WASTE CLASSIFICATION - HISTORY, STANDARDS, AND REQUIREMENTS FOR DISPOSAL

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OUTLINE OF PRESENTATION

(1) Historical development in U.S. of different classes (categories) of radioactive waste.

Focus on operational descriptions developed prior to definitions in laws and regulations.

(2) Laws and regulations in U.S. regarding -

- classification of radioactive wastes;

- requirements for disposal of different waste classes.

Review emphasizes relationship between classification of wastes and requirements for permanent disposal.

(3) Application of laws and regulations for hazardous chemical wastes to classification and disposal of -

- naturally occurring and accelerator-produced radioactive materials;

- mixed radioactive and hazardous chemical wastes.

HISTORICAL DEVELOPMENT OF DEFINITIONS OF RADIOACTIVE WASTE CLASSES

PURPOSE OF EARLY DEFINITIONS OF RADIOACTIVE WASTE CLASSES

Definitions of different classes of radioactive waste originally resulted from operational aspects of handling, storage, and disposition of liquid wastes from chemical reprocessing of spent nuclear fuel.

Definitions of waste classes were extended to reflect operational aspects of solid waste management.

Protection of public health from permanent disposal of solid radioactive wastes usually was not a primary consideration in defining waste classes.

EARLY CATEGORIES OF LIQUID RADIOACTIVE WASTE

During late 1950s, three categories of liquid radioactive waste with decreasing radionuclide concentrations were first defined and used by AEC.

(1) High-level waste - waste that required confinement and storage in underground tanks.

Subcategories of HLW included self-boiling (high decay heat requiring engineered cooling systems) and non-boiling (lower decay heat requiring only natural cooling).

(2) Medium- or intermediate-level waste - waste that could be released to cribs, other underground structures, or seepage basins.

(3) Low-level waste - waste that could be released to holding ponds and lagoons or directly to surface waters.

Categories were operating terms based on requirements for safe handling and disposition of wastes.

IMPORTANT PROPERTIES OF LIQUID HIGH-LEVEL WASTE FROM FUEL REPROCESSING

(1) High concentrations of fission products, principally ^{90}Sr and ^{137}Cs in wastes aged a few years, which produce high heat generation rates and external radiation doses.

Extensive shielding and systems for heat removal are required during waste handling and storage.

(2) High concentrations of long-lived radionuclides, principally alpha-emitting TRU radionuclides, which would result in high internal radiation doses per unit activity of inhaled or ingested material.

Releases to environment could result in unacceptable impacts on public health.

EARLY DEFINITIONS OF LIQUID WASTE CATEGORIES AT HANFORD

Definitions applied to "mixed radioactivity" in liquid wastes typical of composition of irradiated fuels 100-200 days after discharge from reactor.

High-level waste - greater than 100 Ci/m^3;

Intermediate-level waste - between 5×10^{-5} and 100 Ci/m^3;

Low-level waste - less than 5×10^{-5} Ci/m^3.

EARLY CATEGORIES OF SOLID RADIOACTIVE WASTE FOR SHALLOW-LAND BURIAL

In 1960, AEC initiated interim shallow-land burial services for three classes of solid radioactive waste from private sources until civilian disposal facilities became available.

High-level waste - greater than 1,000 Ci/ft^3 (35,000 Ci/m^3);

Intermediate-level waste - between 10 and 1,000 Ci/ft^3 (350 and 35,000 Ci/m^3);

Low-level waste - less than 10 Ci/ft^3 (350 Ci/m^3).

Categories were based primarily on operational requirements for handling and disposition of waste at generating site.

Categories of solid waste were not related to definitions of liquid waste classes.

TRANSURANIC WASTE

In late 1960s, fourth category called transuranic waste (originally alpha-bearing waste) came into use.

TRU waste referred to solid radioactive waste with high concentrations of long-lived, alpha-emitting TRU radionuclides but lower concentrations of fission products than in liquid reprocessing waste.

TRU waste further categorized as "contact-handled," requiring little or no shielding, or "remote-handled," requiring shielding or remote handling due to high levels of gamma or neutron radiation.

Categories of TRU waste were based on operational considerations, rather than requirements for disposal.

EARLY DISPOSAL REQUIREMENTS FOR TRU-CONTAMINATED WASTE

In 1970, AEC established upper limit of 10 nCi/g for shallow-land burial of TRU-contaminated solid waste.

Waste with greater than 10 nCi/g of TRU radionuclides required storage or burial in retrievable manner.

Limit for disposal was based on higher concentrations of radium in earth's crust.

TRU waste thus referred to waste (except for high-level waste) with concentrations of long-lived, alpha-emitting TRU radionuclides greater than 10 nCi/g.

Definition of TRU waste represented first quantification of waste class based primarily on protection of public health from solid waste disposal.

EARLY DEFINITIONS OF LOW-LEVEL WASTE

(1) Low-level waste originally described as liquid or solid waste with low radionuclide concentrations.

Descriptions were based primarily on operational requirements for safe handling and disposition of waste at generating site, rather than requirements for permanent disposal.

(2) Description of LLW was broadened to include radioactive waste other than spent fuel, HLW, TRU waste, or uranium and thorium mill tailings.

Description is not related to requirements for safe handling, storage, or permanent disposal.

