HEALTH PHYSICS SOCIETY
Specialists in Radiation Safety

Background Information on "Low-Level Radioactive Waste Management" Position Statement of the Health Physics Society* Adopted October 1993, Revised May 1995, Updated July 1998, Revised July 1999, Revised September 2005, Revised July 2017

Approved by the Scientific and Public Issues Committee
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INTRODUCTION

The Health Physics Society (HPS) initially issued a position statement in October 1993 titled "Low-Level Radioactive Waste." In that statement, the HPS expressed concern over the way in which the Low-Level Radioactive Waste Policy Act (LLWPA) of 1980, as amended in 1985 (LLWPAA), was being implemented. The position statement was then revised in May 1995 to focus on the issue that disposal facilities were not being developed, resulting in waste being stored at the sites where it was generated. This revision established the Society position that disposal, not temporary storage, is the safest approach. In July 1998, the position statement was updated to reflect obstacles encountered in California and Texas in trying to site a disposal facility. One year later, the Society revised the position statement again. In that revision, the Society took the position that the LLWPA unnecessarily restricted access to available disposal sites and impeded open commercial development of additional facilities. The Society significantly revised the position statement in 2005, giving it a different title, "Low-Level Radioactive Waste Management Needs a Complete and Coordinated Overhaul."

This document provides background supporting information for the revised position statement issued in July 2017 titled "Low-Level Radioactive Waste Management." It should be considered an adjunct to the position statement and is not a stand-alone document.

RATIONALE FOR THE JULY 2017 REVISION

The 2005 position statement titled "Low-Level Radioactive Waste Management Needs a Complete and Coordinated Overhaul" focused on the difficulties of siting new disposal facilities for Class A, B, and C low-level radioactive waste (LLW) pursuant to the LLWPA of 1980, as amended in 1985. Moreover, disposal options available at that time were both limited and expensive as described in the background information supporting the 2005 position statement.

Many of the positions and recommendations were based on written testimony prepared by the HPS for the U.S. Senate Energy and Natural Resources Committee (the "Committee") during a hearing held on 30 September 2004 (Health Physics Society 2004). The Committee scheduled the hearing to gather information regarding the available capacity for disposal of Class A, B, and C LLW based on a report prepared by the Government

Accountability Office (GAO), titled *Low-Level Radioactive Waste, Disposal Availability Adequate in the Short Term, but Oversight Needed to Identify any Future Shortfalls* (Government Accountability Office 2004).

The Committee subsequently commissioned a study by the National Academy of Sciences' Board of Radioactive Waste Management and commissioned other reports by the GAO, which were completed by 2007. The HPS shared its views with the GAO on recommendations needed to improve radioactive waste management and the security of disused radioactive sealed sources. The Society sought improvements that would provide greater accessibility to disposition all classes of LLW, including waste with concentrations exceeding the limits for Class C LLW (referred to as greater-than-class C or GTCC LLW).

A primary focus of positions and recommendations addressed in the 2005 position statement related to the prohibition of most of the states (those states that did not belong to the Atlantic Interstate Low-Level Radioactive Waste Management Compact) to access the regional disposal facility located near Barnwell, South Carolina, beginning on 1 July 2008. Soon thereafter, Class B/C LLW generated in 36 states was effectively stranded with long-term storage of the waste being the only option available. The Society's positions provided recommendations, including recommendations to consider obtaining access to federal lands to construct a new disposal facility or allowing the use of disposal facilities operated by the U.S. Department of Energy (DOE) for disposition of commercially generated Class B/C LLW. While the HPS positions clearly noted the shortfalls in constructing new disposal facilities as envisioned pursuant to the LLWPA of 1980, it recognized the potential for opening a new regional disposal facility in Texas.

Over the next few years after the 2005 position statement was published, the Society was actively engaged with GAO, the U.S. Nuclear Regulatory Commission (NRC), and other stakeholders on its positions to improve radioactive waste management and security of disused radioactive sealed sources in a more risk-informed manner.

On 14 January 2005, the HPS and the Organization of Agreement States (OAS) issued a joint position statement titled "Congressional Action Is Needed to Ensure Uniform Safety and Security Regulations for Certain Radioactive Materials" to members of Congress and select federal government agencies (Guilmette and Thompson 2005). The primary principles specified in this position statement were intended to ensure the establishment of regulatory authority governing the control and disposal of certain naturally occurring and accelerator-produced radioactive materials (NARM). More specifically, the position statement intended to ensure controls were established in regulations that would be promulgated by the NRC for discrete sources of ^{226}Ra and certain accelerator-produced radioactive materials. Uniform regulatory controls were needed over certain radioactive material that could be used in a radiological dispersal device (RDD) or a radiological exposure device (RED) and which would exceed the activity thresholds established by the International Atomic Energy Agency's (IAEA) *Code of Conduct for the Safety and Security of Sealed Sources* (Code of Conduct) (International Atomic Energy Agency 2005). Among other things, the HPS-OAS position statement recommended authorizing flexible waste-disposal options that were safe, economical, and commensurate with the level of risk that these radioactive sources pose to public health and safety. This recommendation was recognized by the National Academy of Sciences as an important step toward making their control more uniform and consistent with their actual radiological properties and risks (National Academy of Sciences 2006).

