

Master Plan For Responsible Advanced Nuclear Development in New York:

Waste Study

NEW YORK STATE

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Notice

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Table of Contents

Notice ..... **i**
List of Figures ..... **v**
List of Tables ..... **vi**
Summary **S-1**
1. Introduction **1**
2. Definitions and Classifications of Nuclear Waste **4**
2.1 High-Level Waste 4
2.1.1 Spent Nuclear Fuel 5
2.2 Low-Level Waste 5
2.2.1 Class A Low-Level Waste 7
2.2.2 Class B Low-Level Waste 7
2.2.3 Class C Low-Level Waste 7
2.2.4 Greater-Than-Class C Low-Level Waste 8
2.2.4.1 Regulatory Definition and Disposal 8
2.2.4.2 Sources and Types 8
2.2.4.3 National Inventory 9
3. Federal Regulatory Framework Overview **11**
3.1 High-Level Waste Federal Regulatory Requirements 12
3.1.1 Nuclear Regulatory Commission Authority 12
3.1.2 Department of Energy Responsibilities 13
3.1.3 Environmental Protection Agency Standards 13
3.1.4 Transportation Regulations 14
3.2 Low-Level Waste Federal Regulatory Disposal Requirements and Initiatives 14
3.3 Finding and Conclusion 16
4. State Regulatory Framework Overview **18**
4.1 Regulation of High-Level Waste in New York State 18
4.1.1 New York State Context 18
4.1.2 State Regulatory Authority and Limitations for High-Level Waste 18
4.2 New York State Regulatory Framework for Low-Level Waste 18
4.3 New York State Agency and Authority Roles 19
4.3.1 New York State Energy Research and Development Authority 19

4.3.1.1 Generator Reporting Requirements 20
4.3.1.2 Low-Level Waste Annual Assessments 20
4.3.2 New York State Department of Environmental Conservation 21
4.3.3 New York State Department of Public Service and Public Service Commission 22
4.3.4 New York State Department of Health 22
4.4 Findings 23
5. Waste Generation by Reactor Type 25
5.1 Existing Large Light-Water Reactors 25
5.1.1 Spent Fuel Physical Characteristics 25
5.1.2 Radiological Characteristics 26
5.1.3 Spent Fuel Generation Rates 27
5.1.4 Spent Fuel National Inventory 27
5.1.5 Greater-Than-Class-C Waste from Large Light-Water Reactors 28
5.1.6 Class A-C Low-Level Waste from Large Light-Water Reactors 29
5.2 Advanced Reactors 30
5.2.1 Waste Characteristics of Advanced Light-Water Reactors 31
5.2.2 Waste Characteristics of Advanced Non–Water-Cooled Reactors 32
5.2.2.1 Gas-Cooled Reactors 32
5.2.2.2 Molten Salt Reactors 34
5.2.2.3 Liquid Metal-Cooled Fast Reactors 36
5.2.2.4 Implications for Managing Advanced Non–Water-Cooled Reactor Waste Streams 38
5.2.3 Research Findings on Small Modular Reactor Waste Generation Quantities 38
5.2.4 Microreactors 39
5.3 Findings and Conclusion 40
6. New York State Nuclear Waste Inventory 42
6.1 Operating Reactor Spent Fuel 42
6.2 Indian Point Decommissioning 42
6.3 West Valley Demonstration Project 43
6.4 Greater-Than-Class-C Waste in New York State 43
6.5 Summary of New York State Nuclear Waste Inventory 44
6.6 Findings 45
7. On-Site and Interim Waste Storage 46
7.1 Spent Nuclear Fuel Storage 46

7.1.1 Spent Fuel Pool Storage 46
7.1.2 Spent Fuel Dry Cask Storage Systems in Independent Spent Fuel Storage Installations....47
7.1.2.1 Storage Technology and Safety 47
7.1.2.2 ISFSI Licensing and Renewals 48
7.1.2.3 High Burnup Fuel Considerations 49
7.1.2.4 New York State Independent Spent Fuel Storage Installations 49
7.1.2.5 Aging Management Considerations for On-Site Storage 49
7.2 Low-Level Waste Storage 50
7.2.1 On-Site Storage at Generator Facilities 50
7.2.2 Decay-in-Storage 51
7.2.3 Storage Container Requirements 51
7.2.4 Class B and C Waste Disposal Access 51
7.2.5 Greater-Than-Class-C Waste Storage 52
7.2.6 Waste Minimization and Volume Reduction 52
7.2.7 Broker and Processor Services 52
7.3 On-Site Storage Considerations for Advanced Reactor Waste 53
7.4 Federal Interim Storage and Permanent Disposal Considerations....53
7.4.1 Considerations for Long-term On-site Storage 53
7.4.2 Consolidated Interim Storage Facility Concept 54
7.4.2.1 Past and Present Federal Government Storage Siting Initiatives....54
7.4.2.2 Private Consolidated Interim Storage Facilities....55
7.5 Local-Level Considerations for On-site Storage....56
7.5.1 Land Use Authority and Zoning 56
7.5.2 Host Community Considerations for Waste Storage....56
7.5.3 Public Engagement and Transparency....56
7.6 Findings 57
8. Waste Transportation 58
8.1 Regulatory Framework 58
8.2 Transportation of Advanced Reactor Waste 58
8.3 Findings and Conclusion 59
9. Waste Disposal....61
9.1 Disposal of Spent Nuclear Fuel and High-Level Waste....61
9.1.1 Deep Geologic Repository Requirements....61

9.1.2 Contract Requirements for Federal Spent Nuclear Fuel Management....61
9.1.2.1 Standard Contract Requirements....61
9.2 Disposal of Advanced Reactor Spent Nuclear Fuel....62
9.3 Disposal of Class A, B, and C Low-Level Waste....63
9.3.1 Class A, B, and C Low-Level Waste Disposal Technologies....63
9.3.2 Class A, B, and C Low-Level Waste Commercial Disposal Facilities....64
9.3.2.1 EnergySolutions Barnwell Operations, Barnwell, SC....65
9.3.2.2 U.S. Ecology, Richland, Washington....65
9.3.2.3 EnergySolutions Clive Operations, Clive, UT....65
9.3.2.4 Waste Control Specialists, Andrews County, TX....66
9.3.3 Alternative Disposal Pathways for Class A, B, and C Low-Level Waste....66
9.4 Findings....66
Acronyms and Abbreviations....68
Endnotes....EN-1

List of Figures

Figure 1. Low-level and High-level Waste Categories....4
Figure 2. Characteristics of High-Level Waste and Low-Level Waste....6
Figure 3. GTCC Inventory in the U.S. and New York State....10
Figure 4. Federal and New York State Nuclear Waste Responsibilities....11
Figure 5. Low-Level Waste Interstate Compacts....16
Figure 6. Light-Water Reactor Fuel....26
Figure 7. Volume of Total U.S. Large Light-Water Reactor Spent Fuel Inventory....28
Figure 8. TRISO Fuel in Pebble Bed and Prismatic HTGRs....33
Figure 9. Uranium Bearing FLiBe as a Solid and Liquid....35
Figure 10. Sodium-Cooled Fast Reactor Design and Fuel Configuration....37
Figure 11. Wet and Dry Storage of Spent Nuclear Fuel....46
Figure 12. Indian Point Spent Fuel in Dry Cask Storage Systems in Independent Spent Fuel Storage Installations....47
Figure 13. Class A, B, and C Low-Level Waste Disposal Pathways in New York State....63
Figure 14. Class A, B, and C Near-Surface Disposal Diagram (left) and Photo (right)....64
Figure 15. Class A, B, and C Low-Level Waste Commercial Disposal Facilities in the U.S....65

List of Tables

Table 1. New York State Operating Nuclear Reactors and Estimated Spent Nuclear Fuel Generation....42
Table 2. Indian Point Spent Fuel Inventory....43
Table 3. Summary of New York State Spent Nuclear Fuel and High-Level Waste in On-Site Storage....45

Summary

New York State is investing in a Nuclear Reliability Backbone Initiative (Nuclear Backbone), which Governor Hochul announced in her 2026 State of the State address. The Nuclear Backbone includes both preserving the 3.4 gigawatts (GW) of existing nuclear capacity that has long served as part of the foundation of the State's carbon-free electricity supply and building 5 GW of new advanced nuclear generation. Completion of the Nuclear Backbone will provide the firm, zero-emission power needed to meet rising demand, complement continued renewable deployment, and maintain system reliability and affordability as the grid decarbonizes.

New York State currently hosts three operating nuclear generating stations: Nine Mile Point Clean Energy Center (Nine Mile Point) Units 1 and 2, James A. FitzPatrick Clean Energy Center (J.A. FitzPatrick), and R.E. Ginna Clean Energy Center (Ginna), all located along Lake Ontario and operated by Constellation Energy. The last of the operating units at Indian Point in Westchester County permanently ceased operations in 2021 and the site is undergoing decommissioning under Holtec International's ownership. Each of these facilities has generated spent nuclear fuel requiring long-term management and on-site storage.

Currently, more than 95,000 metric tons (MT) of commercial spent nuclear fuel is stored at reactor sites and independent spent fuel storage installations across the country. New York State stores approximately 4,957 MTU of spent fuel from commercial reactor operations. The federal government has primary responsibility for permanently disposing of this material. In the interim, it is safely stored at reactor sites under federal regulatory oversight, as it has been for decades. Planning for spent fuel from advanced reactors will be a routine part of New York State's responsible development and construction of new advanced reactor technologies.

This study provides a comprehensive assessment of New York State's waste responsibilities, including the federal regulatory framework, current inventories, storage and disposal pathways, transportation requirements, and applicable state regulations for high-level waste, spent nuclear fuel, and low-level waste. It evaluates state and local roles in managing these materials, analyzes conditions at independent spent fuel storage installations (ISFSIs), and reviews ongoing federal initiatives such as consolidated interim storage, and the U.S. Department of Energy's (DOE) new state-driven approaches to hosting fuel cycle facilities.

Findings

- **Safe interim storage:** Dry-cask storage has been safely used for decades and provides a proven, secure, interim storage solution for spent nuclear fuel while permanent federal solutions are developed.
- **Some advanced nuclear energy technologies may generate different quantities or types of spent fuel:** The maturity of the disposal pathway should be considered when evaluating advanced nuclear reactor technologies.
- **Class A, B, and C low-level waste is routinely and safely managed:** low-level waste is safely managed, and disposal options are currently in place outside of New York State. Continued cooperation with the states that host low-level waste disposal and voluntarily accept waste generated in New York State helps to preserve access to existing disposal capacity.
- **New York State has gained important hands-on experience with nonroutine spent fuel issues.** Indian Point's timely transition to onsite dry cask storage (about 127 casks) and the 25-member Indian Point Decommissioning Oversight Board (DOB) give the State a working model for coordinating multiagency oversight that can be applied to advanced-reactor sites. West Valley has successfully vitrified more than 600,000 gallons of liquid high-level waste into 278 canisters. These examples reinforce confidence in New York State's ability to responsibly manage future nuclear energy waste challenges.

Conclusions:

- **Continue engagement with the federal government on spent-fuel related issues, including consolidated long-term storage, U.S. Department of Energy's Nuclear Lifecycle Innovation Campus Initiative, and strengthened oversight of decommissioning trust funds.**
- **Support research on advanced nuclear technology spent fuel.**
- **Explore a partnership with the U.S. Department of Energy to demonstrate safe transportation of New York State commercial spent nuclear fuel or West Valley high-level waste to complement federal transportation demonstrations and reduce State waste volumes.**

1. Introduction

The Waste Study is one of a collection of studies prepared by the New York State Energy Research and Development Authority (NYSERDA) and the Department of Public Service (DPS) as part of the "Master Plan for Responsible Advanced Nuclear Development in New York" (Master Plan). Collectively, these studies examine the technical, economic, workforce, supply chain, regulatory, environmental, community, and infrastructure considerations associated with the deploying advanced nuclear technologies in New York State. Each study addresses a distinct topic area and offers analysis, findings and conclusions to contribute to a comprehensive roadmap for advanced nuclear development in New York.

NYSERDA and DPS acknowledge the contributions of the Nuclear Innovation Alliance (NIA), working as subcontractors to The Brattle Group, in preparing this study.

Safe and responsible radioactive waste management is a core part of the nuclear energy enterprise, and the nuclear energy industry and regulatory agencies worldwide have decades of experience in this area. In the U.S., a comprehensive framework of federal laws, regulations, and agency responsibilities governs the classification and disposal of radioactive waste. Understanding waste classifications and the regulatory framework governing radioactive waste generation, storage, transportation, and disposal is essential for developing effective waste management strategies and supporting informed policy decisions regarding both existing nuclear facilities and potential deployments of advanced nuclear technologies.[1]

Nuclear reactors produce several categories of radioactive waste requiring specialized handling, storage, and disposal approaches. This study addresses the management requirements for high-level waste, spent nuclear fuel, and low-level waste including Classes A, B, C, and Greater-Than-Class-C (GTCC) low-level waste, which have different regulatory and management pathways. The following section provides regulatory definitions as well as physical and chemical descriptions of each nuclear waste classification.

Currently, nuclear power generates approximately 18 percent of electricity in the United States and 20 percent in New York State, providing reliable, carbon-free baseload power essential to grid stability and climate goals.[2,3] Spent nuclear fuel is safely stored at reactor sites, and its long-term management is an important planning consideration for plant licensees, regulators, and host communities. Each year, the U.S. commercial nuclear fleet produces approximately 2,000 metric tons (MT) of spent nuclear fuel.

The Nuclear Waste Policy Act of 1982 (NWPA) assigned the federal government responsibility for permanent disposal of commercial spent nuclear fuel and high-level waste, funded through fees paid by nuclear utilities.[4] The law identified Yucca Mountain Nuclear Waste Repository in Nevada as the site of the nation's first repository. The Yucca Mountain repository has not been completed, and federal efforts toward permanent disposal are ongoing. In the interim, spent nuclear fuel is safely maintained in on-site storage, using both wet pool storage for recently discharged fuel and dry cask storage for older assemblies that have cooled sufficiently.

The federal framework for low-level waste management began with the Low-Level Radioactive Waste Policy Act of 1980, which established that each state bears responsibility for ensuring adequate disposal capacity for waste generated within its borders.[5] The subsequent Low-Level Radioactive Waste Policy Amendments Act of 1985 (Amendments Act) reinforced this state responsibility while authorizing interstate compacts for regional waste management cooperation.

Dozens of companies are pursuing advanced nuclear reactor technologies and are making rapid progress toward deployment.[6] Several companies have received construction permits and have started construction at various sites across the United States, while others are close behind. These reactors come in a wide range of sizes and use a variety of coolants and fuel types, enabling reactor designs with improved safety and economic characteristics. As New York State moves forward with new advanced nuclear reactor development and deployment, consideration of the waste streams generated from advanced nuclear reactors and their associated spent fuel management requirements will be needed.

The Waste Study includes the following sections:

- **Section 2, Definitions and Classifications of Nuclear Waste,** provides detailed definitions of each nuclear waste category addressed in the study.
- **Section 3, Federal Regulatory Framework Overview,** describes the federal regulatory framework for high-level waste and low-level waste.
- **Section 4, State Regulatory Framework Overview,** outlines State regulatory authority and State entity roles in waste management.
- **Section 5, Waste Generation by Reactor Type,** analyzes waste generation characteristics of conventional and advanced reactor technologies.
- **Section 6, New York State Nuclear Waste Inventory,** provides an inventory of the State's waste from its currently operating, decommissioning, and storage sites.

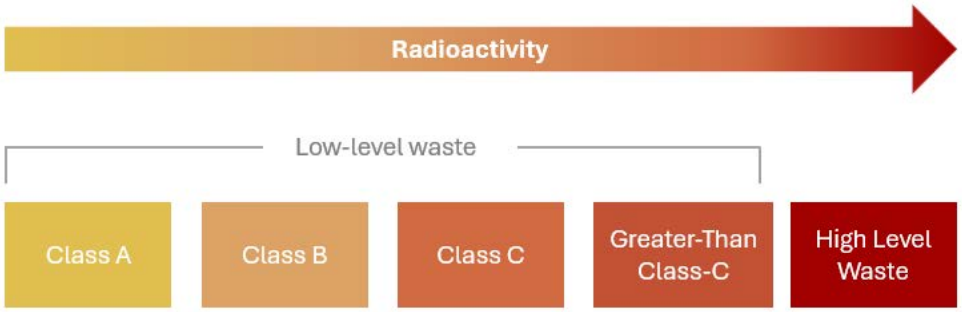
- **Section 7, On-Site and Interim Waste Storage**, describes existing on-site storage practices, considerations for advanced reactor waste, and local-level considerations for on-site storage.
- **Section 8, Waste Transportation,** discusses the federal and State regulatory frameworks for waste transportation, and considerations for transporting waste generated from advanced reactors.
- **Section 9, Waste Disposal,** describes current disposal pathways for high-level waste and low-level waste.

2. Definitions and Classifications of Nuclear Waste

This section provides detailed definitions of each nuclear waste category addressed in this study (Figure 1), including regulatory definitions, physical and radiological characteristics, and management requirements.

Figure 1. Low-level and High-level Waste Categories

Source: Adapted from Matt Bowen, Marine Gapihan, and Maya Lameche, "Revisiting GTCC and GTCC-Like Nuclear Waste Disposal in the United States," Center on Global Energy Policy, Columbia University, July 25, 2024, https://www.energypolicy.columbia.edu/publications/gtcc-and-gtcc-like-nuclear-waste-in-the-united-states/.



2.1 High-Level Waste

Under federal regulations, high-level waste is generally defined by its origin rather than its radiological characteristics. The U.S. Nuclear Regulatory Commission (NRC) defines high-level waste as highly radioactive materials produced as byproducts of fuel reprocessing or reactions that occur inside nuclear reactors. More specifically, the NRC's codified definition for high-level waste in 10 Code of Federal Regulations (CFR) Part 60.2 states that high-level waste includes:

1. Irradiated reactor fuel
2. Liquid wastes resulting from the operation of the first cycle solvent extraction system, or equivalent, and the concentrated waste from subsequent extraction cycles, or equivalent, in a facility for reprocessing irradiated reactor fuel
3. Solids into which such liquid wastes have been converted[7, 8]

Federal statutes also define high-level waste in specific contexts, but this report uses the NRC definition.[9] As an example, the U.S. Department of Energy (DOE) definition for high-level waste includes waste products from spent nuclear fuel reprocessing, but not spent nuclear fuel. There

are also spent nuclear fuel reprocessing waste products that are not considered to be high-level waste by DOE. These high-level waste and non-high-level waste products from spent nuclear fuel reprocessing are predominantly located at DOE sites resulting from historical defense applications. Since there has been very limited commercial nuclear fuel reprocessing in the U.S., almost all spent nuclear fuel reprocessing waste is located at these DOE sites, which may be one driver for the different definitions of high-level waste by NRC and DOE.

2.1.1 Spent Nuclear Fuel

Spent nuclear fuel is defined as fuel that has been withdrawn from a nuclear reactor following irradiation, the constituent elements of which have not been separated by reprocessing.[10] Under the once-through fuel cycle practiced almost exclusively in the history of commercial nuclear power in the United States, spent nuclear fuel is treated as a waste form rather than a resource and is stored pending permanent disposal rather than reprocessed to recover usable materials. Spent nuclear fuel, which is a type of high-level waste based on the NRC definition above, is currently planned to be permanently disposed of in a geologic repository. Spent nuclear fuel and high-level waste are generally treated as distinct waste categories under federal law and by the DOE.[11]

See Section 5 for information on spent nuclear fuel generated by different reactor technologies and Section 6 for a summary of New York State's spent nuclear fuel inventory.

2.2 Low-Level Waste

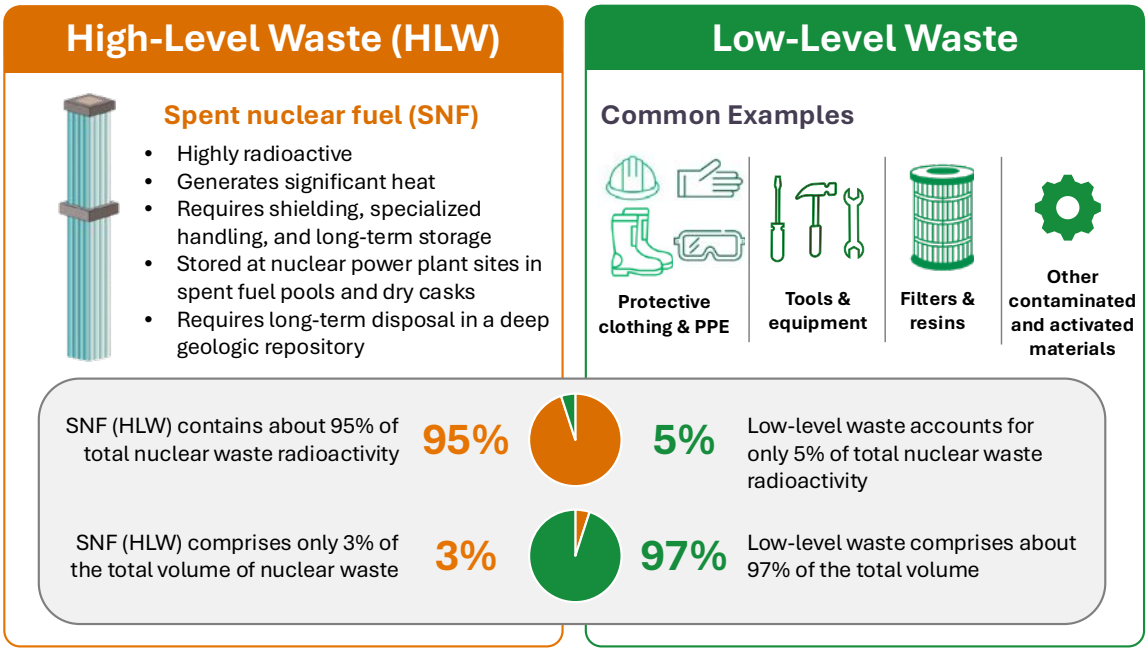
Low-level waste in the United States is defined by exclusion rather than by specific activity levels (Figure 2). According to the NRC, low-level waste includes radioactive material that is not classified as high-level waste, spent nuclear fuel, transuranic waste (TRU),[a] or certain byproduct materials such as uranium mill tailings.[12] Transuranic refers to man-made radioactive elements often produced in nuclear reactors or their waste with an atomic number higher than 92 like plutonium, americium, and neptunium. They are significant because they have relatively long half-lives and often emit significant alpha radiation.