LLW could contain very high radionuclide concentrations, provided activity decays to low levels during storage or period of institutional controls over disposal facility.

PRINCIPAL LAWS AFFECTING CLASSIFICATION AND DISPOSAL OF RADIOACTIVE WASTES

ATOMIC ENERGY ACT OF 1954, AS AMENDED

Governs production and use of source, special nuclear, and byproduct materials for defense and peaceful purposes.

Source material - (1) uranium or thorium, or (2) ores containing these materials.

Special nuclear material - (1) plutonium or uranium enriched in isotopes 233 or 235, or (2) materials artificially enriched by these radionuclides.

Byproduct material - (1) radioactive material (except special nuclear material) resulting from production or use of special nuclear material, and (2) uranium or thorium mill tailings.

Processing and use of source, special nuclear, and byproduct materials in private sector is permitted if licensed by AEC (later NRC).

Atomic Energy Act does not govern production and use of radioactive materials unless associated with burning of nuclear fuel in reactors.

REORGANIZATION PLAN NO. 3 OF 1970

Established authority of EPA to develop generally applicable environmental radiation standards for specific defense and civilian activities subject to Atomic Energy Act.

EPA does not enforce environmental radiation standards developed under authority of Atomic Energy Act.

NRC enforces EPA standards for its licensees and for DOE activities licensed by NRC.

DOE enforces EPA standards for its activities not licensed by NRC.

ENERGY REORGANIZATION ACT OF 1974, AS AMENDED

Divided AEC into two separate agencies -

- ERDA (later DOE) responsible for energy development and defense production activities;
- NRC responsible for licensing of civilian nuclear energy activities and certain defense activities.

NRC given specific licensing authority over -

- facilities for receipt and storage of HLW resulting primarily from activities licensed under authority of Atomic Energy Act;
- retrievable surface storage facilities and other facilities authorized for long-term storage of HLW generated by DOE which are not used for research and development activities.

LOW-LEVEL RADIOACTIVE WASTE POLICY ACT OF 1980, AS AMENDED

Gives States responsibility for management and disposal of most civilian low-level waste.

States are encouraged to form regional compacts, requiring Congressional approval, in developing disposal facilities.

Disposal is regulated by Agreement States (States which enter into agreement with NRC) or by NRC in non-Agreement States.

DOE is given responsibility for disposal of certain higher activity LLW, subject to licensing by NRC.

NUCLEAR WASTE POLICY ACT OF 1982, AS AMENDED

Established program for disposal of civilian spent fuel and high-level waste in geologic repositories.

Facilities are operated by DOE and licensed by NRC.

NWPA also addresses disposal of defense HLW in repositories for civilian spent fuel and HLW.

STATE RESPONSIBILITIES FOR MANAGEMENT OF RADIOACTIVE WASTES

In addition to responsibility for management and disposal of most civilian low-level waste, States presently regulate radioactive materials not subject to Atomic Energy Act -

- naturally occurring radioactive material (e.g., radium) other than source material;
- artificially produced radioactive material (e.g., in an accelerator) not resulting from production or use of special nuclear material.

EPA intends to establish and enforce general environmental standards for management and disposal of these materials under authority of statutes for hazardous wastes.

DEFINITIONS OF HIGH-LEVEL WASTE

IN LAWS AND REGULATIONS

10 CFR PART 50, APPENDIX F (1970)

First regulatory definition of HLW developed by AEC -

> HLW is liquid wastes resulting from operation of first cycle solvent extraction system, or equivalent, and concentrated wastes from subsequent extraction cycles, or equivalent, in facility for fuel reprocessing.

HLW thus refers to concentrated waste from fuel reprocessing which contains virtually all fission products and TRU radionuclides (except plutonium) in spent fuel.

> Definition is qualitative ("concentrated" is not quantified) but presumes normal fuel burnups.

Definition reflects traditional source-based description of HLW as primary waste from fuel reprocessing.

> Definition implies that HLW (1) produces high levels of decay heat and external radiation, due primarily to fission products, and (2) requires high degree of isolation from biosphere, due primarily to TRU radionuclides.

> HLW was defined in terms of its source, rather than its properties, because fuel reprocessing was only significant source of waste with these properties.

10 CFR PART 50, APPENDIX F

(continued)

Additional policy statements of AEC and NRC indicated that HLW does not include -

- radioactive hulls and other irradiated and contaminated fuel structural hardware;

- incidental wastes from reprocessing plant operations, e.g., ion exchange beds or sludges;

- incidental wastes generated in further treatment of HLW, e.g., decontaminated salts containing substantially lower concentrations of ^{90}Sr, ^{137}Cs, and Pu than first-cycle solvent extraction wastes.

MARINE PROTECTION, RESEARCH, AND SANCTUARIES ACT OF 1972

First statutory definition of HLW -

Definition in 10 CFR Part 50, Appendix F, was adopted but broadened to include unreprocessed spent fuel.

WEST VALLEY DEMONSTRATION PROJECT ACT OF 1980

Statutory definition of HLW that applies only to activities at West Valley Center -

> HLW is waste produced by reprocessing at West Valley of spent nuclear fuel including liquid wastes produced directly in reprocessing, dry solid material derived from such liquid waste, and such other material as NRC designates as HLW for purposes of protecting public health and safety.

NRC has not designated any "other material" as HLW under Act.

