research, Development & Testing	3	1
Fernald Environmental Management Project	OH	Defense	13	4
Miamisburg Env. Management Project	OH	Defense	19	74
Portsmouth Gaseous Diffusion Plant	OH	Enrichment	0	16
Savannah River Site	SC	Defense	245	234
Oak Ridge Reservation	TN	Defense, Research, Development, & Testing	68	401
Pantex Plant	TX	Defense	0	198
Hanford Site	WA	Defense	632	1705

Annex D-10. List of Ongoing Formerly Utilized Sites Remedial Action Program Sites[i]

State	Site
Connecticut	CE Site, Windsor
Illinois	Madison Site, Madison
Maryland	W.R. Grace & Company, Curtis Bay
Massachusetts	Shpack Landfill, Norton
Missouri	Latty Avenue Properties, Hazelwood
	St. Louis Airport Site, St. Louis
	St. Louis Airport Site Vicinity Properties, St. Louis
	St. Louis Downtown Site, St. Louis
New Jersey	Maywood Site, Maywood
	Wayne Site, Wayne/Peaquannock
	Middlesex Sampling Plant, Middlesex
	DuPont and Company, Deepwater
New York	Niagara Falls Storage Site, Lewiston
	Ashland 1, Tonawanda
	Linde, Tonawanda
	Guteril Steel, Buffalo
	Praxair, Tonawanda
	Seaway Industrial Park, Tonawanda
	Colonie Site, Colonie
Ohio	Luckey Site, Luckey
	Painesville Site, Painesville
	Dayton Unit I, Dayton
	Dayton Unit III, Dayton
	Dayton Warehouse, Dayton
	Harshaw Chemical
Pennsylvania	Shallow Land Disposal Area, Parks Township

[i] Note: Blanks in the Licensee column indicate Licensee and Installation name are the same.
NA: Not applicable

Annex D-11. Decommissioning Of Licensed Materials Sites[i]

Installation	Location	Regulator	License Number	Decommissioning Status
AAR Manufacturing Group, Inc.	Livonia, Michigan	USNRC	STB-0362 (terminated)	Estimated closure 12/2004, under unrestricted release.
Aerojet General Co	Ran Ramon, California	USNRC	Terminated 1970	Transferred to State of California
American Smelting and Refining	Houston, Texas	USNRC	Terminated 1971	Transferred to Texas
B&W Parks Operating Facility	Parks Township, Pennsylvania	USNRC	SNM-414	Estimated closure 7/2003, under unrestricted release.
B&W Shallow Land Disposal Area	Parks Township, Pennsylvania	USNRC	SNM-2001	Estimated closure 2007, under restricted release.
Cabot Performance Materials Inc.	Reading, Pennsylvania	USNRC	SMC-1562	Estimated closure 10/2003, under unrestricted release.
Department of the Army	Frankford Arsenal, Philadelphia, Pennsylvania	USNRC	Terminated 1981	In process of decommissioning
Dow Chemical	Freeport, Texas	USNRC	Terminated 1964	Transferred to Texas
Dow Chemical Company	Bay City, Michigan	USNRC	STB-527	Estimated closure 4/2004, under unrestricted release.
Fansteel, Inc.	Muskogee, Oklahoma	USNRC	SMB-911	Estimate closure 2015, under unrestricted release.
Hertage Minerals Inc. (HMI)	Lakehurst, New Jersey	USNRC	SMB-1541	Potential closure 2003, under unrestricted release.
Homer Laughlin[ii]	Newell, West Virginia	USNRC	Terminated 1972	Under Regional review
Horizons, Inc	Cleveland, Ohio	USNRC	Terminated 1959	Transferred to Ohio
Isotope Specialties	Burbank, California	USNRC	Terminated 1959	Transferred to State of California
Kaiser Aluminum Specialty Products	Tulsa, Oklahoma	USNRC	STB-472 (terminated)	Estimated final closure 8/2006, under unrestricted release.
Kerr-McGee – Cimmaron	Crescent, Oklahoma	USNRC	SNM-928	Estimated closure 2007, under unrestricted release. Uranium groundwater standard of 180 pCi/l.
Kerr-McGee - Cushing Refinery	Cushing, Oklahoma	USNRC	SNM-1999	Estimated closure 12/2003, under unrestricted release. Some waste being shipped

[i] Source: SECY-02-0169
Note: Blanks in the Licensee column indicate Licensee and Installation name are the same.
NA: Not applicable

[ii] Item is still under NRC Region II review. The license is retired; Lic No. SUB-00081; Docket No. 040-01957.

Annex D-11. Decommissioning Of Licensed Materials Sites[i]

Installation	Location	Regulator	License Number	Decommissioning Status
				off-site.
Kiski Valley Water Pollution Control Authority (KVWPCA)	Vandergrift, Pennsylvania	USNRC	None.	Ultimate steps to closure undecided. Estimated closure 2011, under unrestricted release.
LTV Corporation	Dallas, Texas	USNRC	Terminated 1961	Transferred to Texas
Mallinckrodt Chemical Inc.	St. Louis, Missouri	USNRC	STB-401	Estimated final closure 2008, under unrestricted release.
Marquardt Corp	Hill Air Force Base, Utah	USNRC	Terminated 1972	Transferred to U.S. Air Force
Marquardt Corp	Ogdon, Utah	USNRC	Terminated 1971	Transferred to Utah
Michigan Dept. of Natural Resources (MDNR)	Kawkawlin, Michigan	USNRC	SUC-1581	Estimated closure 2008, under unrestricted release.
Molycorp, Inc (Washington)	Washington, Pennsylvania	USNRC	SMB-1393	Estimated closure 10/2005, under unrestricted release.
Molycorp, Inc (York)	York, Pennsylvania	USNRC	SMB-1408	Estimated closure 6/2003, under unrestricted release.
Permagrain Products, Inc.	Karthaus, Pennsylvania	USNRC	37-17860-02	Estimated closure 10/2004, under unrestricted release.
Reynolds Aluminum	Bauxite, Arkansas	USNRC	Terminated 1957	Transferred to State of Arkansas
Safety Light Corporation (SLC)	Bloomsburg, Pennsylvania	USNRC	37-00030-02	Estimated closure 12/2004, under unrestricted release.
SCA Services	Kawkawlin, Michigan	USNRC	SUC-1565	Estimated closure 2011, proposed for restricted release.
Sequoyah Fuels Corp.[i]	Gore, Oklahoma	USNRC	SUB-1010	USNRC decided that the site front-end waste could be classified as 11e(2) byproduct material. Thereby permitting site control to pass to USDOE. Onsite disposal proposed. Estimated closure 2009, under restricted release.
Shieldalloy Metallurgical Corp	Newfield, New Jersey	USNRC	SMB-1507	Onsite disposal proposed. Estimated closure 2010, under restricted release.
Superior Steel	Pittsburgh, Pennsylvania	USNRC	Terminated 1958	In process of decommissioning

[i] The Sequoyah Fuels Corporation is listed under the decommissioning program, but the 11(e)2 decision designates the waste as being covered under UMTRCA, Title II.