[a] The NRC defines TRU as "Material contaminated with transuranic elements—artificially made, radioactive elements, such as neptunium, plutonium, americium, and others—that have atomic numbers higher than uranium in the periodic table of elements. Transuranic waste is primarily produced from recycling spent fuel or using plutonium to fabricate nuclear weapons."

Figure 2. Characteristics of High-Level Waste and Low-Level Waste

Percentages are approximate and represent the relative volume and radioactivity spent nuclear fuel (high level) compared with other radioactive waste streams in the U.S. nuclear power sector.

Source: Adapted from World Nuclear Association.



This approach to defining low-level waste by exclusion means that the radioactivity levels can range from just above natural background levels to highly radioactive materials, such as activated metal components from inside reactor vessels.

Low-level waste typically includes items contaminated with radioactive material or made radioactive through neutron activation. Common examples from nuclear reactor operations include contaminated protective clothing and shoe covers, wiping rags and mops, filters, reactor water treatment residues, equipment and tools, ion exchange resins, and activated metal components.

The NRC established a classification system for low-level waste under 10 CFR 61.55 based on the potential hazard the waste poses. This system divides waste suitable for near-surface disposal into four classes, Class A, B, C, and GTCC, with progressively higher concentrations of radioactive materials.[13] Each low-level waste class is described in the sections below.

2.2.1 Class A Low-Level Waste

Class A waste contains the lowest concentration of radioactive materials and represents the least hazardous category of low-level waste. This classification accounts for approximately 96 percent of the total volume of commercially generated low-level waste. Class A waste generally contains relatively short-lived radionuclides that decay to safe levels within a period of approximately 100 years. Class A waste has minimum packaging requirements and does not require stabilization unless disposed of with Class B, C, or GTCC waste.

Typical Class A waste from reactor operations includes lightly contaminated materials such as protective clothing, paper products, cleaning supplies, and low-activity resins. The regulatory concentration limits for Class A waste are specified in Tables 1 and 2 of 10 CFR § 61.55.

2.2.2 Class B Low-Level Waste

Class B waste contains higher concentrations of short-lived radionuclides than Class A waste but is still characterized by relatively short decay periods. The primary concern with Class B waste is ensuring adequate isolation during the period of institutional control (typically 100 years) while the radionuclides decay to safe levels. Class B waste must be stabilized to ensure that the waste package maintains its structural integrity for at least 300 years, providing sufficient time for radioactive decay before any potential movement into the environment.

Common Class B waste streams from reactor operations include higher-activity ion exchange resins from reactor water cleanup systems and certain filters with elevated contamination levels. Stabilization typically involves solidification in cement or placement in high-integrity containers (HICs) designed to maintain physical integrity for the required period.

2.2.3 Class C Low-Level Waste

Class C waste represents low-level waste with the highest concentrations of both short-lived and long-lived radionuclides that is generally acceptable for near-surface disposal. Due to its higher activity levels and the presence of longer-lived radionuclides, Class C waste requires additional measures to protect against inadvertent intrusion, such as engineered barriers or burial at greater depths (typically a minimum of 5 m).

Class C waste must meet both minimum and stability requirements, including structural stability for at least 300 years. Examples of Class C waste include certain activated metal components

from reactor cores and concentrated waste streams. The physical form and characteristics of Class C waste are more stringently controlled than lower classifications.

2.2.4 Greater-Than-Class C Low-Level Waste

This section introduces the regulatory definition of GTCC waste, its primary sources, and the current national and New York State inventory.

2.2.4.1 Regulatory Definition and Disposal

The Amendments Act assigned the federal government responsibility for disposing of GTCC waste from NRC-licensed activities, distinguishing it from State responsibilities for Class A, B, and C waste disposal.[14]

GTCC waste is defined under NRC regulations (10 CFR § 61.55) as low-level waste with concentrations of radionuclides that exceed the limits established for Class C waste. [15] Despite being classified as a subset of low-level waste, GTCC waste is "generally not acceptable for near-surface disposal," and it requires "disposal methods different, and in general more stringent than those specified for Class C waste."[16]

A licensed disposal pathway for GTCC waste in the U.S is still being developed. Under existing regulations, GTCC waste must be disposed of in a geologic repository unless the NRC approves an alternative method on a case-by-case basis. DOE issued a final environmental impact statement concluding that its preferred alternative was use of the Waste Isolation Pilot Plant (WIPP) repository and/or land disposal at generic commercial facilities.[17] In 2019, NRC commenced a rulemaking to potentially allow near-surface disposal of certain GTCC waste streams that can be demonstrated to meet performance objectives through site-specific analysis.[18]

2.2.4.2 Sources and Types

GTCC waste originates from three primary source categories.

1. Activated metal parts from nuclear reactor operations and decommissioning: This constitutes the largest volume and includes reactor internal components such as core shrouds, support plates, and baffle assemblies activated by intense neutron irradiation.[19]

2. Sealed sources used in medical, industrial, and research applications: Examples include equipment to diagnose and treat cancer, sterilize medical devices, and irradiate blood for

transplant patients. These highly concentrated sources may be classified as GTCC when they can no longer be used and require disposal.

3. Other contaminated equipment and sources related to cleanup activities: This category includes contaminated equipment, debris, filters, ion exchange resins, soil, and solidified sludges from various activities.

2.2.4.3 National Inventory

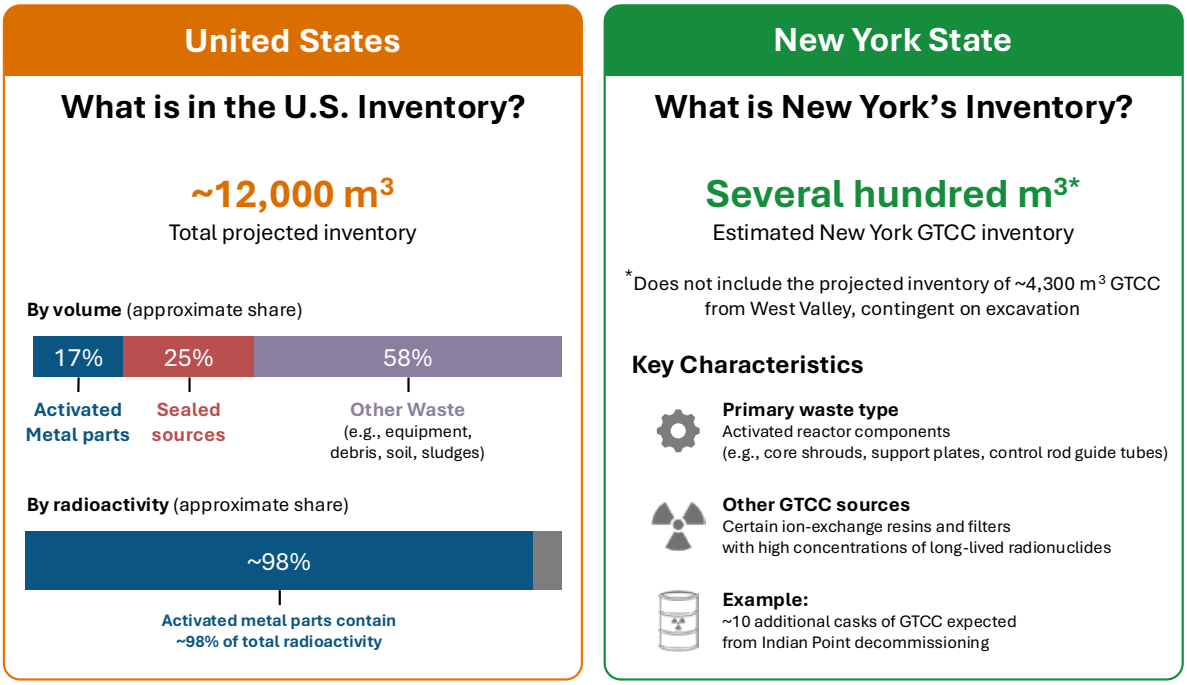
The most recent national inventory of GTCC waste is from DOE's 2016 Final Environmental Impact Statement (EIS), which estimated a combined GTCC and "GTCC-like waste" inventory of approximately 12,000 cubic meters (420,000 cubic feet) with a total activity of approximately 160 million curies to be generated through 2083 (Figure 3). A curie is a measure of radioactivity equivalent to 37 billion (3.7×10^{10}) disintegrations or transformations per second or one gram of radium-226. DOE used the term "GTCC-like" in the EIS to describe certain DOE-owned or generated wastes with characteristics similar to GTCC waste for which a similar disposal approach may be appropriate; the term is not a formal DOE or other federal waste classification. Of this inventory, approximately 75 percent is commercial GTCC waste from NRC-licensed activities and 25 percent is DOE-owned GTCC-like waste.[20]

Nuclear utilities are projected to generate the largest volume of GTCC waste (65-83 percent of total), primarily from reactor decommissioning activities.[21] Activated metal parts from decommissioning represent approximately 2000 cubic meters (70,629 cubic feet) of GTCC waste nationally.[22]

DOE's GTCC and GTCC-like inventory from the 2016 EIS categorized the waste as containing activated metal parts, sealed sources, and other waste. Activated metal parts were estimated to represent approximately 17 percent of total volume but 98 percent of total radioactivity, while sealed sources represented approximately 25 percent of volume and other waste approximately 58 percent.

Figure 3. GTCC Inventory in the U.S. and New York State

Source: U.S. Department of Energy, Summary: Final Environmental Impact Statement for the Disposal of Greater-Than-Class C (GTCC) Low-Level Radioactive Waste and GTCC-Like Waste, DOE/EIS-0375, January 2016; Banerjee, K.; Gadey, H. Spent Nuclear Fuel and Reprocessing Waste Inventory. INL/RPT-25-88353, Rev. 002. U.S. DOE, Office of Nuclear Energy. December 2025; Holtec Decommissioning International. Post-Shutdown Decommissioning Activities Report (PSDAR) / Irradiated Fuel Management Plan, Indian Point Energy Center (via NRC ADAMS).

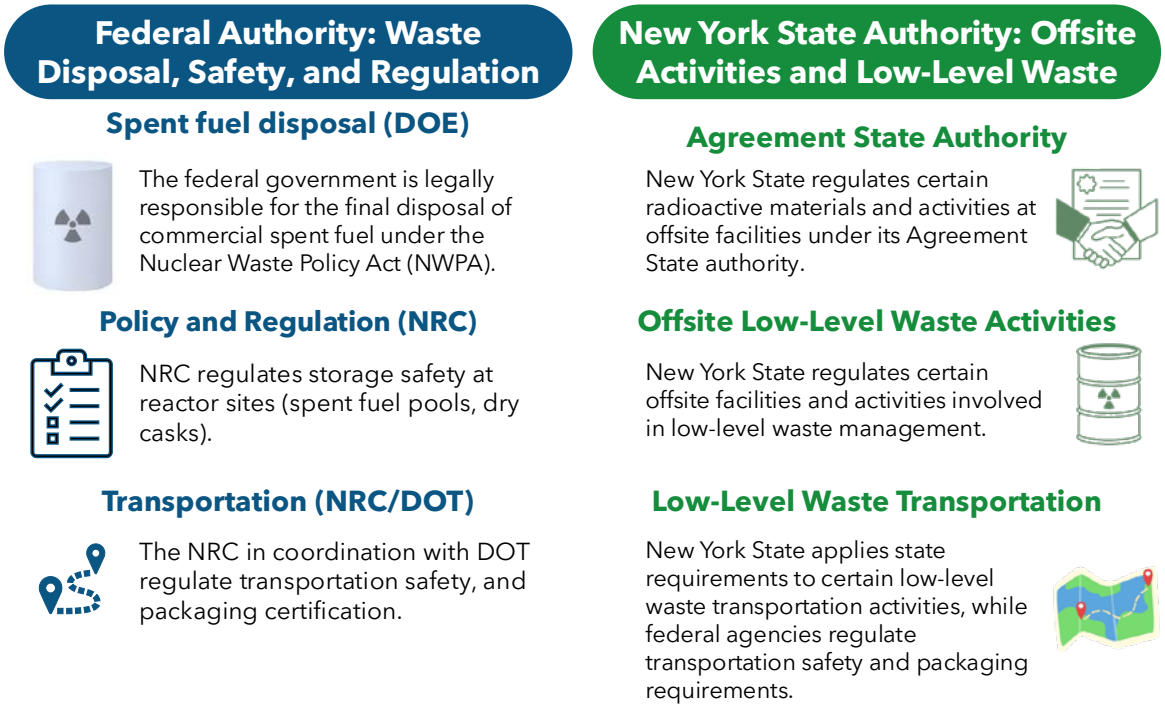


3. Federal Regulatory Framework Overview

The U.S. regulatory framework for radioactive waste management involves multiple federal agencies with distinct responsibilities. The NRC regulates the storage and disposal of all commercially generated radioactive wastes, including spent nuclear fuel, high-level waste, and low-level waste. DOE develops waste disposal technologies, designs and constructs disposal facilities, and manages defense-related radioactive waste. The EPA establishes environmental standards and radiation protection guidance for disposal facilities.

Federal and state roles also differ by waste type (Figure 4). The federal government retains primary responsibility for disposing of commercial spent nuclear fuel and high-level waste, while states dispose of most commercial low-level waste and may regulate low-level waste through NRC Agreement State programs. GTCC waste is an exception because federal law assigns DOE responsibility for its disposal.

Figure 4. Federal and New York State Nuclear Waste Responsibilities



Under the NWPA, as amended, the federal government assumed responsibility for permanent disposal of commercial spent nuclear fuel and high-level waste. This legislation established the framework for repository development and created the Nuclear Waste Fund, supported by fees collected from nuclear electricity generation utilities.

3.1 High-Level Waste Federal Regulatory Requirements

This section describes the federal regulatory requirements for high-level waste and Section 3.2 describes federal regulatory requirements for low-level waste.

3.1.1 Nuclear Regulatory Commission Authority

The NRC has primary federal authority to regulate commercial nuclear fuel cycle facilities, including the storage and transportation of spent nuclear fuel and high-level waste[23] and spent nuclear fuel reprocessing plants. NRC regulations establish comprehensive safety standards for fuel cycle facilities[b] in 10 CFR Part 70. These requirements address:

- Criticality safety controls to prevent inadvertent nuclear chain reactions during chemical processing
- Radiation protection standards for workers and the public
- Material control and accounting systems to track special nuclear materials
- Physical security requirements to prevent theft or sabotage
- Environmental monitoring and effluent controls
- Emergency preparedness planning and response capabilities

The NRC licensing process requires all applicants to demonstrate that facility design, operation, and safety systems meet performance criteria that ensure adequate protection of public health and safety (see the Master Plan Regulatory Issues and Safety Study). For reprocessing facilities handling significant quantities of plutonium or highly enriched uranium, additional security measures under 10 CFR Part 73 mandate multiple physical barriers, armed security forces, intrusion detection systems, and coordination with federal law enforcement agencies.[24]

10 CFR Part 72 establishes mandatory requirements, procedures, and criteria for issuing licenses to receive, transfer, and possess power reactor spent fuel and other radioactive materials associated with spent fuel storage in ISFSIs.[25] This regulation also governs the storage of reactor-related GTCC waste and provides the framework for both general and specific licenses for dry cask storage systems.

[b] While there is no formal definition for a "fuel cycle facility," it is generally recognized as a facility that processes, converts, enriches, fabricates, or reprocesses nuclear fuel. These facilities possess or use special nuclear material in quantities requiring an NRC license.

10 CFR Parts 60 and 63 address the disposal of high-level waste in geologic repositories, with Part 63 specifically addressing disposal at the Yucca Mountain site in Nevada.[26] These regulations establish technical criteria for repository design, operation, and closure, although the Yucca Mountain project licensing proceeding is not currently active.

3.1.2 Department of Energy Responsibilities

Under NWPA, the DOE holds statutory responsibility to develop a permanent repository for disposal of spent nuclear fuel and high-level waste. DOE is also responsible for disposing of GTCC waste under the Amendments Act. Additionally, DOE maintains the Standard Contract program under 10 CFR Part 961, which governs the federal government's contractual obligations to accept and dispose of civilian spent nuclear fuel.

DOE continues to conduct site characterization studies, maintain technical expertise, and manage the Nuclear Waste Fund collected from utility ratepayers.[27] DOE also oversees interim storage of government-owned spent nuclear fuel and high-level waste at various sites.

DOE conducts nuclear fuel cycle research and development through its Office of Nuclear Energy, national laboratories, and the Advanced Research Projects Agency-Energy (ARPA-E). This work is relevant to nuclear waste management because it includes research on spent nuclear fuel treatment, recycling and reprocessing, waste minimization, advanced waste forms, and technologies for managing waste from advanced reactors. DOE research capabilities therefore play an important role in developing potential future approaches to reducing, treating, and disposing of nuclear waste.

3.1.3 Environmental Protection Agency Standards

EPA establishes environmental radiation protection standards for nuclear fuel cycle facilities under authority granted by the Atomic Energy Act (AEA) and other environmental statutes. These include standards for managing and disposing of spent nuclear fuel, high-level waste, and TRU wastes produced from spent nuclear fuel reprocessing under 40 CFR Part 191.[28] These standards define containment and individual protection requirements that any repository system must meet, establishing dose limits and release limits for an isolation period.

EPA also establishes standards under 40 CFR Part 190 to limit radiation doses to members of the public from normal operations of uranium fuel cycle facilities, including any future commercial reprocessing plants.[29] In addition, EPA regulates radioactive emissions to air under the Clean Air

Act and oversees environmental impact assessments for major federal actions that may significantly affect environmental quality.[30]

For geological repositories, EPA previously issued disposal standards in 40 CFR Part 197 specific to Yucca Mountain.

3.1.4 Transportation Regulations

The NRC jointly regulates the transportation of radioactive materials under 10 CFR Part 71[31] with the U.S. Department of Transportation (DOT) under 49 CFR Parts 171-180.[32] The NRC certifies transport packaging designs for spent nuclear fuel and high-level waste, while DOT regulates shipping and carrier operations, routing requirements, and emergency response provisions. These regulations incorporate International Atomic Energy Agency (IAEA) transportation safety standards to facilitate international consistency. The New York State Department of Transportation (NYSDOT) defines and regulates the insurance requirements, size, weight, and axle configurations of vehicles via NYS VTL § 385 and 17 NYCRR Part 154.

3.2 Low-Level Waste Federal Regulatory Disposal Requirements and Initiatives

The regulatory framework for low-level waste management involves both federal requirements (described below) and a comprehensive state regulatory framework (described in Section 4).

The principal regulations governing low-level waste disposal are found in 10 CFR Part 61, which establishes the low-level waste classification system; specifies waste characteristics requirements; and provides licensing procedures, performance objectives,[c] and technical requirements for land disposal facilities.[33]

The NRC's regulations at 10 CFR Part 20, Subpart K, "Waste Disposal," establish general requirements for radioactive waste disposal, including provisions for disposal by release into sanitary sewerage, disposal by incineration, decay-in-storage, and transfer for disposal. Section

[c] Key performance objectives include protection of the general population from releases of radioactivity, protection of individuals from inadvertent intrusion, protection of individuals during operations, and stability of the disposal site after closure.

20.2002 provides a pathway for NRC approval of alternative disposal procedures, which has become increasingly relevant for very low-level waste (VLLW)[d] and certain unique waste streams.[e] 10 CFR Part 20, Subpart K also establishes requirements for transferring low-level waste for disposal and the Uniform Low-Level Waste Manifest system.[f]

The Low-Level Radioactive Waste Policy Act of 1980 (Public Law 96-573) established that each state is responsible for providing disposal capacity for low-level waste generated within its borders. This act encouraged states to form regional compacts to develop shared disposal facilities. It authorized compacts to restrict access to their regional disposal facilities to member states, meaning disposal access can vary by state and compact membership.[34] In practice, states inside a compact have guaranteed access to that compact's facility, while states outside a compact can only dispose of low-level waste at commercial facilities that voluntarily accept waste from non-member states.

Ten compacts have been congressionally approved (although not all have operational disposal facilities), and the compact system remains the primary mechanism for allocating disposal responsibility among states (Figure 5). New York State is not a member of an interstate compact and relies on access to disposal sites in Utah (Class A) and Texas (Class A, B, and C), and to a limited extent, Washington.