> HLW is interpreted only as liquid wastes in storage at West Valley and dry solid materials derived from solidification of these liquid wastes.

10 CFR PART 60 (1983)

NRC's current definition of HLW -

> HLW is (1) irradiated reactor fuel, (2) liquid wastes resulting from operation of first cycle solvent extraction system, or equivalent, and concentrated wastes from subsequent extraction cycles, or equivalent, in facility for fuel reprocessing, and (3) solids into which such liquid wastes have been converted.

NRC has retained qualitative, source-based definition of HLW, and spent fuel is included in HLW.

NUCLEAR WASTE POLICY ACT OF 1982, AS AMENDED

Current statutory definition describes HLW in two parts as -

(A) highly radioactive material from fuel reprocessing, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations; and

(B) other highly radioactive material that NRC, consistent with existing law, determines by rule requires permanent isolation.

Spent fuel is defined separately from HLW.

In context of NWPA, "requires permanent isolation" means disposal in a geologic repository or alternative system with equivalent waste-isolation capabilities.

NUCLEAR WASTE POLICY ACT

(continued)

Definition in Clause (A) follows traditional source-based description.

Definition remains qualitative; i.e., "highly radioactive material" and "sufficient concentrations" of fission products are not quantified, nor are minimum concentrations of TRU radionuclides.

Definition in Clause (B) represents significant departure from previous definitions.

Description calls for generally applicable definition, i.e., one not based on source of waste.

As in Clause (A), "highly radioactive material" and "requires permanent isolation" are not quantified.

40 CFR PART 191 (1985)

EPA's current definition of HLW -

- adopted definition in Nuclear Waste Policy Act;

- defined spent fuel separately from HLW.

Unless NRC develops generally applicable definition of HLW under Clause (B) of NWPA, traditional source-based definition only would continue to apply.

ADVANCE NOTICE OF PROPOSED RULEMAKING

AMENDING 10 CFR PART 60 (1987)

NRC indicated intent to develop quantitative and generally applicable definition of HLW in response to Clause (B) of Nuclear Waste Policy Act.

Definition would be expressed in terms of minimum concentrations of radionuclides constituting HLW, based on analyses of risks from waste management and disposal.

"Highly radioactive" would refer to concentrations of shorter-lived radionuclides and "requires permanent isolation" to concentrations of long-lived radionuclides.

NRC requested comment on whether generally applicable definition of HLW in Clause (B) should encompass and quantify traditional source-based definition in Clause (A) of NWPA.

Definition would quantify "sufficient concentrations" of fission products and minimum concentrations of TRU radionuclides in HLW from fuel reprocessing.

NRC indicated preference that Clause (B) should not apply to primary reprocessing wastes; i.e., Clause (A) would continue to apply to all wastes previously considered HLW according to source-based definitions.

NOTICE OF PROPOSED RULEMAKING AMENDING

10 CFR PART 61 (1988)

NRC indicated intent to abandon effort to develop quantitative and generally applicable definition of HLW in response to Clause (B) of Nuclear Waste Policy Act.

Decision based on NRC's view that -

- Clause (B) would not apply to primary reprocessing wastes classified as HLW in Clause (A) of NWPA;
- there is no compelling need for new definition of HLW given (1) current institutional setup for waste management and (2) small volumes of non-reprocessing waste that likely would be defined as HLW under Clause (B);
- considerable effort would be required to (1) quantify "requires permanent isolation" in context of NWPA and (2) develop technical criteria for disposal of higher activity wastes that do not "require permanent isolation" but are unacceptable for near-surface land disposal.

DOE ORDER 5820.2A, CHAPTER I (1988)

DOE's current definition of HLW -

> HLW is highly radioactive waste material that results from reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid waste derived from the liquid, that contains a combination of transuranic waste and fission products in concentrations requiring permanent isolation.

Traditional source-based definition of HLW is adopted.

Definition is explicit that HLW contains high concentrations of TRU radionuclides and "requires permanent isolation."

SUMMARY OF CURRENT DEFINITIONS OF HIGH-LEVEL WASTE

(1) HLW is primary waste (liquid or solid) from chemical reprocessing of spent nuclear fuel.

Definition is based on source of waste, but incidental waste from fuel reprocessing is not included.

Waste from sources other than fuel reprocessing with equivalent levels of decay heat or external radiation (due to shorter-lived radionuclides) and requiring equivalent degree of waste isolation from permanent disposal to protect public health (due to long-lived radionuclides) is not included in HLW.

(2) Spent nuclear fuel is a form of HLW in some definitions but not others.

Inconsistency is not important, because spent fuel and primary reprocessing wastes require similar precautions for safe handling, storage, and disposal.

(3) NRC has statutory authority to define radioactive materials other than primary reprocessing waste as HLW, but has chosen not to exercise authority.

REQUIREMENTS FOR DISPOSAL OF HIGH-LEVEL WASTE IN LAWS AND REGULATIONS

10 CFR PART 50, APPENDIX F (1970)

First regulatory requirements for disposal of civilian HLW developed by AEC -

Liquid HLW shall be converted to dry solid and transferred to Federal repository no later than 10 years after fuel reprocessing.

Federal repository will assume permanent custody of waste.

Federal repositories will be designated later by AEC.