Annex D-11. Decommissioning Of Licensed Materials Sites[i]

Installation	Location	Regulator	License Number	Decommissioning Status
U.S. Army Jefferson Proving Ground	Madison, Indiana	USNRC	SUB-1435	Estimated closure 1/2006, under restricted release.
U.S. Army Chemical Corp	Fort McClellan, Alabama	USNRC	Terminated 1965	In process of decommissioning
Union Carbide Corporation	Lawrenceburg, Tennesse	USNRC	SNM-724, SMB-720 (terminated)	Estimated closure 12/2005, under unrestricted release.
United Nuclear	New Haven, Connecticut	USNRC	Terminated 1974	In process of decommissioning
Verdi Mill	Mohave, California	USNRC	Terminated 1958	Transferred to State of California
Watertown GSA	Watertown, Massachusetts	USNRC	None.	Estimated closure in 2003, under unrestricted release.
Westinghouse Electric	Blairville, Pennsylvania	USNRC	Terminated 1961	In process of decommissioning
Westinghouse Electric Corp. (Waltz Mill)	Madison, Pennsylvania	USNRC	SNM-770	Estimated closure 8/2003, under unrestricted release.
Whittaker Corporation	Greenville, Pennsylvania	USNRC	SMA-1018	Estimated closure 2007, under unrestricted release.

Annex D-12. USNRC-Licensed Research and Test Reactors Under Decommissioning[i]

Licensee/Location	Reactor Type	Power Level (kW)	D&D Alternative/Current Status
CBS Corporation, Waltz Mill, PA	Tank	20000	SAFSTOR/SAFSTOR
General Atomics, San Diego, CA	TRIGA Mark F	1500	DECON/DECON
General Atomics, San Diego, CA	TRIGA Mark I	250	DECON/DECON
Georgia Institute of Technology, Atlanta, GA	Tank	N.A.[ii]	DECON/DECON
Iowa State University, Ames, Iowa	Argonaut	N.A.	DECON/DECON
Manhattan College, Riverdale, NY	ZPR	0.0001	SAFSTOR/SAFSTOR
University of Illinois, Urbana, Il	TRIGA	1500	DECON/DECON
University of Washington, Seattle, WA	Argonaut	100	DECON/DECON
University of Virginia, Charlottesville, VA	Pool	N.A.	DECON/DECON
University of Virginia, Charlottesville, VA	Pool	2000	DECON/DECON
National Aeronautics and Space Administration, Sandusky, OH	Test	60000	DECON/DECON
National Aeronautics and Space Administration, Sandusky, OH	Mockup	100	DECON/DECON
Cornell University, Ithaca, NY	Tank (ZPR)	0.1	N.A.
General Electric Co., Sunol, CA	GETR (Tank)	50000	N.A.
General Electric Co., Sunol, CA	Pulstar	2000	N.A.

[i] Note: Blanks in the Licensee column indicate Licensee and Installation name are the same.
NA: Not applicable

[ii] N.A. either not applicable or not available.
Source: USNRC Information Digest 2002 Edition (NUREG 1350, Vol. 14)

Annex E-1. USNRC Guidance

USNRC issues guidance to describe and make available to the public such information as methods acceptable to the USNRC staff for implementing specific parts of the USNRC regulations, techniques used by the staff in evaluating specific problems or postulated accidents, and data needed by the USNRC staff in its review of applications for permits and licenses. Guidance such as regulatory guides or staff technical positions, are not substitutes for regulations, and compliance with them is not required. Methods and solutions different from those set out in guidance will be acceptable if they provide a basis for the findings requisite to the issuance or continuance of a permit or license by the USNRC. Some examples of guidance include:

HLW Management

NUREG-1804, Revision 2, "Yucca Mountain Review Plan (Draft Report for Comment)." March 2002

NUREG-1494 "Staff Technical Position on Consideration of Fault Displacement Hazards in Geologic Repository Design," March 1994

NUREG-1563, "Branch Technical Position on the Use of Expert Elicitation in the HLW Program," issued November 1996”

LLW Management

Regulatory Guide 4.20, “Constraint on Releases of Airborne Radioactive Materials to The Environment For Licensees Other Than Power Reactors”

Regulatory Guide 4.18, “Standard Format and Content of Environmental Reports for Near-Surface Disposal of Radioactive Waste,” June 1983

NUREG-1200, “Standard Review Plan for the Review of a License Application for a Low-Level Radioactive Waste Disposal Facility”

NUREG-1300, “Environmental Standard Review Plan for the Review of a License Application for a Low-Level Radioactive Waste Disposal Facility”

NUREG-119, “Standard Format and Content of a License Application for a Low-Level Radioactive Waste Disposal Facility”

NUREG-1241, “Licensing of Alternative Methods of Disposal of Low-Level Radioactive Waste”

NUREG-1573, “A Performance Assessment Methodology for Low-Level Radioactive Waste Disposal Facilities”

Regulatory Guide 4.19, “Guidance for Selecting Sites for Near-Surface Disposal of Low-Level Radioactive Waste,” August 1988

Uranium Recovery

NUREG-1724, "Standard Review Plan for the Review of USDOE Plans for Achieving Regulatory Compliance at Sites with Contaminated Ground Water Under Title I of the Uranium Mill Tailings Radiation Control Act: Draft Report for Comment," June 2000

NUREG- 1623, "Design of Erosion Protection for Long-Term Stabilization," i002

NUREG-1620, Rev. 1. "Draft Standard Review Plan for the Review of a Reclamation Plan for Mill Tailings Sites Under Title II of the Uranium Mill Tailings Radiation Control Act," January 2002