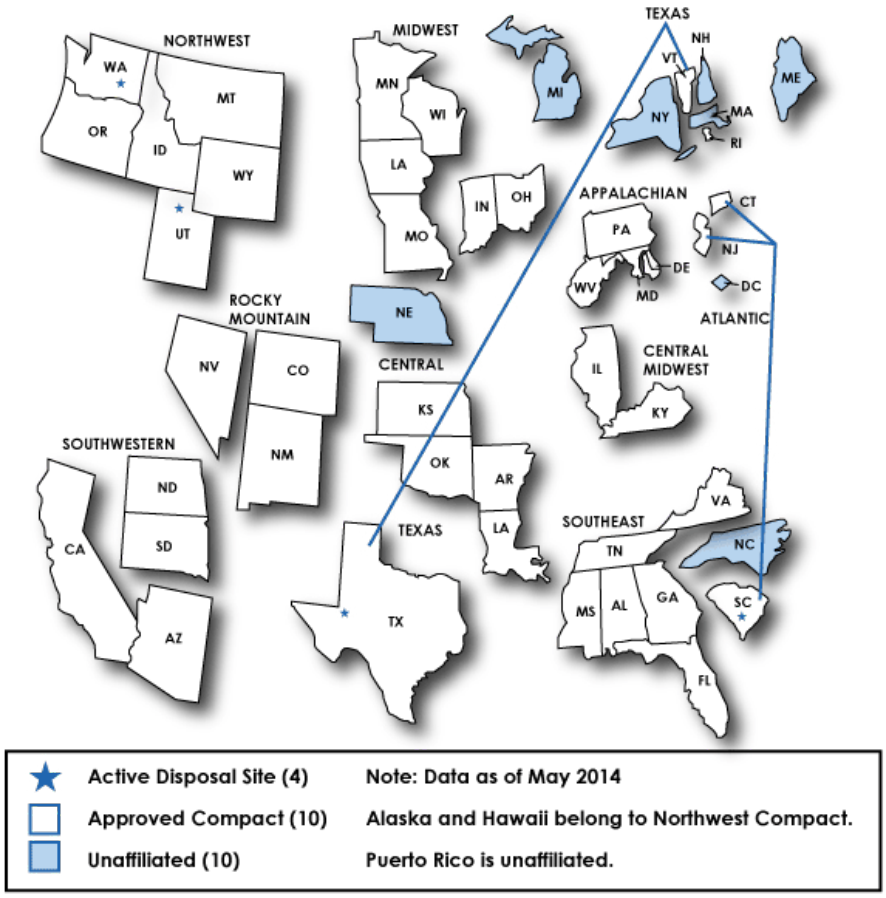
[d] Very low-level waste (VLLW), also referred to as "low-activity waste", represents the lowest activity portion of Class A waste. While VLLW is not a formal regulatory classification with a statutory or regulatory definition, it describes waste containing minimal residual radioactivity that may be safely disposed of in hazardous or municipal solid waste landfills rather than licensed low-level waste disposal facilities. See https://www.nrc.gov/waste/llw-disposal/very-llw.

[e] For example, in 2002, the NRC approved a request by Big Rock Point Nuclear Power Plant to dispose of low-activity demolition debris in a nearby, state-licensed sanitation landfill. The disposal site was licensed by the state of Michigan in accordance with 10 CFR 20.2002. While most of the low-level waste generated is transported to and disposed in facilities under Agreement State regulations, low-level waste disposal pathways such as 10 CFR 20.2002 continue to be available for use by states and generators of low-level waste that fall below Class A limits outlined in 10 CFR part 61.

[f] The manifest system, implemented through NRC Forms 540/540A, 541/541A, and 542/542A, provides a standardized nationwide framework for documenting low-level waste shipments from generation through disposal. The manifest includes information on the shipper, carrier, disposal facility, radionuclide content, physical and chemical form, and waste classification.

Figure 5. Low-Level Waste Interstate Compacts.

Source: Nuclear Regulatory Commission, Low-Level Waste Compacts, updated August 15, 2025, https://www.nrc.gov/waste/llw-disposal/licensing/compacts.



Nuclear facility decommissioning generates large volumes of VLLW. The NRC has examined potential regulatory framework improvements for VLLW, noting that such waste comprises the majority of Class A waste by volume and could potentially be managed through alternative disposal pathways.[35] Development of risk-informed, performance-based approaches to VLLW could reduce disposal costs and conserve capacity at licensed low-level waste disposal facilities for higher-activity waste streams.

3.3 Finding and Conclusion

Regulatory Authority for Waste Management. The federal regulatory framework for nuclear waste management divides responsibility among multiple agencies and between federal and state governments, with the federal government retaining primary authority over spent nuclear fuel and high-level waste while states play a larger role in low-level waste management. This

division of authority requires sustained coordination between New York and federal agencies as waste management policies and regulations evolve.

Conclusion:

- **Continue engagement with the federal government on spent fuel-related issues, including consolidated long-term storage, DOE's Nuclear Lifecycle Innovation Campus Initiative, and strengthened oversight of decommissioning trust funds.**

In support of implementing this conclusion, New York State should:

- Remain actively involved with the NRC as federal low-level waste regulations evolve. This includes participating in NRC rulemaking, particularly the Integrated Low-Level Radioactive Waste Disposal rule, monitoring federal developments on VLLW, and coordinating with NYS entities to ensure state regulations remain compatible with federal requirements.

- Continue to evaluate federal initiatives affecting spent nuclear fuel management, including proposals to establish new waste management organizations, reform the Nuclear Waste Policy Act or Nuclear Waste Fund, or clarify NRC licensing authority for interim storage facilities. NYSERDA should coordinate with the Governor's office, state legislature, and congressional delegation to ensure the State's interests as a waste origin state are represented in nuclear waste policy development.

- Continue the State's oversight of decommissioning trust funds to help ensure that adequate resources remain available for safe spent fuel management through decommissioning.

- Actively participate in interstate organizations addressing nuclear energy and waste policy and coordinate closely with federal agencies on spent nuclear fuel management issues affecting the State. Coordination mechanisms should include coordination with other states and interstate compacts hosting nuclear facilities on common regulatory and policy issues; regular engagement with NRC and DOE on fuel cycle regulatory developments; and formal comment submissions on federal rulemakings affecting fuel cycle facilities.

4. State Regulatory Framework Overview

This section describes New York State's regulatory framework for high-level waste and low-level waste and NYS agency and authority roles with respect to nuclear waste issues and management.

4.1 Regulation of High-Level Waste in New York State

4.1.1 New York State Context

New York State occupies a unique position in the national nuclear waste landscape. The state hosts significant quantities of spent nuclear fuel from both operating and decommissioned reactors and owns the Western New York Nuclear Service Center near West Valley, which was the only privately operated spent nuclear fuel reprocessing facility to operate in the United States. Through the West Valley Demonstration Project Act, DOE vitrified (that is, embedded in glass) high-level waste from West Valley's reprocessing operations that remains stored on-site, pending disposal in a federal repository.

4.1.2 State Regulatory Authority and Limitations for High-Level Waste

Nuclear safety and radiological protection fall primarily under federal jurisdiction. As described in Section 3.1 and in the Master Plan Regulatory Issues and Safety Study, the NRC exercises exclusive regulatory authority over reactor operation, spent nuclear fuel storage, and radioactive materials licensing at commercial nuclear facilities, while states retain authority over numerous non-radiological aspects of nuclear facility siting and operation.

This division of authority makes coordination between State and federal regulators particularly important for nuclear waste management and facility oversight.

4.2 New York State Regulatory Framework for Low-Level Waste

In contrast to high-level waste management, New York State maintains a comprehensive regulatory framework for low-level waste management, implemented through multiple NYS entities with distinct but coordinated responsibilities. New York is an Agreement State under the AEA.

New York State became an Agreement State in 1962, authorizing the New York State Department of Health (DOH) to license and regulate certain radioactive materials under NYS authority. This agreement covers radioactive materials used in medical, industrial, and research applications but does not extend to reactor operations, spent nuclear fuel, or high-level waste, which remain under NRC jurisdiction. As such, New York State maintains important complementary authorities and responsibilities that directly affect nuclear waste management within its borders.

New York State enacted the Low-Level Radioactive Waste Management Act of 1986 (1986 Act), codified as Chapter 673 of the Laws of 1986, in response to the federal Low-Level Radioactive Waste Policy Act of 1980 and subsequent Amendments Act. This legislation established the framework for low-level waste management within the state and assigned specific responsibilities to multiple NYS entities, described below.[36]

4.3 New York State Agency and Authority Roles

This section summarizes specific roles of NYS agencies and authorities with respect to nuclear waste and spent fuel storage. The Master Plan Regulatory Issues and Safety Study provides a full assessment of state regulatory and safety processes.

4.3.1 New York State Energy Research and Development Authority

NYSERDA serves as the state's principal coordinator for nuclear energy and radioactive materials control activities. NYSERDA's President serves as the Governor’s designated State Liaison Officer to the NRC, representing the primary communication channel between the state and federal nuclear regulators. Key responsibilities related to waste include:

- Monitoring generation and management of low-level radioactive waste pursuant to the 1986 Act (Chapter 673 of the Laws 1986);
- Collecting annual reports from facilities producing, storing, or disposing of radioactive waste and preparing annual status reports for the Governor and legislature; and
- Managing portions of the Western New York Nuclear Service Center, also known as the West Valley Site Management Program, including oversight of the State-Licensed Disposal Area (SDA) and representing NYSERDA’s interests in the West Valley Demonstration Project (see Section 6.3).

NYSERDA also serves as the primary coordinating entity for low-level waste policy in New York State. The 1986 Act charged NYSERDA with acquiring lands to design, obtain regulatory

approvals for, construct, and operate low-level waste disposal facilities, although the State does not currently host a low-level waste disposal facility.

4.3.1.1 Generator Reporting Requirements

Under 21 NYCRR Part 502, NYSERDA collects annual reports from all facilities in New York State that generate, store, or dispose of low-level waste in the state.[37] The annual reports provide detailed information on waste generated, stored, and disposed of. Reporting is also required if a facility anticipates generating low-level waste that will require eventual disposal within the next five years. NYSERDA has developed standardized forms and instructions to facilitate compliance, including both long- and short-form options based on generator activities.

This data collection program has operated continuously for nearly four decades, providing detailed information on waste classification, radionuclide content, waste type, disposal facility destination, and storage status. This comprehensive data collection enables trend analysis and supports planning for future waste management needs.

Pursuant to the statute, NYSERDA prepares and submits annual status reports to the Governor and legislature summarizing low-level waste generation, storage, and disposal activities by generator type and county of origin.

According to NYSERDA's 2025 Status Report, New York State generators disposed of 4,293.9 cubic meters (151,618 cubic feet) of low-level waste in out-of-state commercial disposal facilities.[38] Nuclear power plants accounted for roughly 87.7 percent of disposed volume and roughly 99 percent of total radioactivity. Annual disposal volumes vary greatly depending on decommissioning and other activities and should not be interpreted as a steady annual waste generation rate.

4.3.1.2 Low-Level Waste Annual Assessments

NYSERDA is required by Public Authorities Law Section 1854-d(2)(c) to collect annual assessments from nuclear electric generating facilities with full power operating licenses in New York State. The assessments recover expenditures incurred by the New York State Department of Environmental Conservation (DEC) and DOH to implement the 1986 Act. These assessments are made each year by January 31 and are calculated by allocating costs equally across each nuclear reactor operating in the State. The most recent 2025 assessment was released in July 2026.[39]

4.3.2 New York State Department of Environmental Conservation

DEC administers environmental statutes and regulations related to waste from nuclear facilities, including several regulations directly applicable to low-level waste management. Under the 1986 Act, DEC was charged with permitting and regulating low-level waste disposal facilities, although it has not licensed any such facilities in the State. DEC also administers delegated programs under the federal Clean Water Act and Resource Conservation and Recovery Act that relate to nuclear releases and cleanup. DEC's responsibilities fall under the following regulations and guidance documents:

- **6 NYCRR Part 380 (Prevention and Control of Environmental Pollution by Radioactive Materials):** Requires parties discharging radioactive material to maintain records, keep discharges as low as reasonably achievable, and obtain radiation control permits when dose limits or emission levels exceed specified thresholds.[40] Permittees include industrial, research, medical, radiopharmaceutical, and wastewater treatment facilities. Amendments to Part 380 took effect May 10, 2018, incorporating federal rule changes, and clarifying existing requirements.
- **6 NYCRR Part 381 (Transporters of Low-Level Radioactive Waste):** NYCRR Part 381 governs transporters of low-level waste, requiring permits for highway transport through New York State regardless of whether waste is picked up or delivered within state borders. This regulation establishes manifest requirements, operational standards, and reporting obligations. DEC filed a Notice of Adoption in 2024 to update Part 381 for consistency with NRC regulations adopted between 2012 and 2021.
- **6 NYCRR Part 382 (Regulation of Low-Level Radioactive Waste Disposal Facilities)**: Contains requirements for low-level waste site and method selection, establishing the regulatory framework that would apply if the state resumed efforts to build and operate a low-level waste disposal facility.
- **6 NYCRR Part 383 (Regulations for Low-Level Radioactive Waste Disposal Facilities Financial Assurance Requirements):** Establishes financial assurance requirements for low-level waste disposal facilities in New York State, ensuring that owners and operators have adequate funding mechanisms.
- **6 NYCRR Part 384 (Criteria for Decommissioning of Radioactive Materials Licensed Sites):** Cleanup criteria for remediation of sites contaminated with radioactive material, adopted in October 2025.
- **DER-38 Cleanup Guideline:** Guidance document for soils contaminated with radioactive materials, applied to site remediation activities

DEC has also issued Division of Materials Management Program Policy 5, addressing management of soils contaminated with Technologically-Enhanced Naturally Occurring Radioactive Materials, which are natural radioactive materials that become more concentrated or more accessible because of human industrial activities, that were generated, disposed of, or released before the implementation of 6 NYCRR Part 380 in March 1994.[41]

4.3.3 New York State Department of Public Service and Public Service Commission

DPS and the Public Service Commission (PSC) play a complementary role to protect the public interest, ensure cost-effective outcomes for ratepayers, and integrate waste considerations into broader energy planning and regulatory frameworks. While primary authority over nuclear safety, security, licensing, and management of spent nuclear fuel and other radioactive materials rests with the NRC, DPS maintains lightened regulation over nuclear generating facilities under the Public Service Law. The lightened regulation framework includes oversight of financial assurances, ownership transfers, and other economic and reliability matters that can intersect with long-term waste storage and decommissioning. Through coordination with other NYS agencies and authorities, DPS helps ensure that waste-related issues are addressed in State policy development, including in the studies and conclusions of this Master Plan.

Experience with New York's existing nuclear fleet and the ongoing decommissioning of Indian Point has further defined DPS's practical engagement on waste issues. DPS staff and the PSC support mechanisms such as the Zero-Emissions Credit program that sustain the continued, safe operation of the State's currently operating nuclear plants and lead the Indian Point Closure Task Force and Decommissioning Oversight Board (DOB). Indian Point decommissioning efforts include securing accelerated transfer of spent nuclear fuel from pools to dry cask storage, obtaining financial and site-restoration commitments through joint proposals and PSC orders, and engaging with federal partners on the eventual removal of spent nuclear fuel consistent with DOE's statutory responsibilities. In addition, DPS reviews decommissioning trust fund reports annually.

4.3.4 New York State Department of Health

As an Agreement State agency, DOH licenses and regulates radioactive materials for medical, industrial, and research uses (see the Master Plan Regulatory Issues and Safety Study). New York City Department of Health and Mental Hygiene (NYCDOHMH) licenses and regulates medical and academic facilities within the five boroughs of New York City. DOH's Bureau of

Environmental Radiation Protection (BERP) monitors public health implications of radioactive materials, although commercial reactor operations remain under NRC jurisdiction. BERP licenses and inspects approximately 1,300 radioactive materials licensees throughout the state, including commercial, medical, academic, and government facilities.[42] This licensing authority was expanded in 2006 when the New York State Department of Labor's (DOL) radioactive materials program was consolidated with DOH's program.

DOH and DEC work together to ensure safe handling and disposal. For example, DOH issues licenses for the possession and use of radioactive materials under 10 NYCRR Part 16, which establishes radiation protection requirements for control of radioactive material to align with as low as reasonably achievable (ALARA) principles for licensed activities.[43], and DEC establishes waste management standards. Licensees must maintain radiation safety programs, designate qualified Radiation Safety Officers, and comply with training and recordkeeping requirements. DOH also participates in emergency planning.

4.4 Findings

Class A, B, and C Low-level Waste is routinely and safely managed. low-level waste is safely managed, and disposal options are currently in place outside of New York State. Continued cooperation with the states that host low-level waste disposal facilities and voluntarily accept waste generated in New York State helps to preserve access to existing disposal capacity.

State Regulatory Framework for Low-level Waste Management: New York State has a well-established regulatory and institutional framework for managing low-level waste, with responsibilities distributed among NYSERDA, DEC, DPS, DOH, NYCDOHMH and other NYS entities. New York State's Agreement State authority and longstanding low-level waste reporting program give the State experience overseeing radioactive materials and tracking waste generation, storage, and disposal, while spent nuclear fuel and high-level waste remain primarily under federal jurisdiction.

State Entity Coordination and Capacity: The distribution of low-level waste responsibilities across multiple NYS agencies and authorities also makes coordination particularly important. New York State's existing institutional framework provides a strong foundation and maintaining effective oversight as waste management needs evolve will depend on clear agency and authority roles, adequate technical capacity, and state regulatory requirements aligned with federal changes.

Aligning Federal and State Requirements: State entities should adopt federal NRC and DOT amendments promptly to ensure regulatory compatibility.

5. Waste Generation by Reactor Type

Understanding the waste generation characteristics of different reactor technologies is essential for planning waste management systems and evaluating the implications of potential future advanced nuclear deployments in New York State.

This section analyzes waste production from conventional large light water reactors and advanced nuclear technologies including advanced light-water-cooled and non-water-cooled large reactors, small modular reactors (SMRs), and microreactors.

5.1 Existing Large Light-Water Reactors

Large light-water reactors with generating capacities sometimes exceeding 1,000 MWe constitute the vast majority of existing commercial nuclear power generation worldwide. The two primary designs are pressurized water reactors (PWRs) and boiling water reactors (BWRs), which share fundamental characteristics but differ in operating parameters and waste profiles. New York State's operating fleet includes both types: R.E. Ginna Clean Energy Center (Ginna) is a Westinghouse PWR, while Nine Mile Point Clean Energy Center (Nine Mile Point) Units 1 and Unit 2 and James A. FitzPatrick Clean Energy Center (J.A. FitzPatrick) are General Electric BWRs.

Large light-water reactors generate spent nuclear fuel with physical and radiological characteristics that vary by design (PWR vs BWR) as well as various types of low-level waste. The sections below describe typical waste streams and volumes from conventional large light-water reactors, relevant to managing waste from the State’s existing nuclear fleet and considering advanced large light-water reactors.

5.1.1 Spent Fuel Physical Characteristics

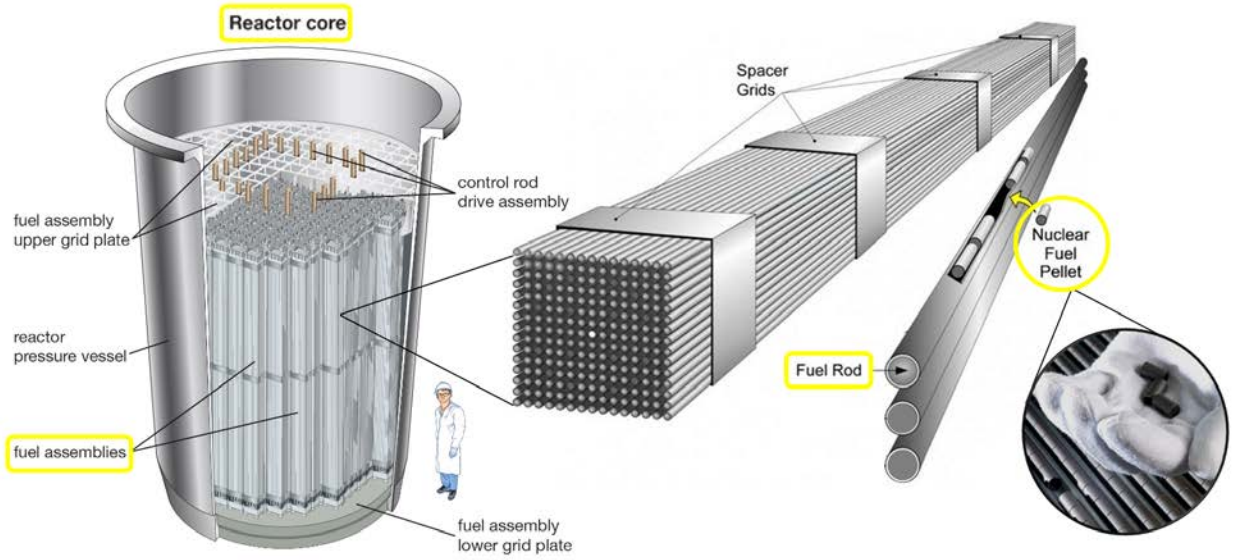
Commercial light-water reactor spent nuclear fuel have traditionally consisted of ceramic uranium dioxide (UO_2) pellets enclosed in zirconium alloy cladding tubes (Figure 6). Multiple fuel rods form a fuel assembly, with configurations that depend on reactor type. PWR assemblies typically contain 264 fuel rods in a 17×17 array, weigh approximately 657 kg, and have an active fuel length of about 3.7 m. BWR assemblies contain approximately 92 fuel rods in configurations that vary by design generation and weigh approximately 275-320 kg.[44]

A typical large PWR with a capacity of 1,000 MWe contains approximately 100 metric tons of uranium fuel in its core, while a comparable BWR contains approximately 140-160 metric tons. During refueling, which occurs every 18-24 months, operators replace about one-fourth to one-

third of the core fuel, resulting in annual spent nuclear fuel discharges of approximately 20–40 metric tons of heavy metal (MTHM) per large reactor. Heavy metal is the sum of the mass of actinide elements like uranium, thorium and plutonium.