Early programs for repository siting -

- AEC program to develop repository in salt mine in Lyons, Kansas (1970);
- ERDA (later DOE) program for repository siting in several geologic media (1975).

NUCLEAR WASTE POLICY ACT OF 1982, AS AMENDED

First statute addressing permanent disposal of spent fuel and HLW.

NWPA established DOE program for disposal of civilian spent fuel and HLW in geologic repositories.

- NWPA applies to any repository not used exclusively for (1) disposal of defense HLW or spent fuel or (2) DOE research and development activities.

NWPA authorizes but does not require disposal of civilian spent fuel and HLW in geologic repositories.

- DOE is directed to investigate alternative technologies for permanent disposal, but is not authorized to construct or operate alternative disposal facilities.

NWPA also addressed disposal of defense HLW.

- President was required to evaluate use of repositories for civilian spent fuel and HLW for disposal of defense HLW.

- Following DOE study in 1985, co-disposal of defense HLW with civilian spent fuel and HLW was recommended.

40 CFR PART 191 (1985)

MANAGEMENT AND DISPOSAL OF HIGH-LEVEL WASTES

EPA standards govern management (except for transportation), storage, and disposal of spent fuel and HLW from defense and civilian activities.

Standards do not specify disposal technology, but -

- geologic repository was only disposal system analyzed in developing standards;
- standards may be inappropriate for alternative disposal systems.

40 CFR PART 191
(continued)

EPA standards include -

- dose limits for members of the public from management and storage;
- containment requirements (i.e., limits on cumulative releases of radionuclides to accessible environment) for 10,000 years after disposal;
- qualitative assurance requirements to provide confidence that containment requirements will be met;
- individual protection requirements (i.e., dose limits) for members of the public in accessible environment for 1,000 years after disposal;
- protection requirements (i.e., limits on radionuclide concentrations) for special sources of ground water for 1,000 years after disposal.

First Circuit Court has vacated individual protection and ground water protection requirements, and EPA has not published proposal for modifying standards.

10 CFR PART 60 (1983)

LICENSING CRITERIA FOR GEOLOGIC REPOSITORIES

NRC regulations govern licensing of DOE activities at geologic repositories intended primarily for (1) disposal of civilian spent fuel and HLW or (2) co-disposal of defense HLW with civilian spent fuel and HLW.

Regulations contain criteria for -

- performance of waste packages, engineered barrier system, and geologic environment;
- siting of repository;
- design of surface and underground facilities, seals for shafts and boreholes, and waste package.

Licensing criteria are intended to provide reasonable assurance that 10,000-year containment requirement in EPA's 40 CFR Part 191 will be met.

Regulations do <u>not</u> require that -

- any radioactive materials, whether or not they are classified as HLW, be disposed of in geologic repository;
- radioactive materials must be classified as HLW in order to be eligible for disposal in geologic repository.

DOE ORDER 5820.2A, CHAPTER I (1988)

Order establishes policies and guidelines for managing DOE's high-level waste and any other materials which, because of their highly radioactive nature, require similar handling.

Storage operations shall comply with applicable EPA and State standards.

Geologic disposal shall comply with EPA and NRC standards.

Order also addresses -

- storage of HLW in doubly contained systems and singly contained tank systems;
- disposal of new and readily retrievable HLW according to requirements of Nuclear Waste Policy Act;
- options for disposal of HLW that is not readily retrievable.

SUMMARY OF CURRENT REQUIREMENTS FOR DISPOSAL OF HIGH-LEVEL WASTE

(1) Geologic repository is only disposal system currently authorized for disposal of civilian spent fuel and HLW.

Repository will be developed and operated by DOE and licensed by NRC.

Repository must comply with EPA's general environmental radiation standards (40 CFR Part 191) and NRC's licensing criteria (10 CFR Part 60).

(2) Defense HLW will be co-disposed in same repository with civilian spent fuel and HLW.

Disposal of defense HLW will be subject to same environmental standards and licensing criteria as disposal of civilian spent fuel and HLW.

(3) Disposal of spent fuel or HLW in geologic repositories is not required by law or regulations.

DOE is charged with investigating alternative disposal technologies.

EPA's general environmental standards may apply to any disposal system, but NRC's licensing criteria apply only to geologic repositories.

DEFINITIONS OF TRU WASTE

IN LAWS AND REGULATIONS

DEVELOPMENT OF CURRENT DEFINITIONS OF TRU WASTE

(1) TRU waste originally defined by AEC as waste containing greater than 10 nCi/g of long-lived, alpha-emitting TRU radionuclides, except for high-level waste.

(2) First statutory definition of TRU waste contained in Low-Level Radioactive Waste Policy Act of 1980, but definition not included in Amendments Act of 1985.

TRU waste mentioned but not defined in Nuclear Waste Policy Act of 1982.

There is presently no statutory definition of TRU waste.

(3) In 1982, Federal agencies agreed to increase lower limit on concentration of long-lived, alpha-emitting TRU radionuclides defining TRU waste from 10 to 100 nCi/g.

Redefinition based on difficulties in measuring low levels of alpha activity and analysis of risks to public health from shallow-land burial of TRU waste.