NUREG-1569, Rev. 1. "Draft Standard Review Plan for In Situ Leach Uranium Extraction License Applications," January 2002

"Uranium Mill In-Situ Leach Uranium Recovery, and 11e(2) Byproduct Material Disposal Site Decommission Inspection,"(Procedure 87654), March 2002

Decommissioning

NUREG/CR-5512, “Residual Radioactive Contamination From Decommissioning Parameter Analysis”

NUREG-1556, “Consolidated Guidance About Nuclear Materials,” Vol 1-20

NUREG-1700, “Standard Review Plan for Evaluating Nuclear Power Reactor License Termination Plans”

Regulatory Guide 1.184, “Decommissioning Of Nuclear Power Reactors”

Regulatory Guide 1.185, “Standard Format and Content for Post-shutdown Decommissioning Activities”

NRC Regulatory Issue Summary 2002-02, “Lessons Learned Related to Recently Submitted Decommissioning Plans and License Termination Plans,” January 2002

NUREG-1575, "Multi-Agency Radiation Survey and Site Investigation Manual"

NUREG-1727, "NMSS Decommissioning Standard Review Plan"

NUREG-1757, “Consolidated NMSS Decommissioning Guidance,” Volumes 1-3

“Action Plan to Ensure Timely Cleanup of Site Decommissioning Management Plan Sites,” 57 FR 13389

Regulatory Guide 1.179, “Standard Format and Content of License Termination Plans for Nuclear Power Reactors”

NUREG/CR-6477, “Revised Analyses of Decommissioning Reference - Non-Fuel-Cycle Facilities”

NUREG-1628, “Staff Responses to Frequently Asked Questions Concerning Decommissioning of Nuclear Power Reactors”

NUREG-0586, “Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities (also NUREG-0586 Supplement 1, Vols. 1 & 2)”

NUREG-1496, “Generic Environmental Impact Statement in Support of Rulemaking on Radiological Criteria for license Termination of NRC-Licensed Nuclear Facilities,” Vols. 1-3, U.S. Nuclear Regulatory Commission, Washington, D.C.

Spent Fuel Management

NUREG-1536, “Standard Review Plan for Dry Cask Storage Systems”

NUREG-1567, “Standard Review Plan for Spent Fuel Dry Storage Facilities”

Interim Staff Guidance:

- ISG-1, Rev. 1 Damaged Fuel
- ISG-2, Fuel Retrievability
- ISG-3, Post Accident Recovery and Compliance with 10 CFR 72.122(l)
- ISG-4, Rev. 1 Cask Closure Weld Inspections
- ISG-5, Rev. 1 Confinement Evaluation
- ISG-6, Establishing Minimum Initial Enrichment for the Bounding Design Basis Fuel Assembly(s)
- ISG-7, Potential Generic Issue Concerning Cask Heat Transfer in a Transportation Accident
- ISG-8, Rev. 2 Burnup Credit in the Criticality Safety Analyses of PWR Spent Fuel in Transport and Storage Casks
- ISG-9, Rev. 1 Storage of Components Associated with Fuel Assemblies
- ISG-10, Rev. 1 Alternatives to the ASME Code
- ISG-11, Rev. 2 Cladding Considerations for the Transportation and Storage of Spent Fuel
- ISG-12, Rev. 1 Buckling of Irradiated Fuel Under Bottom End Drop Conditions
- ISG-13, Real Individual
- ISG-14, Supplemental Shielding
- ISG-15, Materials Evaluation
- ISG-16, Emergency Planning
- ISG-17, Interim Storage of Greater Than Class C Waste

Regulatory Guide 3.44, “Standard Format and Content for the Safety Analysis Report for an Independent Spent Fuel Storage Installation (Water-Basin Type),” Rev.2, January 1989

Regulatory Guide 3.48, “Standard Format and Content for the Safety Analysis Report for an Independent Spent Fuel Storage Installation or Monitored Retrievable Storage Installation (Dry Storage),” Rev. 1, August 1989

Regulatory Guide 3.49, “Design of an Independent Spent Fuel Storage Installation (Water-Basin Type),” December 1981

Regulatory Guide 3.50, “Standard Format and Content for a License Application To Store Spent Fuel and High-Level Radioactive Waste (Draft FP 907-4 published 3/1981)” Rev. 1. September 1989

Regulatory Guide 3.53, “Applicability of Existing Regulatory Guides to the Design and Operation of an Independent Spent Fuel Storage Installation,” July 1982

Regulatory Guide 3.54, “Spent Fuel Heat Generation in an Independent Spent Fuel Storage Installation,” Rev.1. September 1999

Regulatory Guide 3.60, “Design of an Independent Spent Fuel Storage Installation (Dry Storage),” March1987

Regulatory Guide 3.61, “Standard Format and Content for a Topical Safety Analysis Report for a Spent Fuel Dry Storage Cask,” February 1989

Regulatory Guide 3.62, “Standard Format and Content for the Safety Analysis Report for Onsite Storage of Spent Fuel Storage Casks,” February 1989

Annex F-1. Criticality Control Standards & Guides for USDOE Facilities

ANSI/ANS-8.1, “Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors”

ANSI/ANS-8.3, (ANSI N-16.2), “Criticality Accident Alarm System”

ANSI/ANS-8.5, (ANSI N-16.4), “Use of Borosilicate-Glass Raschig Rings as a Neutron Absorber in Solutions of Fissile Material”

ANSI/ANS-8.6, “Safety in Conducting Subcritical Neutron-Multiplication Measurements In Situ”

ANSI/ANS-8.7, “Guide for Nuclear Criticality Safety in the Storage of Fissile Materials”

ANSI/ANS-8.9, “Nuclear Criticality Safety Criteria for Steel-Pipe Intersections Containing Aqueous Solutions of Fissile Materials”

ANSI/ANS-8.10, “Criteria for Nuclear Criticality Safety controls in Operations With Shielding and Confinement “

ANSI/ANS-8.12, “Nuclear Criticality Control and Safety of Plutonium-Uranium Fuel Mixtures Outside Reactors”

ANSI/ANS-8.15, “Nuclear Criticality Control of Special Actinide Elements”

ANSI/ANS-8.17, “Criticality Safety Criteria for the Handling, Storage and Transportation of LWR Fuel Outside Reactors”

ANSI/ANS-8.19, “Administrative Practices for Nuclear Criticality Safety”

ANSI/ANS-8.20, “Nuclear Criticality Safety Training”