Figure 6. Light-Water Reactor Fuel

Source: U.S. Nuclear Regulatory Commission, "Fuel Pellet," updated September 16, 2026, accessed October 20, 2026, https://www.nrc.gov/reading-rm/basic-ref/glossary/pellet-fuel; Deep Isolation, "What Is Spent Nuclear Fuel?," accessed September 4, 2026, https://www.deepisolation.com/about-nuclear-waste/what-is-spent-nuclear-fuel/; Burton I. Spinrad and Wade Marcum, "Nuclear Reactor," Encyclopedia Britannica, updated May 22, 2026, https://www.britannica.com/technology/nuclear-reactor.



5.1.2 Radiological Characteristics

Spent nuclear fuel is radioactive because fission products and transuranic elements accumulate during reactor operation. For this reason, spent nuclear fuel is handled remotely and kept behind substantial shielding throughout storage and transportation, using well-established practices.[45] The composition of irradiated fuel depends on initial enrichment, burnup level (a measure of the total thermal energy extracted from nuclear fuel relative to its initial mass, measured in gigawatt-days per metric ton of heavy metal, GWd/MTHM), and cooling time. Modern large light-water reactor fuel achieves burnups of 45-60 GWd/MTHM.

Spent nuclear fuel thermal characteristics are critical for storage system design. Decay heat is the heat produced by the radioactive decay of fission products and actinides (15 metallic radioactive elements, primarily uranium, plutonium, thorium, neptunium, americium, and curium in this case) inside a nuclear reactor or spent fuel after the nuclear chain reaction has been shut down.

Decay heat depends on many factors but typically starts at about 6–7 percent of the heat produced at full power and decreases to less than one percent after a day. At discharge, decay heat generation may exceed 20 kW per assembly for PWR fuel. After five years of pool cooling, decay heat decreases to approximately 1–to 2 kW per assembly, enabling transfer to passive air-cooled dry storage systems. Heat output continues to decrease logarithmically, reaching approximately 0.5 kW per assembly after 20 years.

5.1.3 Spent Fuel Generation Rates

A typical large light-water reactor (1,000 MWe) operating at a capacity factor of 90 percent generates approximately 20-30 metric tons of spent fuel annually. PWRs typically produce slightly less spent fuel mass per unit of electricity than BWRs due to higher fuel burnup levels. Modern PWRs achieve burnups of 50-60 GWd/MTHM, while BWRs typically operate at 45-55 GWd/MTHM.[46]

5.1.4 Spent Fuel National Inventory

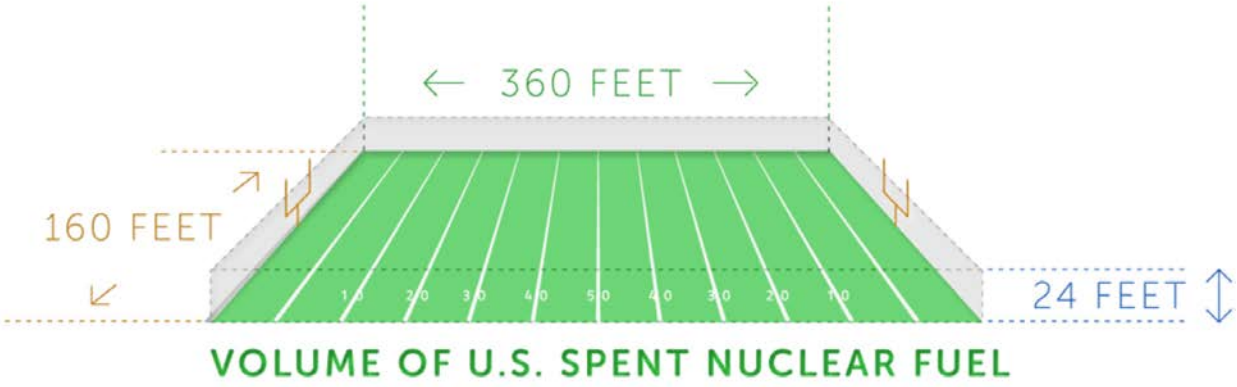
As of 2024, the total U.S. commercial spent nuclear fuel inventory exceeds 95,000 MTHM, stored at 73 commercial nuclear power plant and ISFSI sites in 33 states. This inventory continues to grow by approximately 2,000 MTHM annually from operating reactors. Current projections indicate that the inventory could reach 142,074 MTHM by 2075.[47] Approximately 44 percent of spent nuclear fuel remains in pool storage, with 56 percent transferred to dry cask storage. New York State holds one of the nation's largest inventories of spent nuclear fuel, with approximately 4,957 MTU stored at reactor sites.[48] MTU, or metric tons of uranium, is a measure of the total mass of uranium in the spent nuclear fuel not including oxygen, cladding, or other materials.[g]

For scale, DOE notes that approximately 90,000 MTHM of commercial spent nuclear fuel could fit on a single football field at a depth of less than 30 ft (Figure 7).[49]

[g] MTHM, metric tons of all heavy metals (uranium, plutonium, or thorium) in spent nuclear fuel, may be different that MTU if significant quantities of plutonium or thorium are included as might be the case if a mixed uranium and plutonium fuel. However, light-water reactors use uranium-235 as fuel, producing a very small amount of plutonium (~1%) in spent nuclear fuel such that MTHM and MTU are approximately the same.

Figure 7. Volume of Total U.S. Large Light-Water Reactor Spent Fuel Inventory

Source: Generation Atomic, "Why Nuclear Energy," 2026, accessed September 4, 2026, https://www.generationatomic.org/why-nuclear/.



Therefore, New York State's approximately 4,957 MTU of spent nuclear fuel, about 5 percent of the national inventory, would occupy less than 2 ft of depth if spread across a football field. However, these comparisons reflect the volume of the spent fuel itself and do not account for fuel assemblies, storage casks, shielding, or the spacing required between casks at an operating storage facility. Including the full dry-cask storage systems substantially increases the physical footprint. One estimate found that all U.S. spent fuel generated through 2023 would require approximately 8,500 dry casks, which, if arranged over a single football field, would stack to roughly 135 m (443 ft) in height.[50]

Scaling that estimate to New York State's inventory would correspond to roughly 520 dry casks, or about 27 ft in height if similarly distributed over a football field. These comparisons illustrate that, despite the significant mass and radioactivity of spent nuclear fuel, its physical volume even when shielded is relatively compact.

5.1.5 Greater-Than-Class-C Waste from Large Light-Water Reactors

Large light-water reactors generate relatively small volumes of GTCC waste during normal operations. The primary GTCC waste consists of reactor internal components removed during maintenance or decommissioning, including core shrouds, core support structures, and baffle plates exposed to high neutron flux. Neutron flux is a measure of the intensity of neutron radiation or neutrons passing through an area per time. Neutron flux is high when the reactor is at full power. For a typical large PWR, decommissioning GTCC waste represents less than 1

percent of total decommissioning low-level waste volume, although it contains disproportionately high activity compared to other low-level waste (Class A, B, and C).

Section 2.2.4 provides estimates of national GTCC waste volumes.

5.1.6 Class A-C Low-Level Waste from Large Light-Water Reactors

Large light-water reactors generate most commercial low-level waste in the U.S. These reactors have well-established waste generation profiles based on decades of operational experience.

The radioactive content of disposed low-level waste generally reflects refueling and maintenance activities at nuclear power plants and shows little correlation to overall volume. Significant increases in disposal volumes typically correspond to specific events such as research reactor decommissioning, disposal of irradiated hardware, or large-volume resin disposal during power plant refueling outages.

Conventional large light-water reactors generate the following primary low-level waste streams:

- **Ion Exchange Resins and Filter Media:** Used to purify reactor coolant water and other process streams. These materials become contaminated with fission and activated corrosion products and make up a significant portion of higher-activity low-level waste. Spent resins may be classified as Class A, B, or C depending on their radionuclide content.
- **Dry Active Waste (DAW):** Includes contaminated protective clothing, paper, plastic, wood, and other solid materials used in radiologically controlled areas. DAW typically constitutes the largest volume of low-level waste but generally has the lowest activity concentrations.
- **Contaminated Equipment and Components:** Items such as tools, pumps, valves, and piping that have become radioactively contaminated during reactor operations. Larger components may be segmented for disposal or held for decay-in-storage.
- **Activated Metal Parts:** Structural materials that have been exposed to neutron flux and become radioactive through neutron activation. This neutron activation occurs when neutrons released by fission are captured by another atom, often by corrosion products or metal components in or near the reactor. This category includes components from reactor vessels or in-core locations.

A typical large light-water reactor generates approximately 11.3–25.5 m^3 (400–900 ft^3) of Class B and C low-level waste annually, with volumes varying based on reactor type (BWRs generally

produce more ion exchange resin waste than PWRs), operational practices, and waste minimization programs. Class A waste volumes are significantly higher, often several thousand cubic feet annually per reactor.[51]

In total, according to NRC data, approximately 3.3 million ft^3 and 173 thousand curies of low-level waste were disposed of at licensed facilities in 2023. [52] The volume and radioactivity of waste disposed of vary yearly based on operational activities, maintenance schedules, and decommissioning projects.

5.2 Advanced Reactors

A broad range of advanced nuclear reactor technologies are now under development across the private sector. Some of these designs incorporate innovative fuel forms and coolants that may enable meaningful gains in safety, efficiency, and operational flexibility. Compared to conventional large light-water reactors, many of these new systems aim to achieve higher fuel utilization, improved thermal performance, greater physical robustness, enhanced high-temperature stability, and inherent safety.

Because these reactors may rely on different fuels, materials, and operating conditions, they may produce waste streams that differ from those generated by today's fleet. Understanding those differences requires examining specific reactor technologies and their associated waste streams.

Notably, many advanced reactors under development are categorized as SMRs, which are defined as nuclear reactors with electric power output less than 300 MWe. These designs offer potential advantages including factory fabrication, modular construction, and scalable deployment, but may require different waste management strategies than large light-water reactors, particularly for non–water-cooled designs.

Several advanced reactor designs are progressing through NRC licensing, with near-term deployment anticipated by the end of the decade.

Because most advanced reactor designs discussed in this section do not yet have associated commercial operating experience, descriptions of their expected waste characteristics and volumes are based primarily on design information, licensing materials, and research analyses rather than operating data. Actual waste generation may differ as designs mature and operating experience becomes available. Decommissioning waste may also differ by design because reactor size, materials, neutron spectra, and modular replacement strategies can affect the

quantities and characteristics of activated and contaminated components generated at end of life.

5.2.1 Waste Characteristics of Advanced Light-Water Reactors

An advanced light-water reactor (ALWR) builds on the familiar large light-water reactor design while incorporating specific design and operational improvements. Like today's conventional large light-water reactors, ALWRs use water as both coolant and moderator and rely on uranium oxide fuel pellets.

While ALWRs share the same underlying technology as large light-water reactors, they introduce enhancements that aim to improve safety, efficiency, and operational flexibility. For example, ALWR advancements include passive and inherent safety systems that rely on natural forces such as gravity and natural convection of air for cooling, reducing the need for active mechanical systems. ALWRs include both large light-water reactors and SMRs with smaller power outputs. SMRs have a smaller footprint, a more compact, modular design, lower upfront capital costs, and greater deployment flexibility compared to their large light-water reactor counterparts.

The spent nuclear fuel generated by ALWRs is expected to be broadly similar to spent nuclear fuel generated by conventional large light-water reactors—fuel assemblies that contain ceramic uranium dioxide fuel pellets and their surrounding fuel cladding material. This reflects how similar ALWR and large light-water reactor technologies are. The only minor differences between ALWR and large light-water reactor spent nuclear fuel are burnup characteristics and size of fuel assemblies, because while both use standard light-water reactor fuel assemblies, those used in ALWRs will be slightly shorter in length because of their smaller reactor pressure vessels. New cladding materials are expected to be used more frequently in the future for both large light-water reactors and advanced light-water reactors. While this change may affect the spent nuclear fuel radiochemical and elemental composition characteristics, existing spent nuclear fuel handling methods are expected to be sufficient.

Light-water SMRs, such as NuScale's VOYGR design, Westinghouse's AP300, and GE Vernova's BWRX-300 use fuel and operating principles based on existing large light-water reactors. Research from Argonne National Laboratory indicates that these designs will produce waste with characteristics "roughly comparable with conventional pressurized water reactors, with potential benefits and weaknesses depending on which aspects you are trying to design for."[53] For example, the VOYGR design achieves slightly lower burnup and thermal efficiency than large

PWRs, resulting in comparable or slightly higher spent nuclear fuel mass production per unit energy.

Overall, given the robustness of existing large light-water reactor waste management practices, ALWR waste is not expected to introduce significant new challenges to the overall waste management strategy needed to safely and effectively prevent exposure to the public and environment. Therefore, the interim and permanent disposal methods for this waste are expected to align with those already established for conventional large light-water reactor waste.[54]

5.2.2 Waste Characteristics of Advanced Non–Water-Cooled Reactors

Advanced non-water-cooled reactors can use molten salt, liquid metal (e.g., sodium), or gas as the coolant and present different waste profiles than large light-water reactors. Most relevant non–water-cooled reactor designs are categorized as SMRs by size. The following sections describe the different non–water-cooled designs: gas-cooled reactors, molten salt reactors (MSRs), and liquid metal-cooled fast reactors.

5.2.2.1 Gas-Cooled Reactors

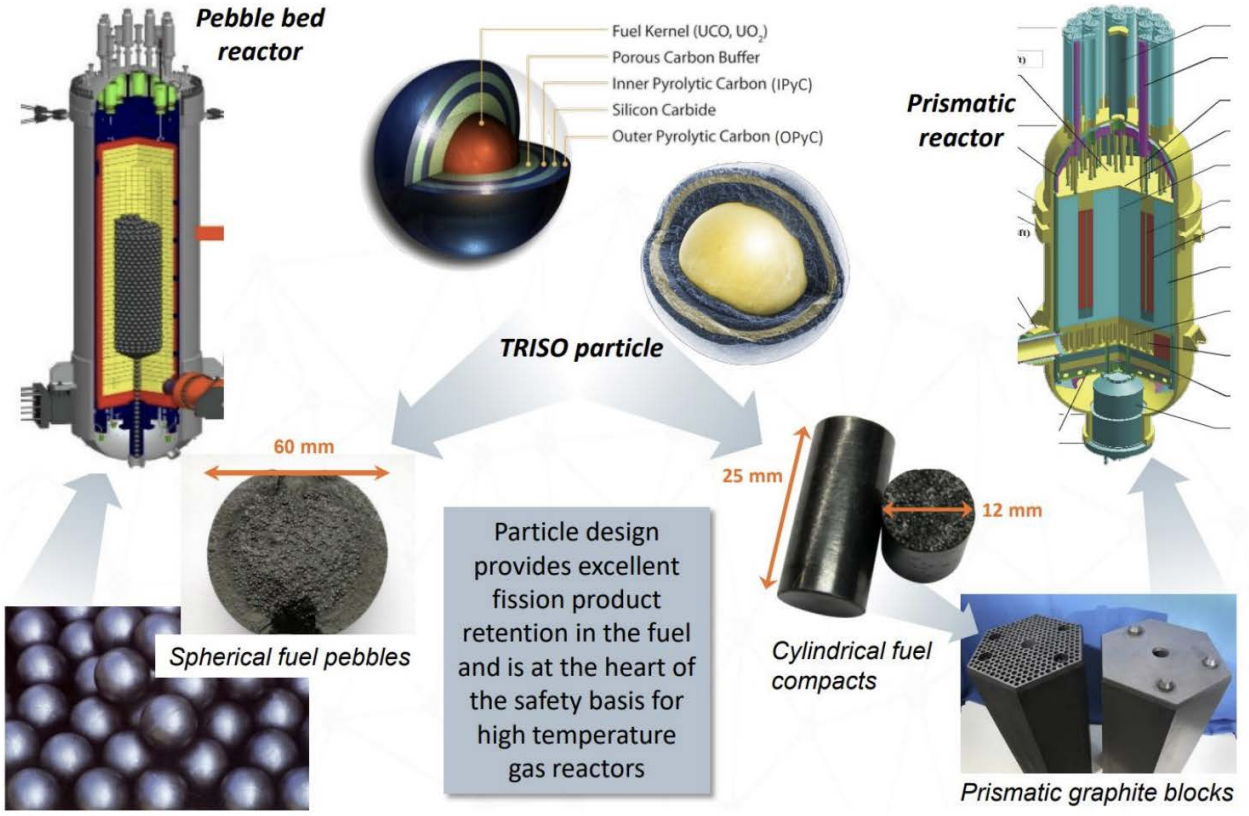
Gas-cooled reactors use gas (typically helium) as the coolant and graphite as a moderator and include high-temperature gas reactors (HTGRs) and gas-cooled fast reactors (GFRs). Helium serves as both the coolant and heat-transfer medium because it is inert and does not react with other materials or degrade reactor components.

HTGRs use TRI-structural ISOtropic (TRISO) fuel particles. These TRISO fuel particles, which are less than one millimeter in diameter, contain a uranium fuel "kernel" in their center and are surrounded by several layers of protective coatings (Figure 8). These layers include a porous carbon buffer, an inner pyrolytic carbon layer, a silicon carbide barrier, and an outer pyrolytic carbon layer. Together, these layers have been demonstrated to provide exceptional structural integrity and containment, allowing the TRISO particles to retain fission products and remain stable under simulated typical and accident conditions for a HTGR (high temperature and radiation).[55] This multi-layered design enhances the fuel's safety and durability compared to a conventional large light-water reactor fuel rod during both reactor operation and waste disposal.[56] Additional work is ongoing to evaluate TRISO fuel stability within a graphite pebble or block matrix under nominal and accident HTGR conditions and to establish an optimal disposal or recycling option.

Notably, two types of HTGRs use TRISO fuel: pebble bed reactors and prismatic block reactors (Figure 8). In pebble bed reactors, the TRISO fuel particles are dispersed within graphite fuel pebbles, each roughly the size of a tennis ball. These pebbles are circulated through the reactor core, and the reactor operates continuously by adding fresh fuel pebbles and removing spent ones as they pass through the core. In prismatic block reactors, the TRISO fuel particles are embedded in a carbon matrix, forming composite cylindrical units known as fuel compacts. These fuel compacts (sometimes called fuel sticks because of their shape) are then placed within hexagonal graphite blocks, known as prismatic block fuel elements. These graphite blocks have fuel holes to house the fuel sticks and coolant channels, which are drilled into the graphite to allow coolant flow. Examples of HTGR designs that use TRISO fuel pebbles and prismatic blocks include X-energy's Xe100 reactor and the BWXT Advanced Nuclear Reactor (BANR), respectively.

Figure 8. TRISO Fuel in Pebble Bed and Prismatic HTGRs

Source: Paul A. Demkowicz, TRISO Fuel: Design, Manufacturing, and Performance, INL/MIS-19-52869 rev. 0 (Idaho Fall, ID: Idaho National Laboratory, July 2019), 10, https://inldigitallibrary.inl.gov/content/uploads/50/2026/04/Sort_24838.pdf.



Despite having very different fuel designs, both pebble bed and prismatic block HTGRs are graphite-moderated, gas-cooled, thermal reactors that use many of the same materials. As a

result, both prismatic block and pebble bed HTGRs produce similar waste streams, with the only major difference being the final shape of the spent fuel form. In pebble bed reactors, the TRISO spent fuel consists of the spent fuel pebbles. In prismatic block reactors, the TRISO spent fuel consists of spent prismatic graphite blocks.

The graphite surrounding the TRISO fuel particles will become activated during reactor operation and represents a significant low-level waste stream. Periodically replacing graphite blocks before they reach higher activity levels can help keep waste within Class A, B, and C limits. However, that surrounding graphite will likely be treated as spent nuclear fuel because separating the fuel particles from the graphite is currently not a viable or economical practice. The National Academies of Sciences, Engineering, and Medicine (National Academies) found that HTGRs "will produce much larger volumes of spent fuel compared with equivalent energy production from light-water reactors."[57] Volume reduction technologies now under development could help address this consideration.[58]

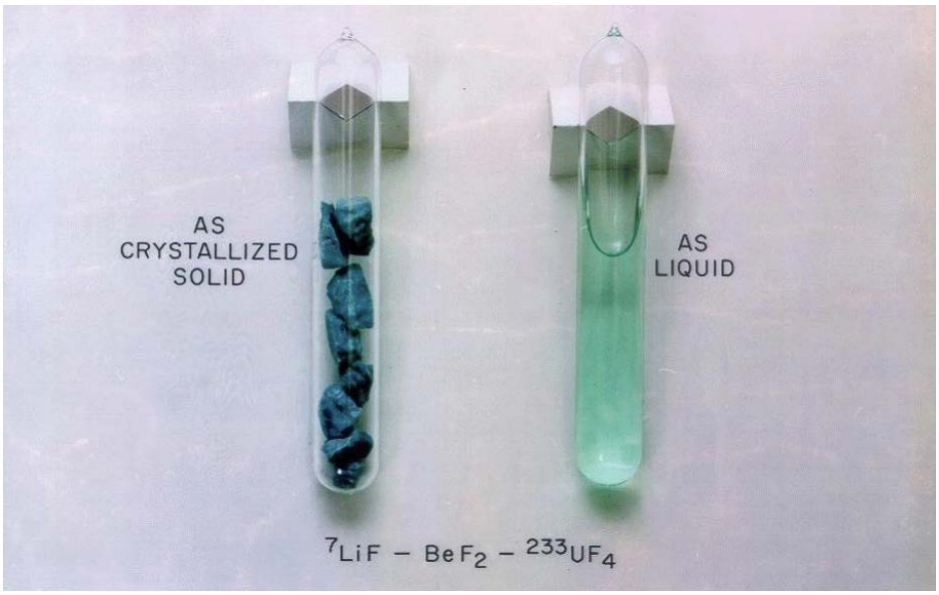
5.2.2.2 Molten Salt Reactors

MSRs are advanced reactors that use molten salt either as the primary coolant or as both the coolant and the medium that carries dissolved nuclear fuel. Broadly, MSRs fall into two categories: liquid-fueled and solid-fueled. In liquid-fueled MSRs, the fissile material is dissolved directly into the circulating salt, allowing the fuel to flow through the core. Solid-fueled MSRs, by contrast, use molten salt solely as a coolant while relying on a separate solid fuel form.