40 CFR PART 191 (1985)

Current regulatory definition of TRU waste developed by EPA -

> TRU waste is waste containing more than 100 nCi/g of alpha-emitting TRU isotopes with half-lives greater than 20 years except for (1) high-level waste, (2) waste that does not need degree of isolation required by 40 CFR Part 191, or (3) waste that NRC approves for disposal in accordance with 10 CFR Part 61.

First exception means that TRU waste may differ from HLW only in concentrations of beta/gamma-emitting radionuclides.

Second exception refers to waste that may not require disposal in geologic repository or equivalent.

Third exception refers to waste that may be acceptable for near-surface land disposal on case-by-case basis.

DOE ORDER 5820.2A, CHAPTER II (1988)

DOE's current definition of TRU waste -

> Without regard to source or form, TRU waste is (1) waste contaminated with alpha-emitting TRU radionuclides with half-lives greater than 20 years and concentrations greater than 100 nCi/g or (2) other alpha-contaminated waste that must be managed as TRU waste.

Definition is similar to EPA's and does not include HLW.

10 CFR PART 61 (1982)

NRC regulations for near-surface land disposal of civilian radioactive waste do not explicitly define TRU waste.

Regulations implicitly acknowledge current definition of TRU waste, because waste with concentrations of long-lived, alpha-emitting TRU radionuclides less than 100 nCi/g is generally acceptable for near-surface land disposal.

REQUIREMENTS FOR DISPOSAL OF TRU WASTE

IN LAWS AND REGULATIONS

REQUIREMENTS IN CURRENT LAW

National Security and Military Applications of Nuclear Energy Authorization Act of 1980 authorized program for disposal of defense TRU waste at Waste Isolation Pilot Plant.

WIPP facility may not be used for permanent disposal of (1) defense or civilian HLW or (2) civilian TRU waste.

Facility will not be licensed by NRC.

Environmental Evaluation Group provides independent technical oversight of DOE activities.

There are no statutes specifically addressing disposal of civilian TRU waste.

40 CFR PART 191 (1985)

EPA standards for management (except for transportation), storage, and disposal of TRU waste from defense and civilian activities.

Standards are same as those for spent fuel and HLW.

DOE ORDER 5820.2A, CHAPTER II (1988)

Order establishes policies and guidelines for managing DOE's TRU waste.

Order addresses -

- classification of materials as TRU waste;
- certification for disposal at Waste Isolation Pilot Plant;
- temporary storage at generating sites;
- new interim storage facilities;
- operation and closure of WIPP;
- alternatives for long-term management of buried TRU waste at inactive DOE sites.

DISPOSAL OF CIVILIAN TRU WASTE

Very little TRU waste is generated in civilian activities.

Alternatives for disposal of civilian TRU waste include -

- near-surface land disposal as approved by NRC on case-by-case basis in accordance with 10 CFR Part 61;
- geologic repositories in accordance with EPA's 40 CFR Part 191 and NRC's 10 CFR Part 60.

DEFINITIONS OF LOW-LEVEL WASTE

IN LAWS AND REGULATIONS

STATUTORY DEFINITIONS OF LOW-LEVEL WASTE

(1) Low-Level Radioactive Waste Policy Act of 1980 contains first statutory definition of LLW.

LLW is radioactive waste not classified as HLW, TRU waste, spent fuel, or uranium or thorium mill tailings.

(2) Nuclear Waste Policy Act of 1982 adopted definition of LLW in Low-Level Radioactive Waste Policy Act.

Definition also included radioactive material that NRC, consistent with existing law, classifies as LLW.

(3) Low-Level Radioactive Waste Policy Amendments Act of 1985 contains current statutory definition of LLW.

LLW means radioactive material that (A) is not HLW, spent fuel, or uranium or thorium mill tailings; and (B) NRC, consistent with existing law and in accordance with Clause (A), classifies as LLW.

Under this definition, TRU waste is a form of LLW.

REGULATORY DEFINITIONS OF LOW-LEVEL WASTE

(1) DOE Order 5820.2A, Chapter III

LLW is radioactive waste not classified as HLW, TRU waste, or spent nuclear fuel.

Definition does not exclude mill tailings, but management of mill tailings is addressed in separate part of Order.

Test specimens of fissionable material irradiated for research and development only may be classified as LLW, provided concentration of long-lived, alpha-emitting TRU radionuclides is less than 100 nCi/g.

(2) Proposed EPA standards in 40 CFR Part 193

LLW is all radioactive waste that is not TRU waste, HLW, spent fuel, or uranium or thorium mill tailings.

(3) NRC regulations in 10 CFR Part 61

Licensing criteria for near-surface land disposal of radioactive waste do not define LLW.

LLW thus can include higher activity waste not generally acceptable for near-surface land disposal.

SUMMARY OF CURRENT DEFINITIONS OF LOW-LEVEL WASTE

(1) LLW is defined only by exclusion.

HLW, spent fuel, and uranium or thorium mill tailings are generally excluded from LLW.

TRU waste is excluded in all definitions except current statutory definition in Low-Level Radioactive Waste Policy Amendments Act, which applies only to civilian LLW.

LLW does not necessarily mean wastes with low radionuclide concentrations.

(2) LLW does not include naturally occurring radioactive material other than source material or artificially produced radioactive material not resulting from production or use of special nuclear material.

These materials are not subject to regulation under Atomic Energy Act.

(3) NRC has statutory authority to define radioactive materials as LLW, but has not exercised authority.