ANSI/ANS-8.21, “Use of Fixed Neutron Absorbers in Nuclear Facilities Outside Reactors”

ANSI/ANS-8.22, “Nuclear Criticality Safety Based on Limiting and Controlling Moderators”

ANSI/ANS-8.23, “Nuclear Criticality Accident Emergency Planning and Response”

ANSI/ANS-13.3, “Dosimetry for Criticality Accidents”

USNRC Regulatory Guide 3.71, “Nuclear Criticality Safety Standards for Fuels and Material Facilities”

USDOE Guidance 421.1-1 “Criticality Safety Good Practices Guide for DOE Nonreactor Nuclear Facilities ”

Annex F-2. Radiation Protection Guidance

Federal guidance is a set of guidelines developed by USEPA for use by Federal and state agencies responsible for protecting the public from the harmful effects of radiation. Guidance on radiation protection from USEPA comes in two forms:

- Federal Guidance Recommendations, which are signed by the President and usually reflected in federal regulations for radiation protection of workers or the general public, and

- Federal Guidance Technical Reports, which help standardize radiation dose and risk assessment methodologies.

Federal Guidance Recommendations

Radiation Protection Guidance for Federal Agencies, Federal Radiation Council 25 FR 9057 September 26, 1961.

This guidance provides recommendations for population groups exposed to environmental sources of radiation. It provides Radiation Protection Guides; guidance on general principles of control applicable to all environmental radionuclides; and specific guidance in connection with exposure of population groups to radium-226, iodine-131, strontium-90, and strontium-89.

Radiation Protection Guidance for Federal Agencies, Federal Radiation Council 25 FR 4402 May 18, 1960.

This guidance provides a general framework for radiation protection and general principles of radiation control based on the annual intake of radioactive materials. These recommendations provide the basis for the control and regulation of radiation exposure during normal peacetime operations. Numerical values for the Radiation Protection Guides, designed to limit the exposure of the whole body and certain organs, are provided.

Radiation Protection Guidance to Federal Agencies for Occupational Exposure, Environmental Protection Agency 52 FR 2822 January 27, 1987.

This guidance provides general principles, and specifies the numerical primary guides for limiting worker exposure. It applies to all workers who are exposed to radiation in the course of their work, either as employees of institutions and companies subject to Federal regulation or as Federal employees.

Radiation Protection Guidance to Federal Agencies for Diagnostic X-rays, Environmental Protection Agency 43 FR 4377 February 1, 1978.

This guidance provides recommendations to reduce radiation exposure from the use of diagnostic x-rays. These recommendations, transmitted to the President jointly by USEPA and the Department of Health, Education and Welfare were based on two guiding principles: avoidance of unnecessary prescription of x-rays, and use of good technique to minimize radiation exposure.

Underground Mining of Uranium Ore, Federal Radiation Council 34 FR 576 January 15, 1969 35 FR 245 December 18, 1970.

This guidance sets forth recommendations for radiation protection activities as they apply to the underground mining of uranium ore. USEPA subsequently reviewed these recommendations and concluded that no modification was necessary.

Federal Guidance Technical Reports

Technical reports summarize current scientific and technical information for radiation dose and risk assessments. Examples of technical reports are:

Background Material for the Development of Radiation Protection Standards, Federal Radiation Council, July 1964.

This guidance provides background material used in the development of guidance for Federal agencies for (1) planning protective actions to reduce potential doses to the population from radioactive fission products which may contaminate food, and (2) doses at which implementation of protective actions may be appropriate.

The Radioactivity Concentration Guides, EPA 520/1-84-010, December 1984.

This guidance provides numerical values for the concentrations of radioactivity in air and water, corresponding to the limiting annual doses recommended for workers in the 1960 “Federal Guidance Document, Radiation Protection Guidance for Federal Agencies,” and

Cancer Risk Coefficients for Environmental Exposure to Radionuclides, EPA 402-R-99-001, September 1999.

This guidance provides methods and data for estimating risks due to both internal and external radionuclide exposures. The information presented in this report is for use in assessing risks from radionuclide exposure in a variety of applications ranging from environmental impact analyses of specific sites to the general analyses that support rulemaking

Annex F-3. Additional Information on USDOE Safety Requirements

The Joint Convention mentions the completion of a commissioning program demonstrating that the facility, as constructed, is consistent with design and safety requirements. This is accomplished for USDOE facilities under requirements for start and restart of nuclear facilities in Order 425.1B, "Startup and Restart of Nuclear Facilities." All USDOE spent fuel management and radioactive waste management facilities fall under this startup order. The Order requires a readiness review/assessment process that must, in all cases, demonstrate that it is safe to start (or restart) the applicable facility. The facility must be started (or restarted) only after documented independent reviews of readiness have been conducted and the approvals specified in this Order have been received. The readiness reviews are not intended to be tools of line management to achieve readiness. Rather, the readiness reviews provide an independent confirmation of readiness to start or restart operations. Operational readiness reviews evaluate minimum core requirements that include:

- Line management is responsible for the protection of employees, the public, and the environment;
- Clear and unambiguous lines of authority and responsibility for ensuring safety and health and protection of the environment are established and maintained at all organizational levels;
- Personnel possess the experience, knowledge, skills, and abilities that are necessary to discharge their responsibilities;
- Resources are effectively allocated to address environment, safety and health, programmatic, and operational considerations - protecting employees, the public, and the environment is a priority whenever activities are planned and performed;
- Before work is performed, the associated hazards are evaluated and an agreed-upon set of standards and requirements is established which, if properly implemented, provide adequate assurance that employees, the public, and the environment are protected from adverse consequences;
- Administrative and engineering controls to prevent and mitigate hazards are tailored to the work being performed and associated hazards - emphasis should be on designing the work and/or controls to reduce or eliminate the hazards and to prevent accidents and unplanned releases and exposures; and
- The conditions and requirements to be satisfied for operations to be initiated and conducted are established and agreed-upon by USDOE and the contractor performing the work.