Both liquid- and solid-fueled MSRs can use either fluoride- or chloride-based salts. Several advanced designs use fluoride salts, particularly the lithium-beryllium fluoride mixture known as FLiBe. FLiBe is a solid at room temperature but melts well below MSR operating temperatures, allowing it to circulate as a liquid during reactor operation (Figure 9).

Figure 9. Uranium Bearing FLiBe as a Solid and Liquid

Source: Nick Touran, "Sodium and Salt Are Different in Nuclear," What Is Nuclear?, November 23, 2020, https://whatisnuclear.com/sodium-vs-salt.html.



An example of a solid-fueled MSR is the Kairos Power KP-FHR reactor design, which uses TRISO fuel pebbles, and an example of a liquid-fueled MSR is TerraPower's Molten Chloride Fast Reactor.

In liquid-fueled MSRs, the circulating fuel-salt mixture becomes uniformly radioactive because fission products, actinides, and other radionuclides are distributed throughout the entire salt volume. Unlike solid-fueled reactors, where spent nuclear fuel remains confined to discrete elements such as pebbles, blocks, or assemblies, liquid-fueled MSRs require managing the entire inventory of used fuel salt as spent nuclear fuel. This calls for tailored strategies to handle, condition, and ultimately dispose of a highly radioactive, chemically active liquid.

Solid-fueled MSRs simplify waste management relative to liquid-fueled MSR designs because the fuel remains contained within a solid form, such as TRISO pebbles, rather than being dispersed throughout the coolant. Spent nuclear fuel from solid-fueled MSRs closely resembles that of HTGR spent fuel because both use TRISO fuel. Some differences remain; for example, TRISO pebbles removed from a solid-fueled MSR will retain residual salt on their surfaces, which may need to be removed before interim storage. After this step, however, the storage and disposal considerations largely mirror those for HTGR spent fuel.[59]

5.2.2.3 Liquid Metal-Cooled Fast Reactors

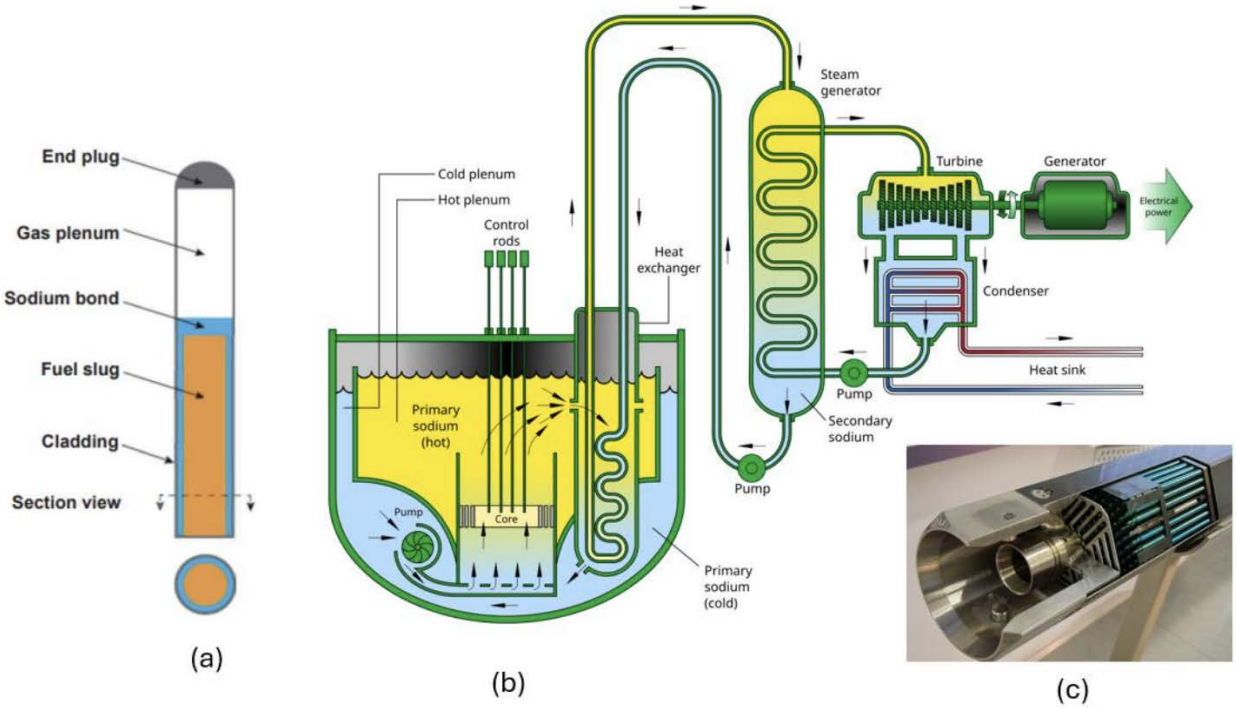
Liquid metal-cooled fast reactors use liquid sodium or lead as the coolant. Sodium-cooled fast reactors (SFRs) use liquid sodium as a coolant to transfer heat from the reactor core to power-generating systems. Unlike conventional light-water reactors, which rely on water as a coolant and moderator, SFRs use liquid sodium because of its excellent heat transfer properties and its ability to remain liquid at high temperatures without boiling. SFRs operate with a fast neutron spectrum and no core neutron moderator, enabling higher burnup. Examples of SFRs currently under development include TerraPower's Natrium reactor and ARC Clean Technology's ARC-100 reactor.

The fuel used in SFRs is a metallic fuel form consisting of uranium that is alloyed with various other metals and designed to withstand the high-temperature environments of fast reactors (Figure 10). These fuel forms include uranium-zirconium (U-Zr) and uranium-plutonium-zirconium (U-PuZr) metallic fuel. In the reactor core, this fuel is encased in metal cladding, and packaged into fuel assemblies, similar to a light-water reactor design. Unlike light-water reactor designs, which operate with a small helium-filled gap between the fuel and the cladding, the solid fuel and fuel cladding are bonded by liquid sodium to improve heat transfer while accommodating the differences in thermal expansion between the metallic fuel and cladding material.

Figure 10. Sodium-Cooled Fast Reactor Design and Fuel Configuration

This figure contains three images: (a) diagram of a sodium-cooled fast reactor (SFR) fuel rod; (b) schematic of an SFR; (c) image of an SFR fuel assembly.

Source: (a) Fast Reactor Working Group, Nuclear Metal Fuel: Characteristics, Design, Manufacturing, Testing, and Operating History, White Paper 18-01 (June 2018), fig. 1, https://www.nrc.gov/docs/ML1816/ML18165A249.pdf; (b) Idaho National Laboratory, "Sodium-Cooled Fast Reactor," technical illustration, n.d., Wikimedia Commons, accessed November 2, 2026, https://commons.wikimedia.org/wiki/File:Sfr.gif; (c) JETSEAL, Inc., "Fragment of a Fuel Rod Element of a Nuclear Reactor," photograph, n.d., accessed November 2, 2026, https://jetseal.com/nuclear/.



Waste streams include spent metallic fuel, activated sodium coolant requiring treatment, and activated structural components. Notably, sodium can bond with metallic fuel during operation. Sodium is often intentionally added to enhance heat transfer between the fuel and cladding, which results in a spent fuel containing sodium metal that is difficult to separate presenting disposal challenges. When fission gases within the fuel escape during irradiation, they produce an interconnected pore structure extending into the fuel slug from the surface. As a result, liquid sodium can enter the interconnected pores within the fuel.[60]

The National Academies noted that "sodium-bonded spent fuel is not suitable for direct disposal and would require treatment by methods not yet technically mature at the industrial scale."[61] However, TerraPower plans to use Type 1B fuel, that uses helium instead of sodium to ensure heat transfer between the fuel and cladding.[62] Additional details on Type 1B fuel are proprietary, and further testing is underway to establish its performance. However, this likely

means Type 1B spent fuel will not contain internal sodium and only the residual sodium metal coolant from the outer surface will need to be removed. If this works as designed, it will facilitate a simpler disposal pathway. Although TerraPower plans to use this novel fuel form in the future, its early-mover reactors will generate sodium-bonded spent metallic fuel.

5.2.2.4 Implications for Managing Advanced Non–Water-Cooled Reactor Waste Streams

Leading research suggests that waste streams from advanced non-water-cooled reactors may differ from those generated by conventional light-water reactors. These reactor waste streams may have different physical, chemical, and radiological characteristics. The NRC licensing process requires a waste management strategy before approval of an operating license.

While advanced reactor waste streams may differ from those produced by conventional light-water reactors, the overall approach to waste management will very likely resemble existing practices for conventional light-water reactor waste. A combination of wet storage and dry storage will be needed to safely store advanced reactor waste, like the approach used for today's inventory of light-water reactor spent nuclear fuel. Well established scientific and engineering principles of radiation protection and shielding will ensure the safe storage of advanced reactor fuel.

Furthermore, precedent exists for safely managing advanced reactor spent nuclear fuel both in the U.S. and worldwide. Advanced reactor technologies, including SFRs and HTGRs, operated in the U.S. throughout the late twentieth century for research purposes. Spent nuclear fuel from reactors such as the Experimental Breeder Reactor II (EBR-II) SFR and Peach Bottom HTGR is currently stored at Idaho National Laboratory, demonstrating that safe storage of advanced reactor fuel is feasible, and is expected to remain feasible for the next generation of advanced reactors.[63]

5.2.3 Research Findings on Small Modular Reactor Waste Generation Quantities

As advanced reactor designs mature their spent fuel streams will continue to be evaluated.[64] As these pre-development analyses are preliminary, and different technologies have different waste profiles, there are uncertainties about the types and volumes of spent fuel from advanced reactors relative to conventional light-water reactors.

For example, one 2022 study analyzed the waste streams from three SMR designs: a water-cooled SMR (NuScale iPWR), an MSR (Terrestrial Energy IMSR), and an SFR (Toshiba 4S). The study concluded that these SMR designs would increase the volume of nuclear waste requiring management and disposal, including spent nuclear fuel and low-level waste, by factors of 2 to 30 compared to conventional light-water reactors on an energy-equivalent basis.[65]

In contrast, a November 2022 study by Argonne National Laboratory and Idaho National Laboratory examined three near-term deployable SMR designs: NuScale's VOYGR (a pressurized water reactor design), TerraPower's Natrium (a sodium-cooled fast reactor), and X-energy's Xe-100 (an HTGR using TRISO fuel). This study concluded that, when considering appropriate waste management system optimization, "no major challenges to the management of SMR nuclear wastes compared to the commercial-scale large light-water reactor wastes" were identified.[66]

These divergent findings reflect different analytical approaches and waste assessment metrics, and the precise quantities of waste expected from SMRs remain uncertain because estimates evolve with ongoing design development and operational assumptions.

5.2.4 Microreactors

Microreactors are very small nuclear reactors with electric output typically below 50 MWe (some definitions use less than 20 MWe as the threshold), designed for factory fabrication. These systems target applications including remote communities that would otherwise rely on shipped diesel, resilient heat and electricity for military installations, and industrial heat supply. Most designs operate for extended periods (10–20 years) without refueling, with the entire reactor core transported to a central facility for refueling or decommissioning.

Key waste considerations for microreactors may include different fuel types, smaller overall waste quantities per unit but higher activity concentrations in some cases, potential for sealed reactor designs that minimize operational waste but concentrate decommissioning waste, and the need for waste management capabilities at potentially numerous distributed deployment locations.[67]

In absolute terms, a single microreactor generates a very small quantity of waste. Its core holds a modest amount of fuel, and it discharges fuel infrequently, sometimes only once in a decade or more. However, on a per-unit-energy basis, microreactors may face amplified neutron leakage challenges because their small cores have a high surface-area-to-volume ratio. Energy-normalized (i.e., the volume of waste generated per unit of energy produced) waste volumes for

microreactors are design-specific. Microreactors may also produce non-fuel waste streams, such as beryllium and graphite reflectors, along with steel structural components.

Microreactors introduce different logistical considerations as the reactor may run for a decade or more and then be removed intact. Rather than the large light-water reactor model of steady on-site refueling, microreactors represent infrequent movement of the radioactive unit to a central facility. The waste management system must contemplate collecting or returning cores from many dispersed locations, each with its own safety, logistical, security, and community considerations.

Microreactor waste management has precedents. Idaho National Laboratory now hosts the Demonstration of Microreactor Experiments (DOME) test bed, the first facility of its kind, built within the repurposed containment of the former EBR-II, and it can host fueled experiments up to 20 MW thermal.[68] The laboratory has also begun to study spent fuel removal and disposal of microreactor experiments as whole units between test campaigns,[69] which will inform real world waste handling. Combined with decades of precedent from compact research reactors and the Training, Research, Isotopes, General Atomics (TRIGA) fuel family, this growing body of experience suggests that microreactor spent fuel is amenable to the same well-established principles of shielding, containment, and radiation protection that govern the waste already managed today.

Microreactor spent fuel streams may vary by design because of differences in fuel types, coolants, materials, and refueling practices. These considerations will become clearer as designs mature and operating and decommissioning experience become available.

5.3 Findings and Conclusion

Some advanced nuclear energy technologies may generate different quantities or types of spent fuel: The maturity of the disposal pathway should be considered when evaluating advanced nuclear reactor technologies.

Conclusion:

- **Support research on advanced nuclear technology spent fuel.**

In support of implementing this conclusion, New York State should monitor and evaluate emerging technical and policy challenges associated with storing, transporting, and disposing of advanced reactor spent fuel. Specifically:

- As the NRC proceeds with licensing of SMRs and other advanced reactors, the State should track waste-related licensing conditions and technical evaluations to inform future policy decisions.
- As new fuel types enter the national landscape, the State should monitor how waste management activities unfold in other states and whether any characteristics of new waste forms create management issues that warrant further investigation, especially those that would affect New York State's efforts to deploy particular advanced reactor technologies.
- New York State should monitor emerging advanced reactor waste analyses to understand how projected volumes of waste generated by advanced reactors may change over time, and how they compare to waste volumes generated by conventional reactors.

6. New York State Nuclear Waste Inventory

This section outlines the State's spent nuclear fuel inventory from its currently operating sites as well as the spent nuclear fuel and high-level waste in safe storage at Indian Point and West Valley.

6.1 Operating Reactor Spent Fuel

New York State's three operating nuclear stations store significant quantities of spent nuclear fuel in pool and dry cask storage (Table 1). Nine Mile Point hosts spent nuclear fuel from both Unit 1 (operational since 1969) and Unit 2 (operational since 1988), with a combined site inventory estimated at over 1,690 MTU. Both units use ISFSIs for dry cask storage.[70]

J.A. FitzPatrick (operational since 1975) hosts approximately 874 MTU of spent nuclear fuel in pool and ISFSI storage. Ginna, the state's only operating PWR and one of the oldest operating U.S. reactors (in commercial operation since 1970), stores approximately 616 MTU of spent nuclear fuel.

Table 1. New York State Operating Nuclear Reactors and Estimated Spent Nuclear Fuel Generation

Source: INL/RPT-25-88353, Rev. 002 (December 2025).

Facility	Reactor Type	Capacity (MWe)	Operating Since	License Expires	Est. Annual SNF (MTU)	Total SNF in Storage (MTHM)
Nine Mile Point 1	BWR-2	622	1969	2029	~18-20	~1,690
Nine Mile Point 2	BWR-5	1,272	1988	2046	~28-32	
J.A. FitzPatrick	BWR-4	854	1975	2034	~22-25	~874
Ginna	PWR	580	1970	2029	~15-18	~616

According to the DOE, New York State ranks fourth nationally for stored spent nuclear fuel volume, with approximately 4,957 MT of uranium accumulated from decades of commercial reactor operation.[71] The state's operating reactors collectively add approximately 80-95 MTU to this inventory annually.

6.2 Indian Point Decommissioning

The Indian Point site, now under active decommissioning by Holtec International, stores approximately 1,777 MTU of spent nuclear fuel.

The last operating reactor at Indian Point permanently ceased all power operations in April 2021. The facility operated three reactors for nearly 60 years (Table 2). By the end of 2024, all spent nuclear fuel had been transferred from spent fuel pools to 127 dry casks,[72] which each weigh approximately 180 tons when loaded and are designed to withstand earthquakes, floods, tornadoes, and other natural or human hazards at the on-site ISFSI (Table 2).[73]

Table 2. Indian Point Spent Fuel Inventory

Unit	Operational Period	Reactor Type	Dry Casks at ISFSI
Unit 1	1962-1974	PWR	
Unit 2	1974-2020	PWR (4-loop)	
Unit 3	1976-2021	PWR (4-loop)	
Total	—	—	**127**

The Indian Point DOB represents New York State's model for state-level engagement with nuclear decommissioning. The 25-member board, led by DPS, includes representatives from multiple NYS agencies and authorities, including NYSERDA, DEC, DOL, DOH, the Division of Homeland Security and Emergency Services (DHSES), and the Department of State (DOS); local and State representatives; environmental stakeholders; labor representatives; an environmental representative; and an independent technical expert.[74] The DOB's primary functions are to coordinate NYS entity oversight and facilitate public engagement during decommissioning.[75]

6.3 West Valley Demonstration Project

The West Valley site holds a unique place in nuclear history as the only privately operated spent nuclear fuel reprocessing facility to operate in the United States. From 1966 to 1972, Nuclear Fuel Services processed 640 MT of spent nuclear fuel, generating over 600,000 gallons of liquid high-level waste. The West Valley Demonstration Project successfully vitrified this liquid waste into 278 stainless steel canisters of borosilicate glass between 1996 and 2002.

The vitrified waste remains stored on-site in vertical storage casks. DOE, currently in legal possession of approximately 200 acres of the Western New York Nuclear Service Center, including the former reprocessing facility that NYSERDA owns pursuant to a 1980 federal law, continues decommissioning activities, with Phase 1 anticipated for completion by 2035–2040.

6.4 Greater-Than-Class-C Waste in New York State

GTCC waste at New York State's operating and decommissioned nuclear facilities primarily consists of activated metal components from reactor internals, including core shrouds, support

plates, control rod guide tubes, and other materials that have been exposed to intense neutron flux during reactor operation. Additional GTCC materials include certain process wastes such as ion exchange resins and filters that have accumulated high concentrations of long-lived radionuclides.

As discussed in Section 2.2.4.3, DOE estimates the total projected U.S. inventory of GTCC waste through the end of reactor operations is approximately 12,000 m^3 (420,000 ft^3), which is roughly the same volume as five Olympic-size swimming pools. Given its reactor fleet size and operational history, New York State's share is estimated at several hundred cubic meters.

While New York State's share of the national GTCC waste inventory is several hundred cubic meters, West Valley currently stores legacy GTCC waste on site. This waste is estimated at approximately 4,300 m^3 and is classified as projected inventory because it would only become generated waste if it were excavated and retrieved from existing disposal areas. If the GTCC waste at West Valley is not retrieved or excavated, no additional GTCC waste volumes would be generated from the site. [76]

Decommissioning activities at Indian Point will continue to generate significant additional GTCC waste, estimated at approximately 10 casks worth of material requiring storage at the ISFSI pending federal disposal solutions. At the end of 2024, an estimated 127 spent nuclear fuel casks and 2 GTCC casks were in inventory for decommissioning of all three units. [77] The design for the ISFSI is intended to hold both the additional GTCC waste that is expected to be generated through remaining decommissioning steps and the existing spent nuclear fuel and GTCC casks filled to date.

6.5 Summary of New York State Nuclear Waste Inventory

Table 3 summarizes New York State's spent nuclear fuel and high-level waste in on-site storage from operating, decommissioning, and cleanup sites. Since ISFSI facilities can be expanded, and their footprint is small compared to site boundaries, it is expected that all spent nuclear fuel generated through the extended lifetime of the four operating reactors can be accommodated. It will be important for New York to follow the NRC approval process for ISFSI expansions.

Table 3. Summary of New York State Spent Nuclear Fuel and High-Level Waste in On-Site Storage

Spent nuclear fuel quantities are approximate estimates based on operational history.

Facility	Total SNF in Storage (MTU)	HLW Canisters	Status
Nine Mile Point Units 1 & 2	~1,690	—	Operating
J.A. FitzPatrick	~874	—	Operating
Ginna	~616	—	Operating
Indian Point	~1,777	—	Decommissioning
West Valley	—	278	Cleanup and storage
TOTAL	**~4,957**	**278**	—

6.6 Findings

New York State Waste Inventory: New York State currently hosts nuclear waste inventories across operating, decommissioning, and cleanup sites. Spent nuclear fuel remains stored at the State's operating reactor sites and at Indian Point, while vitrified high-level waste from historical reprocessing remains stored at West Valley. Operating reactors will continue adding to the State's spent nuclear fuel inventory as long as they remain in service.