REQUIREMENTS FOR DISPOSAL OF LOW-LEVEL WASTE IN LAWS AND REGULATIONS

LOW-LEVEL RADIOACTIVE WASTE POLICY ACT
OF 1980, AS AMENDED

Disposal technology for civilian LLW is not specified, but shallow-land burial is presumed in accordance with existing practice.

NRC is instructed to (1) identify alternatives to shallow-land burial for civilian LLW and (2) establish technical guidance and requirements for licensing of alternatives.

NRC has published technical studies of alternative disposal technologies but has not established licensing criteria.

10 CFR PART 61 (1982)

LICENSING CRITERIA FOR NEAR-SURFACE LAND DISPOSAL

NRC regulations established licensing criteria for near-surface land disposal of civilian radioactive waste containing source, special nuclear, or byproduct materials.

Standards do not apply to disposal of -

- waste by individual licensees as set forth in NRC's 10 CFR Part 20;
- civilian HLW as provided for in NRC's 10 CFR Part 60;
- uranium or thorium mill tailings.

10 CFR PART 61

(continued)

Regulations contain performance objectives for -

- protection of general population (i.e., dose limits for off-site individuals).
- protection of individuals from inadvertent intrusion into disposal facility (no quantitative criteria specified);
- protection of individuals during operations at disposal site as specified in NRC's 10 CFR Part 20;
- stability of disposal site after closure.

Regulations contain technical requirements, intended to ensure that performance objectives are met, which address -

- site suitability and design;
- facility operation and site closure;
- waste classification;
- waste characteristics.

10 CFR PART 61 WASTE CLASSIFICATION SYSTEM

Waste classification system for near-surface land disposal provides protection of inadvertent intruders, taking into account -

- exposure scenarios for direct intrusion;
- assumed dose limits for intruders;
- requirements on institutional controls, waste form, and disposal methods.

Classification system specifies concentration limits of radionuclides for -

- Class-A, -B, and -C wastes containing shorter-lived radionuclides (half-lives less than about 30 years);
- Class-A and -C wastes containing long-lived radionuclides.

Wastes with concentrations of radionuclides greater than Class-C limits are not generally acceptable for near-surface land disposal, but may be acceptable on a case-by-case basis.

REQUIREMENTS FOR DISPOSAL OF GREATER-THAN-CLASS-C LOW-LEVEL WASTE

(1) Low-Level Radioactive Waste Policy Amendments Act of 1985 assigns DOE responsibility for disposal of civilian greater-than-Class-C LLW, subject to licensing by NRC.

(2) In notice of proposed rulemaking amending 10 CFR Part 61 (1988), NRC indicated intent to require disposal of civilian greater-than-Class-C LLW in geologic repository, unless disposal elsewhere has been approved by NRC.

DOE ORDER 5820.2A, CHAPTER III

Order establishes policies, requirements, and guidelines for managing DOE's solid low-level waste.

Order contains performance objectives including -

- dose limit for members of the public in the general environment;
- dose limits for inadvertent intruders into disposal facility;
- requirements for protection of ground water resources.

Order does not incorporate NRC's waste classification system in 10 CFR Part 61 for protection of inadvertent intruders.

PROPOSED 40 CFR PART 193

MANAGEMENT AND DISPOSAL OF LOW-LEVEL WASTE

EPA standards would apply to all civilian and defense LLW, including greater-than-Class-C waste.

Proposed standards for management, processing, and storage of LLW include -

- dose limit for members of the public in the general environment;
- dose limit for any member of the public which defines waste that is Below Regulatory Concern.

BRC waste would be disposed of only in ways expressly permitted by NRC or DOE or in regulated LLW disposal facilities.

PROPOSED 40 CFR PART 193

(continued)

Standards for disposal of LLW, which would be applicable to any technology, include -

- dose limit for members of the public in the general environment;
- implementation requirements to ensure that dose limit will be met;
- ground water protection requirements.

Standards do not address protection of inadvertent intruders.

REQUIREMENTS FOR MANAGEMENT OF URANIUM AND THORIUM MILL TAILINGS IN LAWS AND REGULATIONS

CURRENT LAWS ADDRESSING URANIUM AND THORIUM MILL TAILINGS

(1) Atomic Energy Act of 1954, as amended, defines uranium or thorium mill tailings as type of byproduct material.

(2) Uranium Mill Tailings Radiation Control Act of 1978

Act is concerned with control and stabilization of uranium or thorium mill tailings for protection of public health and environment.

Act addresses (1) remedial actions at inactive sites performed by DOE with concurrence of NRC and (2) regulation of uranium or thorium ore processing and mill tailings disposal at active sites.

(3) Under current law (i.e., Low-Level Radioactive Waste Policy Act of 1980, as amended) mill tailings are not a form of low-level waste.

40 CFR PART 192 (1983)

URANIUM AND THORIUM MILL TAILINGS

EPA standards govern (1) control and cleanup of residual radioactive materials from inactive uranium processing sites and (2) management of uranium and thorium byproduct materials at active sites.

Standards specify limits on -

- release rate of radon to atmosphere or off-site radon concentration in air above background;
- radium concentrations in soil above background;
- radon decay-product concentrations (including background) in any occupied or habitable building;
- gamma radiation level above background in any occupied or habitable building;
- concentrations of radium and gross alpha-particle activity, excluding radon and uranium, in ground water;
- off-site dose from uranium and thorium processing operations.