The USDOE has an extensive set of regulations and orders covering nuclear safety, conduct-of-operations, maintenance, and other functions such as monitoring, inspection, and testing required to ensure safe operation of its nuclear facilities. Building on 10 CFR Part 830 and USDOE Order 420.1A, "Facility Safety," which covers nuclear safety design, criticality safety, fire protection, natural phenomena hazards mitigation, and a system engineer program, USDOE has a system in place that provides strict discipline to operations and maintenance programs. The following discussion focuses on activities that demonstrate how the USDOE facilities meet the terms of the Joint Convention. Additional guidance on the implementation of 10 CFR Part 830 is found in USDOE G 421.1-1, "Criticality Safety Good Practices Guide for DOE Nonreactor Nuclear Facilities," USDOE G 421.1-2, "Implementation Guide For Use in Developing Documented Safety

Analyses To Meet Subpart B Of 10 CFR 830," and USDOE G 423.1-1, "Implementation Guide For Use In Developing Technical Safety Requirements."

USDOE Order 430.1A, "Life Cycle Asset Management", mandates that USDOE in partnership with its contractors, plans, acquires, operates, maintains, and disposes of physical assets as valuable national resources. The management of physical assets, which include spent fuel management facilities, from acquisition through operations and disposition, is integrated in a process linking the various life cycle phases. This Order also prescribes requirements for preparing decommissioning plans and documents needed for turnover of facilities at the end of their planned mission, consistent with plans in the Joint Convention.

Another USDOE Order impacting safe operations at nuclear facilities, USDOE Order 433.1, "Maintenance Management Program for USDOE Nuclear Facilities," defines the program for the management of cost-effective maintenance of USDOE nuclear facilities. Guidance for compliance with this Order is contained in USDOE Guide 433.1-1, "Nuclear Facility Maintenance Management Program Guide for use with USDOE Order 433.1," which references Federal regulations, USDOE directives, and industry best practices using a graded approach to clarify requirements and guidance for maintaining USDOE-owned Government property.

In addition to the general maintenance program requirements of USDOE Order 433.1 discussed above, a nuclear facility maintenance management program must contain a USDOE-approved Maintenance Implementation Plan (MIP). The nuclear facility maintenance management program must establish metrics to measure program performance and identify appropriate voluntary consensus standards that are incorporated into the program. Stewardship of physical assets is accomplished in a safe and cost-effective manner to meet the USDOE mission, and to ensure protection of workers, the public, and the environment. This shall incorporate industry standards, a graded approach, and performance objectives. Of particular note is the process for the operation and maintenance of physical assets, which ensures:

- Identification, inventory, and periodic assessment of the condition of physical assets in the maintenance program;
- Establishment of requirements, budgets, and a work management system to maintain physical assets in a condition suitable for their intended use;
- The preventive, predictive, and corrective maintenance to ensure physical asset availability for planned use and/or proper disposition;
- A configuration management process to ensure the integrity of physical assets and system;
- The efficient and effective management and use of energy and utilities;
- A method for the prioritization of infrastructure requirements;
- The management of backlogs associated with maintenance, repair, and capital improvements
- A method to ensure that prior to the completion of mission actions are implemented to place the facility, systems and materials in stable and known conditions, and to ensure hazards are identified and known, pending transfer or disposition.

As documented in the MIP, the USDOE mandates in “Facility Safety,” Order 420.1A, the implementation of systems engineering to provide engineering and technical support at USDOE nuclear facilities and ensure continued operational readiness of safety systems. Qualified Cognizant System Engineers (CSE) are designated for each such system. The nuclear facility maintenance management program must be integrated with 10 CFR Part 830 and the overall Integrated Safety Management System (ISMS) established by USDOE Policy 450.4, “Safety Management System Policy,” and other safety and quality assurance program regulations. The MIP is reviewed every 2 years and necessary changes are submitted for approval. The MIP addresses the following elements using a graded approach:

- Structures, systems, and components (SSCs) included in the program.
- Periodic inspections of SSCs and equipment required determining whether degradation or technical obsolescence threatens performance and/or safety.
- Management systems used to control maintenance activities associated with the defined SSCs (these include work control, post-maintenance testing, material procurement and handling, and control and calibration of test equipment).
- Assignment of roles and responsibilities and appropriate maintenance-related training and qualification requirements.
- Interfaces between the maintenance organization and other organizations (e.g., operations, engineering, quality, training, industrial health).
- The configuration management process established to ensure the integrity of the identified SSCs using a graded approach.
- The prioritization process used to properly emphasize safety requirements, the maintenance backlog, system availability, and requirements for those infrastructure elements identified as part of the nuclear facility safety basis.
- The process for feedback and improvement established to provide relevant information regarding operations, maintenance, and assessment efforts;
- An accurate maintenance history that compiles maintenance, resource, and cost data in a system which is retrievable and capable of entering required-maintenance costs, actual maintenance costs, and availability data and failure rates for mission-critical and safety SSCs into the USDOE Facility Information Management System (per USDOE Order 430.1A described previously and USDOE Guide 433.1-1, “Nuclear Facility Maintenance Management Program Guide” for use with USDOE Order 433.1); and
- The systems engineer program established for the management of vital safety systems that is consistent with USDOE Order 420.1A and designates a "system engineer" with (a) the requisite knowledge of the system safety design basis and operating limits from the safety analysis and (b) the lead responsibility for the configuration management of design.

Consistent with a graded approach to systems engineering, large, complex, or very important systems may require assignment of one or more technical staff level personnel as Cognizant Systems Engineers (CSE), while small, simple, less important systems may only require assignment of technician level personnel. A program is developed within the context of the site and ISMS, including flow down of implementing procedures on the site and facility level and shall provide for the CSE authorities, responsibilities, and accountability. A graded approach shall be used in the application of the Program to specific systems. The system engineer program integrates the elements of identification of systems within its scope, configuration management, and CSE support

for operations and maintenance. Configuration management is used to develop and maintain consistency among system requirements and performance criteria, system documentation, and physical configuration. Configuration management integrates the elements of system requirements and performance criteria, system assessments, change control/work control, and documentation control. USDOE- STD-1073-93, “Guide for Operational Configuration Management Program,” dated November 1993, provides guidance for configuration management. USDOE-STD- 3024-98, “Content of System Design Descriptions,” dated October 1998, provides guidance on the identification and consolidation of key design documents. This activity directly supports facility safety basis development and documentation required by 10 CFR 830. System assessments include periodic review of system operability, reliability, and material condition during facility inspections required by USDOE Order 433.1, “Maintenance Management Program for USDOE Nuclear Facilities.” These periodic reviews assess the system's ability to perform its design and safety functions. Cognizant system engineers also periodically compare the system physical configuration to the system documentation. System and component performance is monitored and compared to established performance criteria. Work on systems, including maintenance and repair, is controlled under a formal change control/work control process to ensure that changes are not inadvertently introduced and that required system performance is not compromised. Systems are tested after modification to ensure continued capability to fulfill system requirements.