Planning for Future Waste: The composition and location of New York State's waste inventory will also change as facilities move through their operating and decommissioning lifecycles. Indian Point illustrates the transition from an operating reactor site to an ISFSI-only site. For New York State, maintaining an accurate understanding of existing and projected waste inventories is important to anticipate future safe storage, transportation, disposal, regulatory, and community needs.

Hands-on Experience with Non-routine Spent Fuel Issues. Indian Point's timely transition to onsite dry cask storage (about 127 casks) and the 25-member Indian Point Decommissioning Oversight Board give the State a working model for coordinating multi-agency oversight that can be applied to advanced reactor sites. West Valley has successfully vitrified more than 600,000 gallons of liquid high-level waste into 278 canisters. These examples reinforce confidence in New York State's ability to responsibly manage future nuclear waste challenges.

7. On-Site and Interim Waste Storage

Nuclear waste may require storage for months to decades before treatment, transportation, or disposal. In New York, spent nuclear fuel is stored at reactor sites in spent fuel pools and dry cask storage systems, while generators may store low-level waste temporarily pending disposal or decay. This section describes existing storage practices, considerations for advanced reactor waste, potential federal interim storage pathways, and local-level considerations for on-site storage for.

7.1 Spent Nuclear Fuel Storage

Spent nuclear fuel is initially stored in water-filled pools at reactor sites. After sufficient radiological decay while cooling in water, spent nuclear fuel may be transferred to dry cask storage systems (Figure 11). These storage systems and management considerations are described in the sections below.

Figure 11. Wet and Dry Storage of Spent Nuclear Fuel

Source: U.S. Nuclear Regulatory Commission (NRC), "Dry Cask Storage of Spent Nuclear Fuel," photograph, August 25, 2017, Wikimedia Commons, https://commons.wikimedia.org/wiki/File:Dry_Cask_Storage_of_Spent_Nuclear_Fuel_%2836801710635%29.jpg; Curt-Robert Lindqvist, "Clab Spent Nuclear Fuel Wet Storage Ponds," photograph, n.d., courtesy of Swedish Nuclear Fuel and Waste Management Company (SKB), reproduced in Stimson Center, "Geological Disposal and Spent Nuclear Fuel" (2021), https://www.stimson.org/2021/geological-disposal-and-spent-nuclear-fuel/.



7.1.1 Spent Fuel Pool Storage

Initially, spent nuclear fuel is stored in spent fuel pools located at reactor sites. These water-filled pools cool the hot fuel and shield it from radiation while allowing visual inspection and retrieval

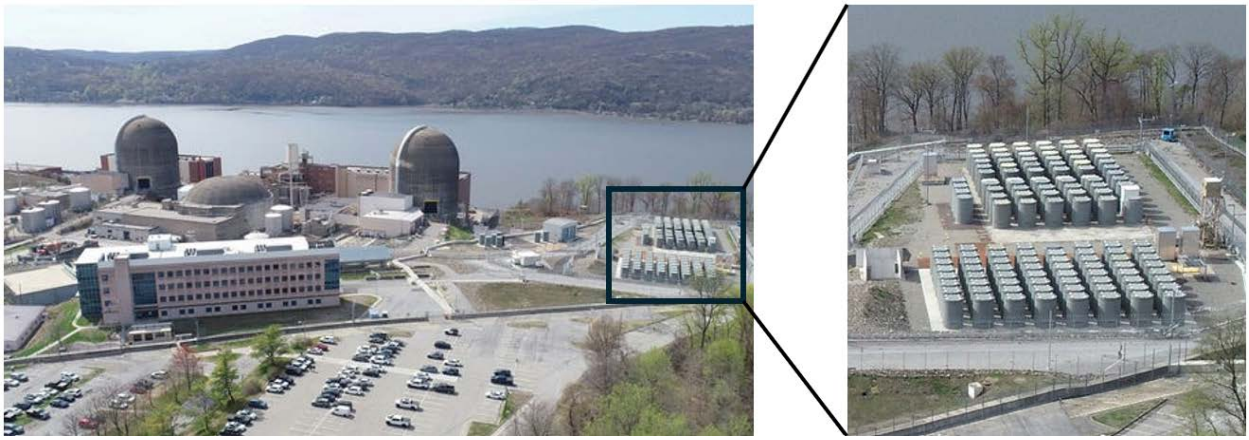
once radiological decay reduces heat generation enough. NRC regulations require spent nuclear fuel to cool in pools for at least 1 year, though typical cooling periods extend to five years or longer before transfer to dry storage. Spent nuclear fuel pools at NYS operating reactors continue to receive discharged fuel assemblies. In contrast, pools at the decommissioned Indian Point facility were emptied, and all fuel was transferred to dry cask storage in 2024.

7.1.2 Spent Fuel Dry Cask Storage Systems in Independent Spent Fuel Storage Installations

Once sufficiently cooled, spent fuel may be transferred to dry cask storage systems for longer-term storage at an ISFSI (Figure 12).

Figure 12. Indian Point Spent Fuel in Dry Cask Storage Systems in Independent Spent Fuel Storage Installations

Source: Peter Carr and John Meore, "What Does Indian Point Energy Center Look Like Now?," The Journal News, June 23, 2025, https://www.lohud.com/picture-gallery/news/2025/06/23/what-does-indian-point-energy-center-look-like-now/83230853007/.



7.1.2.1 Storage Technology and Safety

Dry cask storage systems are designed to maintain subcriticality (this occurs when the mass of fissionable material in one location is too low to sustain a chain reaction so it can be stored safely), provide radiation shielding, remove decay heat through passive cooling, and confine radioactive materials under normal, off-normal, and accident conditions.[78]

Modern dry cask storage systems provide multiple layers of protection against radioactive release. Key safety features include:

- **Containment:** Spent fuel assemblies are sealed in multi-purpose canisters made of thick stainless steel, welded shut, and backfilled with inert helium gas. The canister provides the primary containment barrier.
- **Shielding:** Canisters are placed inside concrete and steel overpacks that provide radiation shielding, reducing dose rates at the facility boundary to within regulatory limits.
- **Structural Protection:** Storage systems are designed and analyzed to withstand earthquakes, tornadoes, floods, aircraft impacts, and other design-basis events. For example, Indian Point casks are placed on reinforced concrete pads designed for seismic stability.
- **Passive Cooling:** Dry storage relies on natural air convection for heat removal, eliminating dependence on active systems, pumps, or external power supplies. This passive design enhances safety during extended storage periods.

7.1.2.2 ISFSI Licensing and Renewals

ISFSIs are licensed under 10 CFR Part 72 for interim storage of spent nuclear fuel in NRC-certified dry cask storage systems at reactor sites. The NRC authorizes dry cask storage through two licensing mechanisms: general licenses under 10 CFR 72.210[79] and specific licenses under 10 CFR 72.40. General licensees may store spent fuel using NRC-certified cask designs listed in 10 CFR 72.214[80] without obtaining a site-specific license, provided they meet applicable conditions and notify the NRC before first storage.

General licensees must evaluate the ISFSI site against the cask design bases, implement required radiation protection and quality assurance programs, conduct cask-specific operations consistent with Certificate of Compliance conditions, and maintain records demonstrating compliance. [81] This framework has enabled efficient deployment of dry storage capabilities at reactor sites nationwide without requiring individual site-specific license proceedings for each ISFSI.

ISFSI licenses are typically issued for 40-year terms, with renewal provisions. As on-site storage periods extend pending a federal disposal solution, license renewals and aging management become increasingly important. NRC regulations require licensees to demonstrate adequate aging management programs to ensure continued safe storage beyond initial license terms. Key considerations include chloride-induced stress corrosion cracking of stainless-steel canisters

(particularly at coastal or humid locations), concrete degradation, and radiation effects on storage system materials.

7.1.2.3 High Burnup Fuel Considerations

Modern reactor fuel achieves higher burnup levels than fuel discharged in earlier decades, extracting more energy per unit of uranium but also producing different storage and handling characteristics. This is relevant to both existing light-water reactors and to many advanced reactor designs expected to operate fuel to higher burnup levels or for longer irradiation periods. High burnup fuel generates more heat, contains higher concentrations of fission products, and may exhibit different cladding properties.

NRC and DOE are researching high-burnup fuel behavior during extended storage and subsequent transportation. NYS facilities storing high-burnup fuel must ensure their storage systems are licensed for such fuel and can meet future transportation requirements.

7.1.2.4 New York State Independent Spent Fuel Storage Installations

New York State hosts ISFSIs at multiple nuclear facility locations. Indian Point maintains an ISFSI under general license authority, which now stores all spent fuel from the three reactor units following completion of the fuel transfer campaign in 2024. All fuel is stored in robust dry storage casks on a seismically engineered concrete pad. Nine Mile Point and J.A. FitzPatrick, located on adjacent sites in Oswego County, each maintains an ISFSI for its respective spent fuel inventories. Ginna in Ontario, Wayne County, also operates an ISFSI.

Most New York ISFSIs operate under general licenses using approved cask systems such as Holtec's HI-STORM systems and Orano’s NUHOMS horizontal storage modules.

7.1.2.5 Aging Management Considerations for On-Site Storage

Until a permanent federal repository or consolidated interim storage facility is available, spent nuclear fuel and GTCC waste will continue to be stored safely at New York sites. While NRC regulations and generic environmental reviews support continued safe storage for extended periods, this situation presents several state-level considerations:

- **Site Reuse:** After partial site release, only a small portion of sites like Indian Point will need to remain within the ISFSI protected area The remainder of the property could be made available for redevelopment supporting local tax bases and economic development opportunities.[82]

- **Long-Term Security Requirements:** ISFSIs require continuous security presence, even at shutdown reactor sites. These ongoing costs are generally supported by decommissioning trust funds.
- **Monitoring and Inspection Continuity:** State agencies and authorities must maintain capacity for long-term environmental monitoring, emergency planning coordination, and regulatory engagement for as long as nuclear materials remain within their jurisdictions.

As dry cask storage durations extend beyond initial design expectations pending availability of a permanent disposal pathway, aging management has become increasingly important. The NRC requires aging management programs for license renewals beyond initial terms. These programs address potential degradation mechanisms including chloride-induced stress corrosion, cracking of stainless-steel canisters in marine or industrial environments, concrete degradation, and radiation embrittlement of materials.

7.2 Low-Level Waste Storage

Some but not all NYS generators store low-level waste on-site on a short-term basis, either pending transfer to disposal facilities or for decay before disposal as non-radioactive waste. Nuclear power plant operators maintain on-site storage capacity for operational flexibility and to accumulate waste volumes economically for shipment. Medical, academic, and industrial generators typically use decay-in-storage for short-lived radionuclides while storing longer-lived materials pending disposal.

As of December 2025, NYS generators reported 21.7 m^3 (766 ft^3) of low-level waste in storage pending disposal.[83] Extended storage periods have occurred historically when disposal facility access was interrupted, such as during the 1994–1995 Barnwell, SC disposal facility closure to non-compact states and the period between the 2008 Barnwell closure and the 2012 opening of the Andrews, TX disposal facility.

7.2.1 On-Site Storage at Generator Facilities

Low-level waste generators, including nuclear power plants, may store waste on-site under their NRC or Agreement State licenses. Storage typically occurs while waste accumulates to economical shipping quantities, during processing and characterization, while awaiting disposal facility access, or during decay-in-storage for short-lived radionuclides.

The NRC's policy position treats long-term on-site storage of low-level waste as a last-resort measure. The NRC prefers that low-level waste be permanently disposed of as soon as practical

after generation. Historically, periods of limited disposal facility access have required some generators, particularly those outside compact areas with access to Class B and C waste disposal, to store such waste for extended periods. Current disposal access is described in Section 9.3.

7.2.2 Decay-in-Storage

Decay-in-storage (DIS) is an approved waste management practice for low-level waste containing only relatively short-lived radionuclides.[84] Under 10 CFR 35.92 (for medical licensees) and through license conditions for other generators, radioactive material may be held in storage until it has decayed to levels that permit disposal as ordinary waste.

For DIS to be applied, the material must have a radiological decay half-life of less than 120 days (for medical use licensees) or meet other license-specific criteria, be stored for a minimum of 10 half-lives, be surveyed to confirm radiation levels are indistinguishable from background, and be monitored to remove or obscure all radiation labels before release.

7.2.3 Storage Container Requirements

Low-level waste held in storage must be packaged to prevent release of radioactive materials under normal storage conditions. Common storage containers include steel drums (55-gallon, 30-gallon, or other sizes), steel boxes, HICs for higher-activity waste, and specialized containers for unique waste forms such as resins and sludges.[85]

HICs are engineered to maintain structural stability for at least 300 years and are required for Class B and C waste to meet stability requirements. HICs undergo rigorous testing and must be approved by disposal facility operators and NRC.

7.2.4 Class B and C Waste Disposal Access

Following the 2008 closure of the Barnwell, SC, disposal facility to generators outside the Atlantic Compact states (South Carolina, Connecticut, and New Jersey), most nuclear power plants in the United States had limited access to disposal capacity for Class B and C waste. Without access to disposal, generators must store the waste on-site indefinitely. In 2012, the Waste Control Specialists facility in Andrews, Texas opened and is allowed to accept Class B and C waste from non-compact generators with shipment-specific approval by the Texas Compact Commission (see Section 9.3.2).

The NRC has addressed the Class B and C disposal challenge in part by revising guidance on waste blending. Current NRC guidance permits blending Class B or C waste with Class A waste

to achieve an overall Class A classification, provided the blending involves mixing with other radioactive waste (not clean materials). This approach allows some higher-activity waste to be disposed of at facilities accepting only Class A waste.

7.2.5 Greater-Than-Class-C Waste Storage

GTCC waste may be stored under 10 CFR Part 72 within ISFSIs, following amendments to that regulation in 2001.[86] This allows reactor-related GTCC waste, including activated metal components and certain process waste, to be co-located with spent nuclear fuel storage until a permanent disposal pathway is developed. For example, Indian Point's ISFSI is expected to host GTCC waste from decommissioning activities, estimated at approximately 10 additional casks.

The NRC retains federal jurisdiction over reactor-related GTCC waste throughout interim storage. ISFSI licensing for GTCC storage requires amending existing licenses or incorporating it into new licenses. The ISFSI must be sized and licensed to accommodate both spent fuel and GTCC waste quantities.

7.2.6 Waste Minimization and Volume Reduction

Volume reduction and waste minimization practices have significantly decreased the amount of low-level waste requiring disposal. Nuclear power plant operators employ compaction, incineration, and improved operational practices to minimize waste generation. Medical and research facilities increasingly utilize short-lived radionuclides amenable to DIS.

The high cost of low-level waste disposal is driven largely by transportation expenses, disposal fees, and surcharges, and creates strong economic incentives for waste minimization. Generators have responded by implementing source reduction programs, improving segregation practices, and using waste processing services that reduce volumes through compaction, super-compaction, and incineration with proper controls.

7.2.7 Broker and Processor Services

Commercial brokers and processors provide valuable services to NYS generators, particularly smaller generators that lack the expertise or infrastructure for direct disposal arrangements. These entities consolidate waste shipments, provide treatment and volume reduction services, and manage transportation and disposal logistics.

Under 6 NYCRR Part 381, brokers and collectors must comply with manifest requirements and provide copies of manifests to DEC within 15 business days of waste collection.[87] This regulatory oversight ensures traceability throughout the waste management chain.

7.3 On-Site Storage Considerations for Advanced Reactor Waste

On-site storage requirements for advanced reactor spent fuel may vary based on reactor design and fuel form. For ALWRs, existing storage methods are expected to remain broadly applicable because their spent fuel is similar to that generated by conventional light-water reactors. Existing wet storage and dry cask storage methods could therefore be adapted for ALWRs.

Non-water-cooled advanced reactors are expected to rely on the same fundamental storage approach used for conventional spent nuclear fuel where radioactive material must be contained, shielded, cooled as necessary, and stored in engineered systems such as canisters, casks, or other robust containment structures. Specific storage systems may differ by fuel type.

Differences in spent fuel volume, fuel type, geometry, heat generation, chemical characteristics, and plans for refueling or module replacement could affect the number and type of on-site storage systems required and the land area needed. Physical security requirements and costs will also need to be addressed. These requirements will be defined for each design and should be evaluated on a technology-specific basis as designs mature and licensing progresses.

7.4 Federal Interim Storage and Permanent Disposal Considerations

This section describes considerations for long-term on-site storage of spent nuclear fuel and federal and private efforts around consolidated interim storage facilities (CISFs).

7.4.1 Considerations for Long-term On-site Storage

Current NRC policy, as affirmed in the 2014 Continued Storage Rule,[88] allows spent nuclear fuel to remain in on-site storage indefinitely, with the NRC finding reasonable assurance that safe storage can be accomplished without significant environmental impacts for at least 160 years and potentially longer. Even so, moving spent fuel to consolidated storage would offer several benefits: reactor sites, particularly those undergoing decommissioning, could fully release site land for other uses; consolidation would reduce the ongoing security and regulatory compliance costs of maintaining storage at multiple distributed locations; and removing spent fuel would

allow decommissioning and license termination to be completed. Moving spent fuel off reactor sites to a durable, centralized solution remains a shared priority for host communities, local policymakers, and the State.

7.4.2 Consolidated Interim Storage Facility Concept

CISFs, which could be either federally or privately owned, offer an alternative storage approach, centralizing spent nuclear fuel from multiple reactor sites at purpose-built storage locations pending repository availability. CISFs provide a practical bridge to permanent disposal, allowing progress on waste removal even as the long-term solution advances on a separate track. Notably, CISFs could be pursued in parallel with, and independent of, repository siting. The practical details of how the federal and state governments would work together through this process are still being developed.

By moving spent nuclear fuel off individual reactor sites, CISFs can accelerate decommissioning at shutdown plants, reduce the number of locations that require long-term security and regulatory oversight, and capture economies of scale in storage operations. Just as importantly, CISFs establish the transportation, handling, and institutional capabilities needed for eventual repository operations. In this way, CISFs not only provide near-term relief for host communities but also function as a structured, phased glidepath to permanent disposal, demonstrating visible federal progress. At the same time, the repository moves forward on its own timeline.

7.4.2.1 Past and Present Federal Government Storage Siting Initiatives

Until 2025, DOE pursued a consent-based siting process for federal CISFs in accordance with the recommendations from the Blue-Ribbon Commission on America's Nuclear Future, which recommended that the federal government develop new waste management infrastructure using processes based on community consent rather than federal mandates.[89] As part of these efforts, DOE issued a Request for Information (RFI) seeking public input on a consent-based approach,[90] established a Consent-Based Siting Consortia, developed a consent-based siting roadmap, awarded $26 million to 12 geographically and institutionally diverse consortia to assist with consent-based siting research and community engagement, and engaged in other activities to pursue a formalized federal government-led consent-based siting process.[91]

In January 2026, DOE issued an RFI that sought comments from states interested in hosting a proposed Nuclear Lifecycle Innovation Campus, a new concept intended to give states a structured, state driven pathway to host advanced nuclear fuel cycle facilities, including potential

storage and disposal sites.[92] The RFI sought input on how a Nuclear Lifecycle Innovation Campus could integrate spent nuclear fuel management activities, including reprocessing or recycling, high-level waste treatment, interim storage, and pathways for permanent disposal within a state-led, full-cycle nuclear ecosystem. In effect, the RFI invited states to self-identify their interest in hosting interim storage and permanent disposal facilities.

DOE is still determining whether and how to implement the Innovation Campuses concept. In July 2026, DOE announced Utah, Tennessee, Oklahoma, Louisiana, and Idaho signed Memoranda of Understanding with DOE to continue exploring the opportunity to become host states.[93] Even at this early stage, the Innovation Campus concept signals a meaningful shift in federal posture in which future waste management infrastructure may emerge first in states that actively seek the economic, research, and workforce benefits associated with an innovation-oriented campus.

New York State has a strong interest in any national effort that could enable the eventual removal of spent fuel from Indian Point, the Oswego area reactor complex (Nine Mile Point and J.A. FitzPatrick), and Ginna. The Innovation Campus framework introduces new potential pathways for used fuel recycling, waste treatment, interim storage, and long-term disposal. Successful implementation of this approach could enable the removal of spent fuel from New York sites and the release of land for other uses. Advancing these capabilities remains central to New York State's long-term waste management strategy.

7.4.2.2 Private Consolidated Interim Storage Facilities

In addition to the federal efforts described above, several efforts toward privately owned CISFs have developed in recent years, described below. These developments show private-sector interest in providing away-from-reactor storage and underscore the importance of state and community buy-in for these kinds of facilities. Together with the federal efforts described above, they represent potential pathways for moving spent fuel away from New York reactor sites, consistent with this study's conclusion supporting continued engagement on consolidated long-term storage.

Nuclear Regulatory Commission licensing: The NRC issued specific licenses for two private CISFs: Interim Storage Partners' Waste Control Specialists (WCS) CISF in Andrews County, TX issued in 2021,[94] and Holtec International's HI-STORE CISF in Lea County, NM, issued in 2023.[95] Both facilities would provide commercial away-from-reactor storage for spent nuclear fuel from multiple utilities. These licenses were issued under the NRC's authority under the AEA to license the possession and storage of special nuclear material.