Proposed revisions of standards (1987) would include limit on concentration of ^{234}U plus ^{238}U in ground water.

10 CFR PART 40, APPENDIX A

URANIUM MILL TAILINGS

NRC regulations conform in most respects to EPA standards in 40 CFR Part 192, except -

- external photon exposures from tailings or wastes should be reduced to background levels;
- indoor radon decay-product concentrations are not addressed.

NRC regulations also contain -

- technical criteria for siting and design of disposal facilities and protection of ground water;
- requirement that airborne effluents from milling operations shall be as low as reasonably achievable.

DOE ORDER 5820.2A, CHAPTER IV

Order establishes policies and guidelines for managing DOE's uranium and thorium mill tailings.

Materials shall be stored, stabilized in place, and/or disposed of consistent with requirements for residual radioactive material in EPA's 40 CFR Part 192.

Small volumes of waste containing uranium or thorium mill tailings may be managed as low-level waste.

REQUIREMENTS FOR DISPOSAL OF NATURALLY OCCURRING AND ACCELERATOR-PRODUCED RADIOACTIVE MATERIALS IN LAWS AND REGULATIONS

CLASSIFICATION OF NATURALLY OCCURRING AND ACCELERATOR-PRODUCED RADIOACTIVE MATERIALS

Naturally occurring and accelerator-produced radioactive materials are not a form of source, special nuclear, or byproduct material.

NARM is not subject to Federal regulation under Atomic Energy Act, but currently is regulated only by States.

NARM waste is not classified as low-level radioactive waste.

LEGAL AUTHORITY FOR FEDERAL REGULATION OF NATURALLY OCCURRING AND ACCELERATOR-PRODUCED RADIOACTIVE MATERIALS

Because radionuclides are hazardous materials (e.g., as declared in Clean Air Act), EPA may establish general environment standards for management and disposal of NARM under authority of statutes for hazardous materials.

Applicable statute for regulating NARM is Toxic Substances Control Act.

EPA enforces standards for radioactive materials developed under authority of statutes for hazardous materials.

PROPOSED 40 CFR PART 764
MANAGEMENT AND DISPOSAL OF NATURALLY OCCURRING AND ACCELERATOR-PRODUCED RADIOACTIVE WASTE

EPA standards would require that regulated NARM waste be placed in regulated disposal facility for low-level waste.

NARM is defined as any radioactive material not classified as source, special nuclear, or byproduct material under Atomic Energy Act.

Regulated NARM waste means waste with specific activity greater than 2 nCi/g, except for specified consumer products containing small quantities of activity.

Regulated disposal facility means facility for LLW licensed by NRC or Agreement State or authorized by DOE.

NARM waste would be classified as Class-A, -B, or -C waste according to modification of waste classification system in NRC's 10 CFR Part 61.

Proposed EPA standards place similar requirements on disposal of NARM waste and LLW for protection of general public and inadvertent intruders.

REQUIREMENTS FOR MANAGEMENT AND DISPOSAL OF MIXED RADIOACTIVE AND HAZARDOUS CHEMICAL WASTES

RESOURCE CONSERVATION AND RECOVERY ACT OF 1976, AS AMENDED

RCRA imposes "cradle-to-grave" management system on generation, transport, treatment, storage, and disposal of solid hazardous waste with objective of protecting human health and environment.

Detailed reporting mechanisms are established to provide continuous accountability in handling hazardous waste.

Technical standards are established for treatment, storage, and disposal of hazardous waste.

Adherence to technical standards is provided by permitting system for treatment, storage, and disposal facilities.

RCRA and EPA's implementing regulations do not contain quantitative performance objectives to define "protection of human health and environment."

Objective is met by complying with detailed and prescriptive technical standards for obtaining operating permits.

APPLICABILITY OF RCRA TO DISPOSAL OF RADIOACTIVE WASTES

(1) Definition of solid waste in RCRA explicitly excludes source, special nuclear, or byproduct material as defined in Atomic Energy Act.

Result was uncertainty concerning applicability of RCRA to hazardous wastes containing radioactive materials.

(2) EPA, NRC, and DOE agreed that source, special nuclear, and byproduct materials refer only to radionuclides.

Mixed waste contains radionuclides subject to regulation under Atomic Energy Act and hazardous materials subject to regulation under RCRA.

Mixed wastes are subject to regulation under RCRA regardless of classification of radioactive constituents (e.g., as HLW, TRU waste, LLW, or mill tailings).

(3) Mixed waste is subject to dual regulation, i.e., by EPA and NRC or by EPA and DOE.

RCRA precludes any hazardous waste regulation that is "inconsistent" with requirements of Atomic Energy Act.

In event of inconsistencies, Atomic Energy Act would take precedence and RCRA requirement would not apply.

SUMMARY

DEFINITIONS OF PRINCIPAL CLASSES OF RADIOACTIVE WASTE

Principal classes of radioactive waste defined in current law and regulations include high-level waste, transuranic waste, and low-level waste.

HLW is primary waste from reprocessing of spent nuclear fuel (qualitative, source-based definition).

TRU waste is waste containing more than 100 nCi/g of long-lived, alpha-emitting TRU radionuclides, except for HLW.