The CSE also provides technical assistance in support of line management responsibility to ensure continued operational readiness of the system. This requirement applied to USDOE nuclear facilities meets the provisions of the Joint Convention. The CSE ensures that the configuration of assigned system(s) is being effectively managed. The CSE remains apprised of operational status and ongoing modification activities and assists operations personnel to review key system parameters and evaluates system performance. The CSE initiates actions to correct problems, remains cognizant of system-specific maintenance/ operations history and industry operating experience, identifies trends from operations, provides assistance in determining operability or correcting out-of-specification conditions or evaluating questionable data, provides or supports analysis to determine operability when the system is suspected of inoperability or degradation, reviews and concurs with design changes, and provides input to development of special operating/test procedures. The qualification requirements for the CSE position are strictly defined in technical staff positions described in USDOE Order 5480.20A, “Personnel Selection, Qualification, and Training Requirements for USDOE Nuclear Facilities.”

The Joint Convention addresses reporting of incidents significant to safety. USDOE Order 232.1A, Occurrence Reporting and Processing of Operations Information,” prescribes reporting requirements for keeping government officials fully informed on a timely basis of these and a variety of other defined events. This information is analyzed for generic implications and for opportunities to improve operations. An electronic information system for reporting operations information related to USDOE-owned and -leased facilities and processing that information to identify the root causes of Unusual, Off-Normal, and Emergency Occurrences and provide for appropriate corrective action has been established. The system is known as “ORPS,” Occurrence Reporting and Processing System. It provides information to USDOE to perform the following:

- Timely identification, categorization, notification, and reporting to USDOE management of reportable occurrences at USDOE-owned and -leased facilities;
- Review of reportable occurrences to assess the significance, root causes, generic implications, and the need for corrective actions;
- Timely evaluation and implementation of appropriate corrective actions; and
- Dissemination of occurrence reports to USDOE operations and facilities to prevent similar occurrences and facilitate analyses.

A manual accompanies the Order providing specific information on occurrence reporting. The ORPS information system ensures that data collection and analysis programs are in effect and working.

In addition to the occurrence information, reporting of emergencies is governed by USDOE Order 151.1A, "Comprehensive Emergency Management System." This Order requires that events are properly categorized and emergency notifications are made. The USDOE Headquarters Emergency Operations Center serves as the point of contact for receipt of all emergency notifications and reports, and it further coordinates, and disseminates emergency information to USDOE organizations, the White House Situation Room, and other Federal agencies, as required.

Emergency planning on the part of the USDOE is required under the USNRC regulations in 10 CFR Part 63, Subpart I. Specifically, the USDOE is required to develop and be prepared to implement a plan to cope with radiological accidents the may occur at the GROA, at any time before permanent closure and decommissioning of the surface facilities. This plan must comply with 10CFR72.32(b) of USNRC regulation on the storage of spent fuel.

Finally, USDOE Order 231.1, "Environment, Safety, and Health Reporting," ensures collection and reporting of information on environment, safety and health that is required by law or regulation to be collected, or that is essential for evaluating USDOE operations and identifying opportunities for improvement needed for planning purposes.

Annex I-1. Relevant Provisions of Title 10, CFR Part 110: Exports and Imports of Radioactive Waste

Definitions of Radioactive Waste and Incidental Radioactive Material

Radioactive waste *means any waste that contains or is contaminated with source, byproduct, or special nuclear material, including any such waste that contains or is contaminated with "hazardous waste" as defined in section 1004(5) of the Solid Waste Disposal Act, 42 U.S.C. 6903(5), but such term does not include radioactive material that is:*

(1) Contained in a sealed source, or device containing a sealed source, that is being returned to any manufacturer qualified to receive and possess the sealed source or the device containing a sealed source;

(2) A contaminant on service equipment (including service tools) used in nuclear facilities, if the service equipment is being shipped for use in another nuclear facility and not for waste management purposes or disposal; or

(3) Generated or used in a United States Government waste research and development testing program under international arrangements.

Incidental Radioactive Material *means any radioactive material not otherwise subject to specific licensing under this part that is contained in or a contaminant of any non-radioactive material that:*

(1) For purposes unrelated to the regulations in this part, is exported or imported for recycling or resource recovery of the non-radioactive component; and

(2) Will not be processed for separation of the radioactive component before the recycling or resource recovery occurs or as part of the resource recovery process.

The term does not include material that contains or is contaminated with "hazardous waste" as defined in section 1004(5) of the Solid Waste Disposal Act, 42 U.S.C. 6903(5).

General Export License Provisions Modified In 10 CFR Part 110

§110.21 (d) – The general licenses in paragraphs (a), (b), and (c) of this section do not authorize the export of special nuclear material in ***radioactive waste****.*

§110.21 (e) – Persons using the general licenses in paragraphs (a), (b), and (c) of this section as authority to export special nuclear material as ***incidental radioactive material*** *shall file a completed USNRC Form 7 before the export takes place if the total weight of the shipment exceeds 100 kilograms.*

*§110.22 (f) – Paragraphs (a), (b), (c), and (d) of this section do not authorize the export under general license of source material in **radioactive waste**.*

*§110.22 (g) – Persons using the general licenses in paragraphs (a), (b), (c) and (d) of this section as authority to export source material as **incidental radioactive material** shall file a completed USNRC Form 7 before the export takes place if the total weight of the shipment exceeds 100 kilograms.*

*§110.23 (a) (1) – This section does not authorize the export of byproduct material to any embargoed country listed in § 110.28, or byproduct material in **radioactive waste**, or tritium for recovery or recycle purposes.*

*§110.23 (c) – Persons using the general licenses in paragraphs (a) of this section as authority to export byproduct material as **incidental radioactive material** shall file a completed NRC Form 7 before the export takes place if the total weight of the shipment exceeds 100 kilograms.*

Additional Criteria for Reviewing Applications for Export/Import of Radioactive Waste

Additional criteria for reviewing applications for export/import of radioactive waste are found in the Statement of Considerations in the June 1995 Federal Register Notice of Part 110 amendments establishing requirements for imports/exports of radioactive waste:

- The USNRC will consult with USEPA regarding Part 110 license applications relating to movements [exports/imports] of [radioactive] mixed waste.