- **Project status:** Both Texas and New Mexico have enacted legislation opposing the construction of CISFs within their borders. New Mexico passed legislation in 2023 prohibiting state permits for spent nuclear fuel storage facilities without explicit state consent. Holtec announced in October 2025 that it was canceling its agreement to develop the HI-STORE CISF in New Mexico, citing state opposition. The status of Interim Storage Partners' Texas facility continues to evolve.

7.5 Local-Level Considerations for On-site Storage

7.5.1 Land Use Authority and Zoning

While federal preemption limits local authority over nuclear safety matters, municipalities retain authority over land-use decisions, zoning, and certain aspects of facility siting (see the Master Plan Regulatory Issues and Safety Study for further details). Legal precedents from other states illustrate the boundaries of local authority. In Massachusetts, residents challenged zoning approvals for the Pilgrim Nuclear Power Station's ISFSI, arguing that construction of a new dry storage facility required a separate special permit and public hearing. While that decision ultimately found the ISFSI to be an accessory use under existing permits, the case highlighted the importance of clear local zoning guidance for nuclear waste storage facilities.[96]

7.5.2 Host Community Considerations for Waste Storage

Host communities have an important stake in how on-site spent fuel storage is planned and managed. The expected duration of on-site spent fuel storage for currently operating reactors, new advanced reactors, and decommissioning sites can influence long-term land-use decisions, municipal planning, and local service needs in host communities, and clear information and early planning can help communities account for storage in their long-term plans.

7.5.3 Public Engagement and Transparency

Local communities consistently emphasize the importance of meaningful public engagement and access to information about on-site spent fuel storage management. The Maine Yankee Community Advisory Panel on Spent Nuclear Fuel Storage and Removal (CAP), which facilitates communication, public engagement, and education on interim storage at the decommissioned Maine Yankee plant, is often cited as a successful model. CAP attributes its effectiveness to trust-building relationships, inclusive engagement with both proponents and opponents, involvement of non-nuclear experts and community leaders, and written agreements defining success criteria and deliverables.

In New York State, the Indian Point DOB provides a forum for public engagement, including regular public meetings, opportunities for public comment, and access to technical information. The DOB's independent technical expert provides publicly available research and analysis on decommissioning topics.

7.6 Findings

Safe interim storage: Dry-cask storage has been safely used for decades and provides a proven, secure interim storage solution for spent nuclear fuel while permanent federal solutions are developed.

Spent nuclear fuel Storage: Until a federal repository or CISF is available, spent nuclear fuel will continue to be stored at NYS reactor sites using established wet and dry storage systems that provide proven methods for safely managing spent nuclear fuel.

Low-Level Waste Storage: Low-level waste is stored and managed safely and routinely. Continued cooperation with low-level waste disposal sites helps to preserve access to existing Class A, B, and C disposal capacity. Clear, current public information on how low-level waste is classified, stored, and transported will help to inform communities weighing advanced reactor projects**.**

ISFSI Aging Management and Preparedness: For spent fuel management at New York State's ISFSIs, the State should ensure appropriate oversight of aging management programs.

8. Waste Transportation

This section discusses the federal and state regulatory frameworks for transporting high-level waste and low-level waste as well as considerations for transporting waste generated by advanced reactors.

8.1 Regulatory Framework

The transportation of spent nuclear fuel and high-level waste is subject to extensive federal regulation by both NRC and DOT. The NRC certifies transportation package designs under 10 CFR Part 71, establishing requirements for package performance under normal transport conditions and hypothetical accident conditions including drops, fires, and water immersion. DOT regulations under 49 CFR Parts 171-180 govern operational aspects, including shipping papers, packaging marking and labeling, vehicle placarding, routing requirements, driver training, and emergency response procedures.

Low-level waste transportation is similarly jointly federally regulated by NRC under 10 CFR Part 71 and DOT under 49 CFR Parts 171-180, in addition to NYS regulations under 6 NYCRR Part 381. Low-level waste transportation must comply with DOT and NRC regulations, and New York State's Part 381 regulations for low-level waste transportation incorporate federal requirements by reference, ensuring that state transportation standards remain compatible with evolving federal rules.

8.2 Transportation of Advanced Reactor Waste

Advanced reactor waste will generally be transported under the same NRC and DOT regulatory framework that applies to existing nuclear materials, but novel fuel forms may affect the packages, handling equipment, transportation modes, and infrastructure needed for shipment. For advanced light-water reactors, existing transportation approaches are likely to remain broadly applicable, although differences in fuel enrichment, burnup, and assembly geometry may require new or amended package certifications.[97]

For non-water-cooled reactors, the main consideration is adapting transportation systems to fuel forms that differ from conventional light-water reactor assemblies. TRISO fuel and metallic fuel may require packages designed around different dimensions, weights, thermal characteristics, and loading configurations. MSR waste presents a more substantial departure from light-water reactor waste because the radioactive fuel and salt mixture would generally

need to be in a stable form and suitable transportation package before shipment, which may require on-site treatment or separation.[98]

Microreactors could introduce a different transportation model altogether. Some microreactors are designed for transporting a sealed fueled core or reactor module rather than removing and shipping individual fuel assemblies. This could shift transportation from periodic shipments of spent fuel to less frequent movement of much larger integrated components, including the entire sealed microreactor, and may require specialized packages, vehicles, routes, and handling infrastructure.

8.3 Findings and Conclusion

Transportation of Nuclear Waste: Established federal and State requirements govern nuclear waste transportation, including packaging, routing, security, and emergency response. Future federal storage or disposal pathways would require transportation of spent nuclear fuel and high-level waste from NYS generators, including potentially West Valley. New York State therefore has a direct interest in transportation readiness and coordination with federal agencies, neighboring states, and affected communities.

Conclusion:

- **Explore a partnership with the DOE to demonstrate safe transportation of New York State commercial spent nuclear fuel or West Valley high-level waste to complement federal transportation demonstrations and reduce State waste volumes.**

The demonstration would involve either spent nuclear fuel from a commercial or decommissioning nuclear power plant or vitrified high-level waste from the West Valley site. This demonstration would directly benefit New York by reducing the high-level waste inventory at West Valley or the spent nuclear fuel inventories at legacy or commercial nuclear power sites.

A transportation demonstration would complement and validate DOE's nuclear waste transportation innovations, such as the Atlas railcar, a 12-axle railcar specially developed by DOE to transport spent nuclear fuel and high-level waste.

The demonstration would also serve as an exercise between federal and NYS entities, strengthen emergency preparedness relationships and collaboration along transportation corridors, and provide New York State and the federal government operational experience to support future

high-level waste transportation strategies. Additionally, the demonstration would show communities that spent nuclear fuel and high-level waste can be transported safely and that the State and federal government are working together on its long-term management.

New York State should work collaboratively with DOE, host communities, Indigenous Nations, and relevant NYS agencies and authorities to determine the feasibility, logistics, regulatory requirements, and community engagement frameworks necessary to enable a high-level waste/spent nuclear fuel transportation demonstration campaign.

In addition, New York State should prepare for potential future spent nuclear fuel transportation campaigns by ensuring that emergency response capabilities along transportation corridors meet federal requirements. The State should continue to participate in DOE transportation planning activities, such as DOE's Transportation Emergency Preparedness Program, and ensure that State transportation authorities are engaged in route evaluation and emergency response training opportunities.

The State should also evaluate other modes of low-level waste transportation beyond by truck (e.g., rail, maritime vessels).

9. Waste Disposal

This section discusses current and developing waste disposal pathways for high-level waste and low-level waste and considers disposal of spent nuclear fuel from advanced reactors.

9.1 Disposal of Spent Nuclear Fuel and High-Level Waste

As described in Section 3.1, the federal government has statutory responsibility to permanently dispose of spent nuclear fuel and high-level waste. The sections below describe the requirements and status of these permanent disposal responsibilities.

9.1.1 Deep Geologic Repository Requirements

The NWPA, as amended in 1987, directs that high-level waste and spent nuclear fuel be disposed of in a deep geologic repository.[99] Such a repository must isolate waste from the accessible environment for extremely long time periods, with EPA standards requiring protection of the public for up to one million years. The repository concept relies on a combination of engineered barriers and favorable natural geological characteristics to prevent radionuclide migration.

A federal repository is not yet accepting waste, and federal efforts toward permanent disposal are ongoing. In the interim, spent nuclear fuel and high-level waste remain safely stored at the sites where they were generated.

9.1.2 Contract Requirements for Federal Spent Nuclear Fuel Management

9.1.2.1 Standard Contract Requirements

Under Section 302 of the NWPA, DOE was required to enter into contracts with owners and generators of spent nuclear fuel providing federal acceptance and disposal of such fuel. The Standard Contract, codified in 10 CFR Part 961,[100] obligates DOE to begin accepting spent nuclear fuel by January 31, 1998. In exchange, utilities paid fees into the Nuclear Waste Fund, assessed at 0.1 cents per kilowatt-hour ($1/MWh) of nuclear-generated electricity, to fund the federal disposal program. Collection of the fee has been suspended since 2014. Pending federal acceptance of spent nuclear fuel, the federal government reimburses utilities for the costs of continued on-site storage through agreements and court judgments.

9.2 Disposal of Advanced Reactor Spent Nuclear Fuel

The permanent disposal requirements for advanced reactor spent nuclear fuel are expected to be broadly consistent with those used for spent nuclear fuel from existing large light-water reactors given the shared need for long-term isolation, containment, and security. Overall, both conventional and advanced reactor spent nuclear fuel will require long-term isolation in a geologic repository where engineered and natural barriers work together to contain radioactivity for thousands of years.

However, the new spent nuclear fuel forms and materials used in many advanced reactor designs introduce important questions about how these waste streams will behave in a geological repository. Variations in spent nuclear fuel characteristics mean some advanced reactor spent nuclear fuel may behave differently under repository conditions, requiring careful evaluation to ensure safe, effective disposal. For example, spent nuclear fuel with a higher burnup may have a higher heat load, requiring additional spacing between casks in a repository environment.

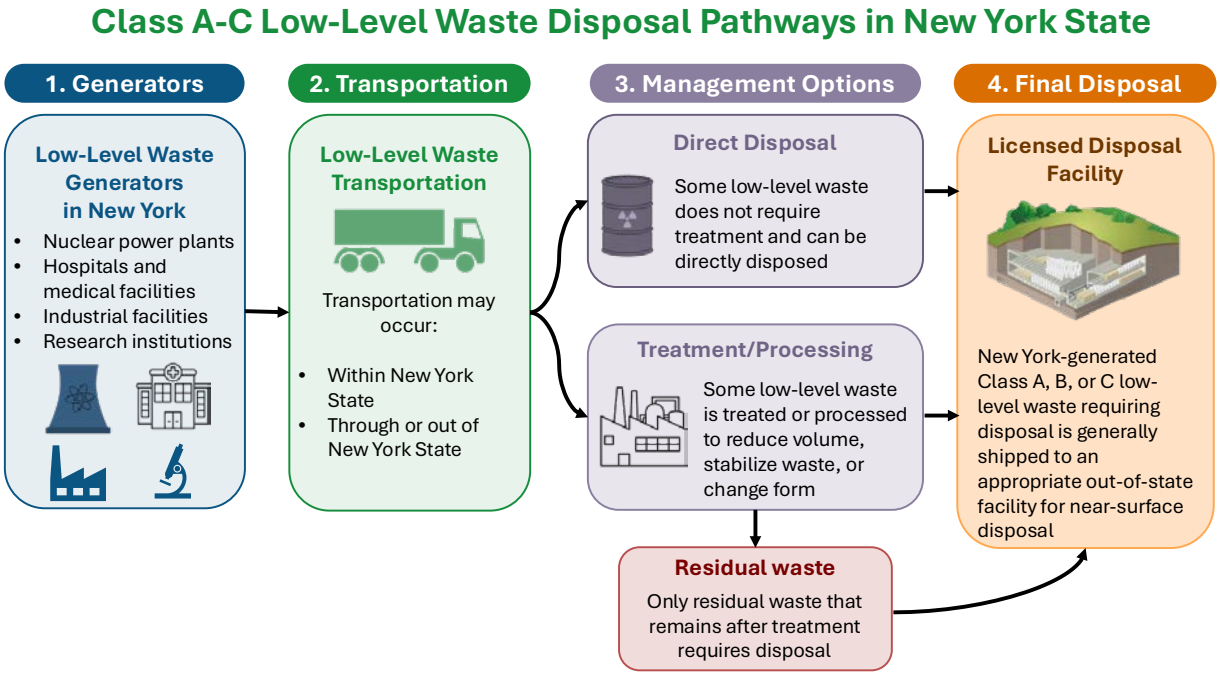
A key consideration is whether these new waste forms might affect how a deep geologic repository performs, given that such facilities are engineered to contain radionuclides over extremely long timescales. Notably, one recent study found that most advanced reactor technologies will have little impact on estimates of long-term repository performance.[101] More specifically, the study determined that key factors for long-term repository performance are the redox conditions of the geochemical environment (redox or reduction-oxidation is the tendency for reduction reactions where electrons are gained are dominant or the tendency for oxidation reactions like corrosion where electrons are lost to be dominant), waste form stability, groundwater flow rates, and solubility/sorption of radionuclides, and that waste from advanced reactor technologies would have little or no impact on these factors.

Waste-form stability remains an important factor in determining repository performance. Spent nuclear fuel from several advanced reactor technologies, including spent nuclear fuel from SFRs and liquid-fuel MSRs will likely require appropriate treatment and conditioning before they can meet repository acceptance criteria.

9.3 Disposal of Class A, B, and C Low-Level Waste

Figure 13 and the sections below summarize the Class A, B, and C low-level waste disposal pathways.

Figure 13. Class A, B, and C Low-Level Waste Disposal Pathways in New York State



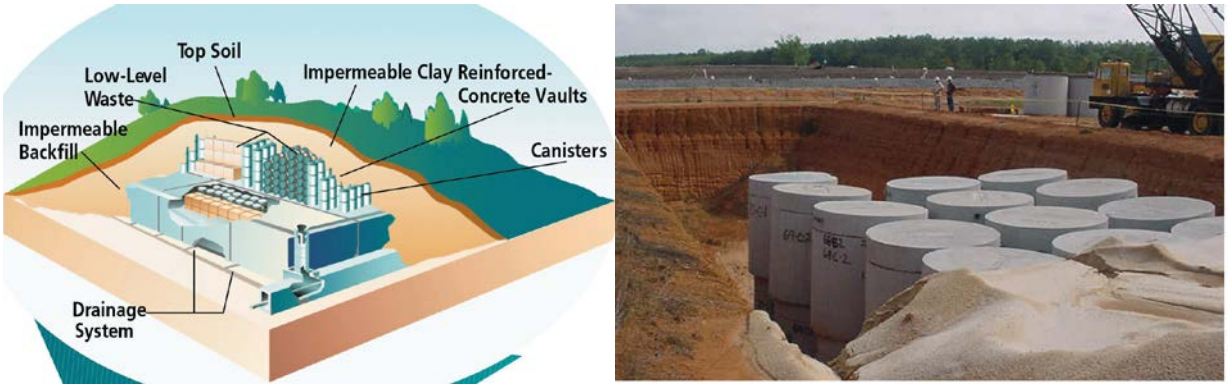
9.3.1 Class A, B, and C Low-Level Waste Disposal Technologies

The primary method for commercial Class A, B, and C low-level waste disposal in the United States is near-surface disposal, which involves placement of waste in engineered facilities within the upper 30 meters of the Earth's surface (Figure 14). Disposal cells typically incorporate multiple engineered barriers including liners, drainage systems, and covers designed to limit water infiltration and radionuclide migration.

Figure 14. Class A, B, and C Near-Surface Disposal Diagram (left) and Photo (right).

Diagram (left) illustrating near-surface disposal of Class A, B, and C waste, and image (right) of an actual disposal facility.

Source: U.S. Nuclear Regulatory Commission. "Backgrounder on Updating Disposal Rules for Low-Level Waste," September 14, 2026. https://www.nrc.gov/regulations-legislation/fact-sheets-brochures/backgrounder-on-updating-disposal-rules-for-low-level-waste.; U.S. Nuclear Regulatory Commission. Low-Level Waste Disposal Site. August 23, 2012. Flickr. https://www.flickr.com/photos/nrcgov/7845752326/in/photostream/.



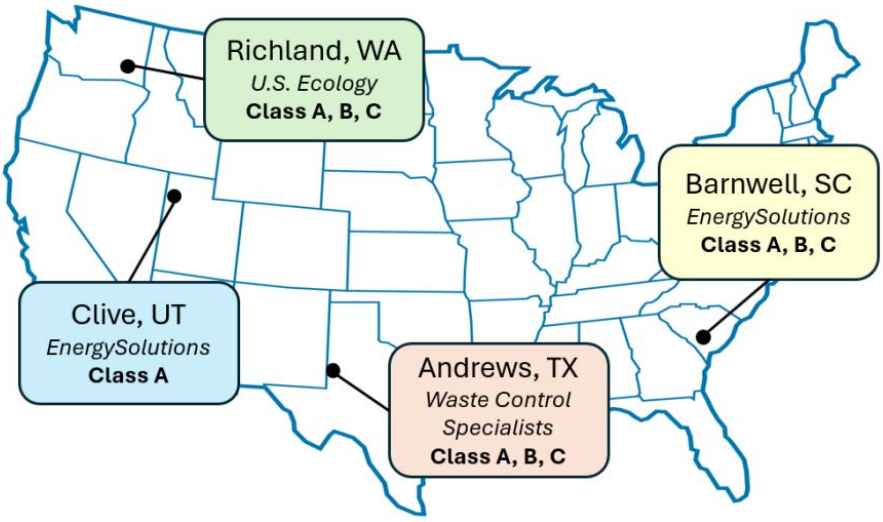
Some facilities use enhanced designs with concrete or reinforced barriers for Class C waste, meeting the regulatory requirement for additional protection against inadvertent intrusion. These enhanced near-surface disposal approaches may include burial at greater depths, reinforced vault systems, or engineered intruder barriers.

9.3.2 Class A, B, and C Low-Level Waste Commercial Disposal Facilities

Four licensed commercial Class A, B, and C low-level waste disposal facilities currently operate in the United States (Figure 15). Each facility is in an Agreement State and is licensed by the respective state regulatory authority.[102] Access for NYS waste generators varies by waste classification and interstate compact arrangements, described below. Data for low-level waste disposal by facility provided below is from the "New York State Low-Level Radioactive Waste Status Report for 2025."[103]

Figure 15. Class A, B, and C Low-Level Waste Commercial Disposal Facilities in the U.S.

Source: Cothron and Koshgarian, From Reactors to Repositories, https://nuclearinnovationalliance.org/sites/default/files/2026-01/From Reactors to Repositories - Disposal Pathways for Advanced Nuclear Reactor Waste v1.1.pdf.



9.3.2.1 EnergySolutions Barnwell Operations, Barnwell, SC

EnergySolutions Barnwell Operations in Barnwell, SC accepts Class A, B, and C waste, but is restricted to waste from the Atlantic Compact states (Connecticut, New Jersey, and South Carolina).[104] NYS generators have not had access to this facility since July 1, 2008, when it closed to non-compact states. The facility has been operational since 1971 and uses shallow land burial technology with engineered barriers.

9.3.2.2 U.S. Ecology, Richland, Washington

U.S. Ecology in Richland, WA accepts Class A, B, and C waste, but is restricted to waste from the Northwest Compact states (Alaska, Hawaii, Idaho, Montana, Oregon, Utah, Washington, and Wyoming) and Rocky Mountain Compact states (Colorado, Nevada, and New Mexico). The facility accepts limited volumes of low-level waste containing small quantities of naturally occurring radioactive material from NYS generators, accounting for 0.2 percent of NYS disposal volume in 2023. No waste from NYS generators was reported disposed of at this facility in 2024 or 2025. The facility has operated since 1965.

9.3.2.3 EnergySolutions Clive Operations, Clive, UT

EnergySolutions Clive Operations in Clive, UT accepts Class A waste from all regions of the United States without compact restrictions, including from New York State. This facility received

36.1 percent of the volume disposed of by NYS generators in 2025 and contained 49.5 percent of total radioactivity. The Clive facility can also accept and treat most solid mixed waste meeting site radioactivity concentration limits. The Clive facility has been operational since 1988 and uses above-grade engineered disposal cells in the arid Great Salt Lake Desert environment.

9.3.2.4 Waste Control Specialists, Andrews County, TX

Waste Control Specialists (WCS) in Andrews, TX accepts Class A, B, and C waste[105] from the Texas Compact (Texas and Vermont) and accepts waste from non-compact generators with approval from the Texas Compact Commission, subject to a 30 percent limit relative to total licensed capacity. In 2025, this facility received 63.9 percent of the volume disposed by NYS generators, containing 50.5 percent of total radioactivity. WCS has operated since 2012 and is the only commercial facility to receive a new low-level waste disposal license and commence operations in the past 40 years.[106]

WCS also operates the Federal Waste Facility (FWF), which began operations in 2013 and is designated for disposal of low-level waste that the federal government is responsible for under the Low-Level Radioactive Waste Policy Act of 1980.

9.3.3 Alternative Disposal Pathways for Class A, B, and C Low-Level Waste

10 CFR 20 allows for several alternative disposal pathways for Class A, B, and C low-level waste:

- **10 CFR 20.2002 alternative disposal**: This regulatory provision allows licensees to request NRC approval for alternative disposal procedures not otherwise authorized by regulation. Approved alternative disposal has been used for very low-activity materials at licensed hazardous waste facilities and, in some cases, municipal landfills.
- **Sanitary sewerage disposal**: Under 10 CFR 20.2003 and 6 NYCRR Part 380, certain radioactive materials may be released to sanitary sewerage systems if the material is readily soluble or dispersible in water, the quantity released does not exceed specified limits, and the total quantity released in a year complies with regulatory limits. This pathway is used primarily for very low-activity liquid waste.