LLW is waste that is not HLW, spent fuel, or uranium or thorium mill tailings; TRU waste is excluded in some definitions but not others.

Definitions apply only to wastes regulated under Atomic Energy Act, i.e., wastes from production and use of source, special nuclear, and byproduct materials.

IMPLICATIONS OF WASTE DEFINITIONS

(1) Current definitions of HLW, TRU waste, and LLW are not -

- quantitative, i.e., expressed strictly in terms of limits on radionuclide concentrations;
- generally applicable to any waste, regardless of its source; and
- based primarily on considerations of risk, particularly from waste disposal.

(2) Present waste classification system does not distinguish unambiguously between different waste classes.

Primary source of ambiguities in waste definitions is qualitative, source-based definition of HLW.

(3) Wastes with similar properties and requiring similar handling and disposal can be HLW, TRU waste, or LLW.

Different classification of wastes with similar properties results from definitions that depend on source of waste and particular radionuclide constituents.

PROPOSALS FOR NEW CLASSIFICATION SYSTEMS FOR RADIOACTIVE WASTES

(1) D. C. Kocher and A. G. Croff, "A Proposed Classification System for High-Level and Other Radioactive Wastes," ORNL/TM-10289 (1987); Radioact. Waste Manage. Nucl. Fuel Cycle (in press)

Proposed definitions of HLW, TRU waste and equivalent, and LLW based on quantification of terms "highly radioactive" and "requires permanent isolation" using risk analysis.

(2) C. F. Smith and J. J. Cohen, "Development of a Comprehensive Radioactive Waste Classification System," Waste Management '89 (in press)

Proposed definitions of below regulatory concern (BRC) waste, LLW, intermediate-level waste (ILW), and HLW based on quantification of "persistence" (i.e., time required for waste isolation) and different measures of "radioactivity."

Both proposals provide classification system which encompasses all radioactive waste regardless of its source.

REQUIREMENTS FOR DISPOSAL OF PRINCIPAL CLASSES OF RADIOACTIVE WASTE

Under current law and regulations, none of the principal waste classes (HLW, TRU waste, and LLW) require particular disposal systems.

- Decoupling of waste definitions from requirements for disposal permits selection of disposal system without regard to waste classification; i.e., disposal is not affected by ambiguities in present waste classification system.

According to current law, only certain disposal systems are authorized for disposal of some wastes.

- Geologic repositories are only authorized disposal system for civilian spent fuel and HLW and defense HLW.
- Only Waste Isolation Pilot Plant is authorized for disposal of defense TRU waste.

CURRENT INSTITUTIONAL FRAMEWORK FOR REGULATING DISPOSAL OF PRINCIPAL CLASSES OF RADIOACTIVE WASTE

(1) EPA establishes general environmental radiation standards for disposal of particular waste classes.

Standards for particular waste classes apply to any disposal system.

Standards apply to civilian and defense wastes and are enforced by NRC or DOE.

(2) NRC establishes licensing criteria for particular disposal systems.

Regulations for particular disposal systems apply to any waste class.

Regulations apply to all facilities for civilian wastes and certain DOE facilities (e.g., geologic repository).

(3) DOE regulates disposal of defense wastes not licensed by NRC.

Examples include disposal of defense TRU waste at Waste Isolation Pilot Plant and near-surface land disposal of defense LLW at DOE sites.

CURRENT INTENTIONS FOR DISPOSAL OF PRINCIPAL CLASSES OF RADIOACTIVE WASTE

Definitions of waste classes are not associated with requirements for particular disposal systems, but with current legal and regulatory framework -

- spent fuel, HLW, TRU waste, and greater-than-Class-C LLW are intended for disposal in geologic repositories;
- LLW less than Class-C limits is intended for near-surface land disposal.

Current legal and regulatory framework thus admits only two options for radioactive waste disposal.

There are presently no intentions to develop legal and regulatory framework for intermediate disposal facilities.

Facilities would have waste-isolation capabilities intermediate between those for near-surface land disposal and geologic repositories.

Intermediate disposal could be suitable for relatively dilute HLW, TRU waste, or greater-than-Class-C LLW.

REQUIREMENTS FOR DISPOSAL OF OTHER TYPES OF RADIOACTIVE WASTE

(1) Uranium or thorium mill tailings

Mill tailings are byproduct materials regulated under Atomic Energy Act, but are not a form of LLW.

Management and disposal of mill tailings is subject to separate legal and regulatory requirements from other wastes regulated under Atomic Energy Act.

(2) Naturally occurring and accelerator-produced radioactive materials

NARM is not source, special nuclear, or byproduct material and is not regulated under Atomic Energy Act; i.e., NARM waste is not a form of LLW.

EPA proposes to regulate management and disposal of NARM, under authority of Toxic Substances Control Act, as if it were LLW.

REQUIREMENTS FOR DISPOSAL OF MIXED WASTE

(1) Mixed waste is waste containing radioactive materials, as defined in Atomic Energy Act, and hazardous materials, as defined in RCRA.

(2) In disposing of mixed waste, only radionuclides are regulated under Atomic Energy Act, and hazardous materials are regulated under RCRA.

(3) If inconsistencies arise in dual regulation of mixed waste, Atomic Energy Act would take precedence and inconsistent RCRA requirements would not apply.