- USNRC will publish a [public] notice in the Federal Register of receipt of an application for import or export of radioactive waste. USNRC will exchange information with interested [state LLW] compacts. USNRC will take other reasonable steps to inform states and compacts of pending requests.

- USNRC recognizes the authority of LLW compacts to decide whether or not to accept an import of LLW for disposal in the compact region. The USNRC will consult with interested states and LLW compacts prior to issuing an import license for LLW. USNRC will not grant an import license for waste intended for disposal unless it is clear that the waste will be accepted by a disposal facility, host state and compact, where applicable. This will be part of the determination regarding the appropriateness of the facility that has agreed to accept the waste for management or disposal.

Specific Licensing Provisions for Export and Import of Radioactive Waste

110.32 Information required in an application for a specific license/NRC Form 7.

(a) Name and address of applicant.

(b) Name and address of supplier of equipment or material.

(c) Country of origin of equipment or material, if known.

(d) Names and addresses of all intermediate and ultimate consignees, other than intermediate consignees performing shipping services only.

(e) Dates of proposed first and last shipments.

(f) Description of the equipment or material including, as appropriate, the following:

(1) Maximum quantity of material in grams or kilograms (curies for byproduct material) and its chemical and physical form.

(2) For enriched uranium, the maximum weight percentage of enrichment and maximum weight of contained U-235.

(3) For nuclear equipment, total dollar value.

(4) For nuclear reactors, the name of the facility and its design power level.

(5) For proposed exports or imports of radioactive waste, and for proposed exports of incidental radioactive material -- the volume, classification (as defined in §61.55 of this chapter), physical and chemical characteristics, route of transit of shipment, and ultimate disposition (including forms of management) of the waste.

(6) For proposed imports of radioactive waste -- the industrial or other process responsible for generation of the waste, and the status of the arrangements for disposition, e.g., any agreement by a LLW compact or state to accept the material for management purposes or disposal.

(7) Description of end use by all consignees in sufficient detail to permit accurate evaluation of the justification for the proposed export or import, including the need for shipment by the dates specified.

110.42 Export Licensing Criteria

(d) The review of license applications for the export of radioactive waste requiring a specific license under this part is governed by the following criteria:

(1) The proposed export is not inimical to the common defense and security.

(2) The receiving country, after being advised of the information required by §110.32(f)(5), finds that it has the administrative and technical capacity and regulatory structure to manage and dispose of the waste and consents to the receipt of the radioactive waste. In the case of radioactive waste containing a nuclear material to which paragraph (a) or (b) of this section is applicable, the criteria in this paragraph (d) shall be in addition to the criteria provided in paragraph (a) or (b) of this section.

110.43 Import Licensing Criteria.

The review of license applications for imports requiring a specific license under this part is governed by the following criteria:

(a) The proposed import is not inimical to the common defense and security.

(b) The proposed import does not constitute an unreasonable risk to the public health and safety.

(c) Any applicable requirements of Subpart A of 10 CFR Part 51 are satisfied.

(d) With respect to the import of radioactive waste, an appropriate facility has agreed to accept the waste for management or disposal.

110.45 Issuance or Denial of Licenses.

(a) The USNRC will issue an export license if it has been notified by the State Department that it is the judgment of the Executive Branch that the proposed export will not be inimical to the common defense and security; and:

(1) Finds, based upon a reasonable judgment of the assurances provided and other information available to the Federal government, that the applicable criteria in §110.42, or their equivalent, are met. (If an Executive Order provides an exemption pursuant to section 126a of the Atomic Energy Act, proposed exports to EURATOM countries are not required to meet the criteria in §110.42(a) (4) and (5)); or

(2) Finds that there are no material changed circumstances associated with an export license application (except for byproduct material applications) from those existing at the time of issuance of a prior license to export to the same country, if the prior license was issued under the provisions of paragraph (a)(1) of this section.

(b) The USNRC will issue an import license if it finds that:

(1) The proposed import will not be inimical to the common defense and security*;*

(2) The proposed import will not constitute an unreasonable risk to the public health and safety;

(3) The requirements of subpart A of 10 CFR Part 51 of this chapter (to the extent applicable to the proposed import) have been satisfied; and

(4) With respect to a proposed import of radioactive waste, an appropriate facility has agreed to accept the waste for management or disposal.

(c) If, after receiving the Executive Branch judgment that the issuance of a proposed export license will not be inimical to the common defense and security, the USNRC does not issue the proposed license on a timely basis because it is unable to make the statutory determinations required under the Atomic Energy Act, the USNRC will publicly issue a decision to that effect and will submit the license application to the President. The USNRC's decision will include an explanation of the basis for the decision and any

dissenting or separate views. The provisions in this paragraph do not apply to USNRC decisions regarding license applications for the export of byproduct material or radioactive waste requiring a specific license.

(d) The USNRC will deny: (1) Any export license application for which the Executive Branch judgment does not recommend approval; (2) any byproduct material export license application for which the USNRC is unable to make the finding in paragraph (a)(1) of this section; or (3) any import license application for which the USNRC is unable to make the finding in paragraph (b) of this section. The applicant will be notified in writing of the reason for denial.

Annex J-1. Regulations Applicable to Sealed Sources and Devices

Some specific-licensed products are required, by regulation, to meet certain specific requirements in addition to the general registration criteria provided in 10 CFR 32.210. The following Parts of 10 CFR contain regulations applicable to sealed source and devices:

- 10 CFR Part 2, "Rules of Practice for Domestic Licensing Proceedings and Issuance of Orders"
- 10 CFR Part 19, "Notices, Instructions and Reports to Workers: Inspection and Investigation"
- 10 CFR Part 20, "Standards for Protection against Radiation"
- 10 CFR Part 21, "Reporting of Defects and Noncompliance"
- 10 CFR Part 30, "Rules of General Applicability to Domestic Licensing of Byproduct Material"
- 10 CFR Part 31, "General Domestic Licenses for Byproduct Material"
- 10 CFR Part 32, "Specific Domestic Licenses to Manufacture or Transfer Certain Items Containing Byproduct Material"
- 10 CFR Part 34, "Licenses for Radiography and Radiation Safety Requirements for Radiographic Operations"
- 10 CFR Part 35, "Medical Use of Byproduct Material"
- 10 CFR Part 36, "Licenses and Radiation Safety Requirements for Irradiators"
- 10 CFR Part 39, "Licenses and Radiation Safety Requirements for Well Logging"
- 10 CFR Part 40, "Domestic Licensing of Source Material"
- 10 CFR Part 70, "Domestic Licensing of Special Nuclear Material"
- 10 CFR Part 71, "Packaging and Transportation of Radioactive Material"