9.4 Findings

Spent nuclear fuel and high-level waste disposal: Commercial spent nuclear fuel and HLW are currently stored safely on-site on an interim storage basis while federal policy and repository development continues.

Class A, B, and C low-level waste disposal: Commercial disposal pathways exist for Class A, B, and C low-level waste, but access varies substantially by waste classification and interstate compact arrangements.

Class A, B, and C low-level waste disposal access: New York State should continue working with existing disposal facilities to preserve access to Class A, B, and C disposal pathways, especially as national demand may grow with advanced reactor deployment.

Acronyms and Abbreviations

ALWR	Advanced Light Water Reactor
BWR	Boiling Water Reactor
CFR	Code of Federal Regulations
CISF	Consolidated Interim Storage Facility
DAW	Dry Active Waste
DEC	New York State Department of Environmental Conservation
DHSES	New York State Division of Homeland Security and Emergency Services
DIS	Decay-In-Storage
DOE	U.S. Department of Energy
DOL	New York State Department of Labor
DOT	U.S. Department of Transportation
EBR-II	Experimental Breeder Reactor II
EPA	U.S. Environmental Protection Agency
EPZ	Emergency Planning Zone
ft	feet
FWF	Federal Waste Facility
GFR	Gas-Cooled Fast Reactor
GTCC	Greater-Than-Class-C Waste
GW	Gigawatt
HALEU	High Assay Low-Enriched Uranium
HIC	High-Integrity Containers
HLW	High-Level Waste
HTGR	High Temperature Gas Reactor
ISFSI	Independent Spent Fuel Storage Installation
kWh	kilowatt hours
LEU	Low-Enriched Uranium
LLRWPA	Low-Level Radioactive Waste Policy Act
m/s	meters per second
MSR	Molten Salt Reactor

MT	Metric Tons
MTHM	Metric Tons of Heavy Metal
MTU	Metric Tons of Uranium
MW	Megawatt
MWe	Megawatt Electric
MWth	Megawatt Thermal
NRC	U.S. Nuclear Regulatory Commission
NWPA	Nuclear Waste Policy Act
NYCRR	New York Codes, Rules and Regulations
NYDOH	New York State Department of Health
NYDPS	New York State Department of Public Service
NYS	New York State
NYSERDA	New York State Energy Research and Development Authority
PWR	Pressurized Water Reactor
SFR	Sodium Fast Reactor
SMR	Small Modular Reactor
SNF	Spent Nuclear Fuel
TRISO	Tri-structural Isotropic Fuel
VLLW	Very Low-Level Waste
W	watts
WIPP	Waste Isolation Pilot Plant
WCS	Waste Control Specialists

Endnotes

[1] U.S. Nuclear Regulatory Commission (NRC), "Backgrounder on Radioactive Waste," September 2026, accessed September 4, 2026, https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/radwaste.

[2] U.S. Energy Information Administration (EIA), *Electric Power Monthly*, table 1.1, "Net Generation by Energy Source," n.d., accessed September 4, 2026, https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_1_01.

[3] U.S. EIA, "Electricity Data Browser: Net Generation for All Sectors (Thousand Megawatt-hours), New York, Annual, 2001–2024," n.d., accessed September 4, 2026, https://www.eia.gov/electricity/data/browser/.

[4] Nuclear Waste Policy Act of 1982, Pub. L. No. 97-425, 96 Stat. 2201, codified as amended at 42 U.S.C. §§ 10101–10270.

[5] Low-Level Radioactive Waste Policy Act of 1980, Pub. L. No. 96-573, 94 Stat. 3347; Low-Level Radioactive Waste Policy Amendments Act of 1985, Pub. L. No. 99-240, 99 Stat. 1842.

[6] Nuclear Innovation Alliance (NIA), "U.S. Nuclear Energy Project Tracker," last updated October 16, 2024, accessed November 2, 2026, https://nuclearinnovationalliance.org/project_tracker.

[7] U.S. NRC, "High-Level Radioactive Waste (HLW)," March 12, 2020, https://www.nrc.gov/waste/high-level-waste.

[8] 10 C.F.R. pt. 60, "Disposal of High-Level Radioactive Wastes in Geologic Repositories."

[9] U.S. Government Accountability Office (GAO), *Nuclear Waste Cleanup: Clarifying Definition of High-Level Radioactive Waste Could Help DOE Save Tens of Billions of Dollars*, GAO-26-108018 (Washington, DC: U.S. GAO, March 25, 2026), https://www.gao.gov/products/gao-26-108018.

[10] 42 U.S.C. § 10101(23).

[11] 10 C.F.R. pt. 60, "Disposal of High-Level Radioactive Wastes in Geologic Repositories."

[12] 10 C.F.R. pt. 61, "Licensing Requirements for Land Disposal of Radioactive Waste," last updated October 29, 2026, accessed November 2, 2026, https://www.nrc.gov/reading-rm/doc-collections/cfr/part061/.

[13] 10 C.F.R. § 61.55, "Waste Classification," last updated October 29, 2026, accessed November 2, 2026, https://www.ecfr.gov/current/title-10/chapter-I/part-61/subpart-D/section-61.55.

[14] Low-Level Radioactive Waste Policy Amendments Act of 1985, Pub. L. No. 99-240, 99 Stat. 1842.

[15] U.S. NRC, "Greater-Than-Class C and Transuranic Waste," October 29, 2026, accessed November 2, 2026, https://www.nrc.gov/waste/llw-disposal/decision-support/gtcc-transuranic-waste-disposal.

[16] 10 C.F.R. § 61.55, "Waste Classification."

[17] U.S. Department of Energy (DOE), *Final Environmental Impact Statement for the Disposal of Greater-Than-Class C (GTCC) Low-Level Radioactive Waste and GTCC-Like Waste*, DOE/EIS-0375 (Washington, DC: U.S. DOE, January 2016), https://www.energy.gov/sites/default/files/2016/02/f30/EIS-0375-FEIS_Summary-2016.pdf.

[18] "Greater-Than-Class C and Transuranic Waste," 84 Fed. Reg. 35037 (July 22, 2019).

[19] Terrence C. Brimfield et al., "Not All Greater-Than-Class C (GTCC) Waste Streams Are Created Equal," paper 15373, WM2015 Conference, Phoenix, Arizona, March 15–19, 2015, https://www.osti.gov/biblio/22824291.

[20] U.S. DOE, *Final Environmental Impact Statement for the Disposal of Greater-Than-Class C (GTCC) Low-Level Radioactive Waste and GTCC-Like Waste*.

[21] EG&G Idaho, *Greater-than-Class C Low-Level Radioactive Waste Characterization: Estimated Volumes, Radionuclide Activities, and Other Characteristics*, rev. 1 (September 1994), https://doi.org/10.2172/10110584.

[22] U.S. DOE, *Final Environmental Impact Statement for the Disposal of Greater-Than-Class C (GTCC) Low-Level Radioactive Waste and GTCC-Like Waste*.

[23] Nuclear Waste Policy Act of 1982, Pub. L. No. 97-425, 96 Stat. 2201, codified as amended at 42 U.S.C. §§ 10101–10270.

[24] 10 C.F.R. pt. 73, "Physical Protection of Plants and Materials."

[25] 10 C.F.R. pt. 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater Than Class C Waste."

[26] 10 C.F.R. pt. 60, "Disposal of High-Level Radioactive Wastes in Geologic Repositories"; 10 C.F.R. pt. 63, "Disposal of High-Level Radioactive Wastes in a Geologic Repository at Yucca Mountain, Nevada."

[27] U.S. GAO, *Commercial Nuclear Waste: Effects of a Termination of the Yucca Mountain Repository Program and Lessons Learned*, GAO-11-229 (Washington, DC: U.S. GAO, April 8, 2011), https://www.gao.gov/products/gao-11-229.

[28] 40 C.F.R. pt. 191, "Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes."

[29] 40 C.F.R. pt. 190, "Environmental Radiation Protection Standards for Nuclear Power Operations."

[30] Clean Air Act, 42 U.S.C. §§ 7401–7671q.

[31] 10 C.F.R. pt. 71, "Packaging and Transportation of Radioactive Material."

[32] 49 C.F.R. pts. 171-180, "Hazardous Materials Regulations."

[33] 10 C.F.R. pt. 20, subpt. K, "Waste Disposal," last updated October 29, 2026, accessed November 2, 2026, https://www.ecfr.gov/current/title-10/chapter-I/part-20/subpart-K.

[34] Low-Level Radioactive Waste Policy Act of 1980, Pub. L. No. 96-573, 94 Stat. 3347.

[35] U.S. NRC, *Results of the Very Low-Level Waste Scoping Study*, SECY-21-0057 (June 1, 2021), https://www.nrc.gov/docs/ML2113/ML21132A296.html.

[36] New York State Low-Level Radioactive Waste Management Act, 1986 N.Y. Laws ch. 673.

[37] 21 NYCRR pt. 502, "Low-Level Radioactive Waste Generator Reports."

[38] New York State Energy Research and Development Authority (NYSERDA), *New York State Low-Level Radioactive Waste Status Report for 2025* (Albany: NYSERDA, July 2026), https://www.nyserda.ny.gov/-/media/Project/Nyserda/Files/Publications/Energy-Analysis/New-York-State-Low-Level-Radioactive-Waste-Status-Report-for-2025.pdf.

[39] NYSERDA, *New York State Low-Level Radioactive Waste Status Report for 2025*.

[40] 6 NYCRR pt. 380, "Prevention and Control of Environmental Pollution by Radioactive Materials."

[41] New York State Department of Environmental Conservation (DEC), *Management of Soils Contaminated with Technologically-Enhanced Naturally Occurring Radioactive Materials*, DMM-5 (October 27, 2023), https://extapps.dec.ny.gov/docs/materials_minerals_pdf/dmm5tenormpolicy.pdf.

[42] New York State Department of Health (DOH), "Radioactive Materials Licensing," August 2026, accessed September 4, 2026, https://www.health.ny.gov/environmental/radiological/radon/radioactive_material_licensing/.

[43] 10 NYCRR Part 16, "Ionizing Radiation" and 12 NYCRR Part 38, "Industrial Code Rule 38."

[44] World Nuclear Association, "Nuclear Power Reactors," August 5, 2026, accessed September 11, 2026, https://world-nuclear.org/information-library/nuclear-power-reactors/overview/nuclear-power-reactors.

[45] U.S. NRC, "Backgrounder on Radioactive Waste," September 8, 2026, accessed September 11, 2026, https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/radwaste.

[46] Harold Feiveson et al., eds., *Managing Spent Fuel from Nuclear Power Reactors: Experience and Lessons from Around the World* (Princeton, NJ: International Panel on Fissile Materials, September 2011), https://fissilematerials.org/library/rr10.pdf; Jianwei Hu et al., *US Commercial Spent Nuclear Fuel Assembly Characteristics: 1968–2013*, NUREG/CR-7227, ORNL/TM-2015/619 (U.S. NRC, September 2016), https://info.ornl.gov/sites/publications/files/Pub59593.pdf.

[47] Banerjee and Gadey, *Spent Nuclear Fuel and Reprocessing Waste Inventory*. Inventory data as of December 31, 2024.

[48] Banerjee and Gadey, *Spent Nuclear Fuel and Reprocessing Waste Inventory*.

[49] U.S. DOE, "5 Fast Facts about Spent Nuclear Fuel," October 3, 2022, https://www.energy.gov/ne/articles/5-fast-facts-about-spent-nuclear-fuel.

[50] Nick Touran, "How Much Nuclear Waste Is There?," *What Is Nuclear?*, February 19, 2023, https://whatisnuclear.com/calcs/how-much-waste.html.

[51] NYSERDA, *New York State Low-Level Radioactive Waste Status Report for 2023* (Albany: NYSERDA, May 2024), https://www.nyserda.ny.gov/-/media/Project/Nyserda/Files/Publications/Energy-Analysis/EEA-LLRW-2024-r-1-v1-acc.pdf.

[52] U.S. NRC, "Low-Level Waste Disposal Statistics," updated October 2024, https://www.nrc.gov/waste/llw-disposal/licensing/statistics.html.

[53] Taek K. Kim, Lawrence Boing, and Brent Dixon, "Nuclear Waste Attributes of Near-Term Deployable Small Modular Reactors," *Nuclear Engineering and Technology* 56, no. 3 (2024): 1100–1107, https://doi.org/10.1016/j.net.2024.01.046.

[54] Erik Cothron and Zach Koshgarian, *From Reactors to Repositories: Disposal Pathways for Advanced Nuclear Reactor Waste* (Washington, DC: NIA, December 2024), https://nuclearinnovationalliance.org/sites/default/files/2026-01/From%20Reactors%20to%20Repositories%20-%20Disposal%20Pathways%20for%20Advanced%20Nuclear%20Reactor%20Waste%20v1.1.pdf.

[55] A. Sowder and C. Marciulescu, "Uranium Oxycarbide (UCO) Tristructural Isotropic (TRISO) Coated Particle Fuel Performance," Topical Report EPRI-AR-1 (NP), May 2019, https://www.nrc.gov/docs/ML1915/ML19155A173.pdf; U.S. NRC "Final Safety Evaluation for EPRI TRISO

Topical Report," docket no. 99902021, n.d., accessed November 2, 2026, https://www.nrc.gov/docs/ML2021/ML20216A453.pdf.

[56] Katarzyna Kiegiel et al., "Management of Radioactive Waste from HTGR Reactors Including Spent TRISO Fuel—State of the Art," *Energies* 15, no. 3 (2022): 1099, https://doi.org/10.3390/en15031099.

[57] National Academies of Sciences, Engineering, and Medicine, *Merits and Viability of Different Nuclear Fuel Cycles*, 71.

[58] Cothron and Koshgarian, *From Reactors to Repositories*.

[59] Cothron and Koshgarian, *From Reactors to Repositories*.

[60] Cothron and Koshgarian, *From Reactors to Repositories*.

[61] National Academies of Sciences, Engineering, and Medicine, *Merits and Viability of Different Nuclear Fuel Cycles*, finding 15.

[62] Gordon M. Petersen, et al., "Preliminary Analysis of Advanced Reactor Spent Nuclear Fuel Storage, Transportation, and Disposal," INL/CON-23-75963, Revision 0 (INL, March 2024), https://inldigitallibrary.inl.gov/content/uploads/50/2026/04/Sort_82335.pdf.

[63] Cothron and Koshgarian, *From Reactors to Repositories*.

[64] Edward Matteo et al., Advanced Reactors Spent Fuel and Waste Streams Disposition Strategies: Spent Fuel and Waste Disposition, SAND2023-08602R (Albuquerque, NM: Sandia National Laboratories, June 28, 2023), https://www.osti.gov/servlets/purl/2335764/.

[65] Lindsay M. Krall, Allison M. Macfarlane, and Rodney C. Ewing, "Nuclear Waste from Small Modular Reactors," *Proceedings of the National Academy of Sciences* 119, no. 23 (2022): e2111833119, https://doi.org/10.1073/pnas.2111833119.

[66] Kim, Boing, and Dixon, "Nuclear Waste Attributes of Near-Term Deployable Small Modular Reactors."

[67] INL, "Microreactor Technology at Idaho National Laboratory," n.d., accessed September 4, 2026, https://inl.gov/trending-topics/microreactors/.

[68] INL, "MARVEL Microreactor."

[69] Kristy Diane Yancey Spencer, et al., "Special Considerations for the Removal and Disposal of Micro-Reactor Experiments," paper presented at the WM2024 Conference, Phoenix, Arizona, March 10–14, 2024, INL/CON-23-74343-Rev002, https://www.osti.gov/biblio/2328095.

[70] Constellation Energy, "Nine Mile Point Clean Energy Center," n.d., accessed September 4, 2026, https://www.constellationenergy.com/about/locations/nine-mile-point-clean-energy-center.html.

[71] Banerjee and Gadey, *Spent Nuclear Fuel and Reprocessing Waste Inventory*.

[72] Banerjee and Gadey, *Spent Nuclear Fuel and Reprocessing Waste Inventory*.

[73] Holtec International, "Indian Point Decommissioning," n.d., accessed September 4, 2026, https://holtecinternational.com/company/divisions/hdi/our-fleet/indian-point/.

[74] New York State Department of Public Service (DPS), "About the Indian Point Decommissioning Oversight Board," n.d., accessed September 4, 2026, https://dps.ny.gov/about-indian-point-dob.

[75] Indian Point Decommissioning Oversight Board, Bylaws, adopted June 23, 2021, https://dps.ny.gov/system/files/documents/2022/10/ipdob-bylaws.pdf.

[76] U.S. DOE, *Final Environmental Impact Statement for the Disposal of Greater-Than-Class C (GTCC) Low-Level Radioactive Waste and GTCC-Like Waste*.

[77] Banerjee and Gadey, *Spent Nuclear Fuel and Reprocessing Waste Inventory*.

[78] 10 C.F.R. § 72.236, "Specific Requirements for Spent Fuel Storage Cask Approval and Fabrication."

[79] 10 C.F.R. § 72.210, "General License Issued."

[80] 10 C.F.R. § 72.214, "List of Approved Spent Fuel Storage Casks."

[81] U.S. NRC, *Standard Review Plan for Spent Fuel Dry Storage Systems and Facilities*, NUREG-2215 (Washington, DC: U.S. NRC, April 2020), https://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr2215/index.

[82] 10 C.F.R. § 50.83, "Release of Part of a Power Reactor Facility or Site for Unrestricted Use."

[83] NYSERDA, *New York State Low-Level Radioactive Waste Status Report for 2025*.

[84] 6 NYCRR pt. 380, "Prevention and Control of Environmental Pollution by Radioactive Materials."

[85] 10 C.F.R. § 61.56, "Waste Characteristics."

[86] "Interim Storage for Greater Than Class C Waste," 66 Fed. Reg. 51823 (October 11, 2001).

[87] 6 NYCRR pt. 381, "Transporters of Low-Level Radioactive Waste."

[88] "Continued Storage of Spent Nuclear Fuel," 79 Fed. Reg. 56238 (September 19, 2014), https://www.federalregister.gov/documents/2014/09/19/2014-22215/continued-storage-of-spent-nuclear-fuel.

[89] Blue Ribbon Commission on America's Nuclear Future, *Report to the Secretary of Energy* (January 2012), https://www.energy.gov/sites/default/files/2013/04/f0/brc_finalreport_jan2012.pdf.

[90] U.S. DOE, "Request for Information (RFI) on Using a Consent-Based Siting Process to Identify Federal Interim Storage Facilities; Correction," 86 Fed. Reg. 73247 (December 27, 2021), https://www.federalregister.gov/documents/2021/12/27/2021-28009/request-for-information-rfi-on-using-a-consent-based-siting-process-to-identify-federal-interim.

[91] U.S. DOE, "Consent Based Siting Consortia," n.d., accessed October 15, 2026, https://www.energy.gov/ne/consent-based-siting-consortia.

[92] U.S. DOE, "Department of Energy Seeks Hosts for Nuclear Lifecycle Innovation Campuses," January 28, 2026, https://www.energy.gov/articles/department-energy-seeks-hosts-nuclear-lifecycle-innovation-campuses.

[93] U.S. DOE, "Nuclear Lifecycle Innovation Campuses Contenders Announced," July 28, 2026, https://www.energy.gov/articles/nuclear-lifecycle-innovation-campuses-contenders-announced.

[94] U.S. NRC, *Materials License No. SNM-2515, Interim Storage Partners LLC* (September 13, 2021), https://www.nrc.gov/docs/ML2118/ML21188A096.html.

[95] U.S. NRC, *Materials License for Holtec HI-STORE Consolidated Interim Storage Facility*, Docket No. 72-1051 (May 9, 2023), https://www.nrc.gov/docs/ML2310/ML23103A418.pdf.

[96] *Barrett v. Entergy Nuclear Generation Co.*, No. 13 MISC 479028 (Mass. Land Ct. April 4, 2017).

[97] U.S. NRC, "Transportation of New Fuels," updated October 8, 2024, https://www.nrc.gov/materials/new-fuels/transportation.

[98] Peter LaPlante et al., Storage and Transportation of Molten Salt Reactor Wastes: Identification of Technical Information Needs and Safety Implications for Safety Review Guidance, TLR-RES/DE/REB-2024-15 (U.S. Nuclear Regulatory Commission, September 25, 2024), https://www.nrc.gov/docs/ML2425/ML24256A003.pdf.

[99] Nuclear Waste Policy Amendments Act of 1987, Pub. L. 100-203, Title V, Subtitle A.

[100] 10 C.F.R. § 961.11, "Standard Contract for Disposal of Spent Nuclear Fuel and/or High-Level Radioactive Waste."

[101] National Academies of Sciences, Engineering, and Medicine, *Merits and Viability of Different Nuclear Fuel Cycles*.

[102] U.S. NRC, "Low-Level Waste," accessed September 9, 2026, https://www.nrc.gov/waste/low-level-waste.

[103] NYSERDA, *New York State Low-Level Radioactive Waste Status Report for 2025*.

[104] "Atlantic Interstate Low-Level Radioactive Waste Compact," n.d., accessed September 4, 2026, https://www.atlanticcompact.org/.

[105] Waste Control Specialists (WCS), "About WCS," n.d., accessed November 3, 2026, https://www.wcstexas.com/about/

[106] WCS, "Texas Compact Waste Facility," n.d., accessed September 4, 2026, https://www.wcstexas.com/about/our-facilities/facilities/.



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