LIST OF ACRONYMS

Acronym	Name
ACNW	Advisory Committee on Nuclear Waste
AEA	1954 Atomic Energy Act
ALARA	As Low as Reasonably Achievable
CCA	Compliance Certification Application
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CNS	Convention on Nuclear Safety
DNFSB	U.S. Defense Nuclear Facilities Safety Board
EH	USDOE Office of Environment, Safety and Health
EIS	Environmental Impact Statement
EnPA	Energy Policy Act of 1992
ERDA	Energy Research and Development Administration
FUSRAP	Formerly Utilized Sites Remedial Action Program
GTCC	Greater Than Class C Low Level Waste
GROA	Geologic Repository Operations Area
HLW	High-Level Waste
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiation Protection
INEEL	Idaho National Engineering and Environmental Laboratory
ISFSI	Independent Spent Fuel Storage Installation
ISL	In-Situ Leach
ISMS	Integrated Safety Management System
LANL	Los Alamos National Laboratory
LILW	Low and Intermediate Level Waste
LILW-LL	Low and Intermediate Level Waste – Long Lived
LILW-SL	Low and Intermediate Level Waste – Short Lived
LLW	Low-Level Waste
LLWPA	Low-Level Radioactive Waste Policy Act of 1980
LLWPAA	Low-Level Radioactive Waste Policy Amendments Act of 1985
LTSP	Long-Term Surveillance Plan
MED	Manhattan Engineer District
MLLW	Mixed Low-Level Waste
MTHM	Metric Tons Heavy Metal
NAS	U.S. National Academy of Sciences
NCRP	U.S. National Council on Radiation Protection And Measurements
NEPA	National Environmental Policy Act
NORM	Naturally Occurring Radioactive Materials
NUREG	USNRC Regulatory Guide
NWPA	Nuclear Waste Policy Act
NWPAA	Nuclear Waste Policy Amendments Act of 1987
NWTRB	U.S. Nuclear Waste Technical Review Board
OA	USDOE Office of Independent Oversight and Performance Assurance
QA	Quality Assurance

Acronym	Name
RCRA	Resource Conservation and Recovery Act of 1976
RMEI	Reasonably Maximally Exposed Individual
S&ER	Yucca Mountain Science and Engineering Report
SFP	Spent Fuel Pool
SNF	Spent Fuel or Spent Nuclear Fuel
SSC	Systems, Structures, and Components
SSE	Site Suitability Evaluation (Yucca Mountain)
TENORM	Technologically Enhanced NORM
TRU Waste	Transuranic Waste
U.S.	United States of America
UMTRCA	Uranium Mill Tailings Radiation Control Act
USACE	U.S. Army, Corps of Engineers
USAEC	U. S. Atomic Energy Commission
USDOE	U.S. Department of Energy
USDOL	U.S. Department of Labor
USEPA	U.S. Environmental Protection Agency
USNRC	U. S. Nuclear Regulatory Commission
VPP	Voluntary Protection Program
WIPP	Waste Isolation Pilot Plant
WIPP LWA	Waste Isolation Pilot Plant Land Withdrawal Act Of 1992

LIST OF ADDITIONAL REFERENCES

Numerous references to laws, regulations, regulatory guides, standards, and USDOE Orders are provided throughout this report and are not repeated here (See Table E-1, Table E-2, Annex E-1, Annex F-1, Annex F-2, and Annex J-1) for brevity. Also, Internet web sites are provided in Table A-2. The following additional resources were used:

- International Atomic Energy Agency, "Classification of Radioactive Waste; A Safety Guide," Safety Series No. 111-G-1.1., IAEA 1994.

- International Atomic Energy Agency, "Establishing a National System for Radioactive Waste Management," Safety Series No 111-S-1.1, Vienna Austria, 1995.

- 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," Vienna, Austria, December 13, 2002.

- International Atomic Energy Agency, Worldatom website, http://www.iaea.org/worldatom/Documents/Legal/jointconv.shtml.

- International Atomic Energy Agency, "Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management," INFCIRC/516, December 24, 1997.

- Oregon Office of Energy, "Naval Nuclear Reactor Compartment Shipments on the Columbia River," website htpp://www.energy.state.or.us/nucsafe, February 2003.

- U.S. Nuclear Regulatory Commission, "Radioactive Waste: Production, Storage, Disposal," (NUREG/BR-0216).

- U.S. Nuclear Regulatory Commission, The United States of America, "National Report for the Convention on Nuclear Safety," NUREG-1650, Washington DC, September 2001.

- U.S. Nuclear Regulatory Commission Information Digest 2002 Edition (NUREG 1350, Vol. 14).

- U.S. Department of Energy, Energy Information Administration, Report No. USDOE/EIA-0592, February 1995.

- U.S. Department of Energy, Energy Information Administration Form RW-859 Spent Fuel Data (1998),

- U.S. Department of Energy, “DOE’s Current, Planned, and Projected Dry Storage Facilities Table,” (January 2003).

- U.S. Department of Energy, “The 2001 Annual Report of Waste Generation and Pollution Prevention Progress,” USDOE-EM-0630, Washington DC, June 2002. http://tis.eh.doe.gov/p2/wastemin/2001ar.pdf.

- U.S. Department of Energy Environmental Management Stream Disposition Data (IPABS, 8/28/01).

- U.S. Department of Energy Grand Junction Office, Internet web site.

- U.S. Department of Energy, “LLW Disposal Capacity Report,” (2000).

- U.S. Department of Energy, Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada, USDOE/EIS-0250, Washington DC, February 2002.

- U.S. Department of Energy National Spent Fuel Database (Version 4.2.0, March 2002).

- U.S. Environmental Protection Agency, “Fact Sheet on Ocean Dumping of Radioactive Waste Materials,” Office of Radiation Programs, Washington, DC, 1980 (web site).

- U.S. Environmental Protection Agency, “Data from Studies of Previous Radioactive Waste Disposal in Massachusetts Bay,” Office of Radiation Programs, Washington, DC, 1984 (web site).