Many of the provisions contained in the position statement were ultimately incorporated in Section 651 of the Energy Policy Act of 2005 (EPAct). On 8 August 2005, President George W. Bush signed this legislation into law, and the United States became the first of 74 member states committed to implement the Code of Conduct, bringing ^{226}Ra and certain accelerator-produced radioactive materials under uniform federal control. Approximately two years later, the NRC promulgated a rulemaking titled *The Expanded Definition of Byproduct Material* to implement provisions specified in the EPAct.

The Society prepared a report titled *Actions Needed to Better Secure Vulnerable Radioactive Sources: A Contemporary Report Prepared by a Working Group of the Health Physics Society* in September 2005 (McBurney 2005). In January 2006, the Society also issued a position statement titled "Continued Federal and State Action Is Needed For Better Control of Radioactive Sources" based on information contained in this report. This report regarding actions needed to protect vulnerable sources was submitted to the Senate Committee, GAO, and various federal regulatory agencies. The HPS recognized that security of disused sealed sources was complicated by the expense and lack of accessible disposition pathways, as well as the shortage of available transportation packages licensed by the NRC. This information provided by the HPS and other stakeholders was included in GAO's report titled *Low-Level Radioactive Waste: Approaches Used by Foreign Countries May Provide Useful Lessons for Managing U.S. Radioactive Waste*, GAO-07-221, published in March 2007 (Government Accountability Office 2007).

In March 2007, the HPS requested the South Carolina legislature to authorize access to the disposal facility in Barnwell to nonregional generators through 2023. The Society requested such action to seek other waste-disposal alternatives to avoid stranding Class B/C LLW generated in 36 states not belonging to the Atlantic Compact (Dodd 2007). However, South Carolina prohibited access to nonregional waste generators for the disposal of Class A, B, and C LLW beginning on 1 July 2008.

NEW SOLUTIONS EMERGED: MUCH HAS CHANGED SINCE 2005

Events have occurred related to accessible waste-management disposal options and waste minimization, as well as waste-classification practices, that have necessitated revisions to the 2005 position statement. These events, which are discussed in more detail herein, include:

- The opening of a new regional disposal facility in Texas at which Class B/C LLW that had been stranded in 36 states since 1 July 2008 may be safely disposed of.
- Volume reduction and blending services provided by waste processors that have significantly reduced the volumes of Class B/C LLW generated.
- Revisions to the 1995 NRC branch technical position (BTP) on concentration averaging and encapsulation.
- Regulatory flexibility that further authorizes the disposal of waste with very low levels of radioactivity in a disposal facility controlled by the Resource Conservation and Recovery Act (RCRA).

Regional Compacts

Pursuant the LLWPA of 1980, Congress charged each state with developing disposal facilities for commercial waste generated within its borders, but also authorized states to join together and enter into regional compacts. While the legislation has not produced the results that Congress intended, it has resulted in some successes.

Additionally, significant changes have developed within the nuclear industry that were not envisioned when the LLWPA was established by Congress in 1980.

At present, 40 states have entered into 10 regional compacts, some of which have access to dispose of commercially generated LLW in one of three disposal facilities located in Richland, Washington; Barnwell, South Carolina; and Andrews County, Texas. Moreover, the waste generated in three states belonging to the Rocky Mountain Low-Level Radioactive Waste Compact (Rocky Mountain Compact) were granted access to the disposal facility in Richland, Washington, in accordance with an agreement with the Northwest Interstate Compact on Low-Level Radioactive Waste Management (Northwest Compact). Additionally, generators of Class A LLW not belonging to either the Rocky Mountain or the Northwest Compacts are authorized to dispose of Class A LLW in a facility owned by Energy*Solutions* Inc., which is located in Clive, Utah.

The Opening of a New Regional Disposal Facility

In 2003, Texas enacted legislation that authorized the "privatization" of a new regional waste-disposal facility that would provide services both to the commercial sector and for certain radioactive wastes owned or generated by the federal government. The Texas Radiation Control Act required Texas to take title of Class A, B, and C LLW generated by the commercial sector at the time of disposal. It also required DOE to take title of LLW as defined in the LLWPAA of 1985 at the time of site closure in perpetuity.

Prior to enacting this legislation, Texas had unsuccessfully attempted to license a regional disposal facility for Class A, B, and C LLW near Sierra Blanca, Texas; failure was attributable largely to lack of community support. Several states had also been unsuccessful at opening regional disposal facilities at 10 other locations across the country at a cost of over $600 million as reported by the GAO (Government Accountability Office 1999). These failed attempts at opening new regional disposal facilities were primarily the result of lack of political will and had less to do with technical issues. Moreover, these unsuccessful attempts underscored the difficulties of fulfilling the expectation of Congress as mandated by the LLWPAA of 1985.

Constructing a disposal facility would be expensive and only small volumes of commercial waste were expected to be generated within the Texas Low-Level Radioactive Waste Disposal Compact (Texas Compact[1]). As such, policy makers recognized early on that both disposal facilities would be needed to ensure the economic viability of a regional disposal facility that would be licensed, constructed, and operated by the private sector in Texas.

In September 2009, the Texas Commission on Environmental Quality (TCEQ) issued a license resulting in the construction and operation in Andrews County, Texas[2] of the first regional disposal facility since Congress enacted the LLWPA of 1980. Soon after the license was granted, efforts began that would allow for the importation of Class B/C LLW generated in states not belonging to the Texas Compact. This initiative was directed to provide a disposal path for waste that had been stranded in 36 states with the decision to limit access to the disposal facility in Barnwell by nonregional generators.

[1]Texas Compact is comprised of Texas and Vermont.

[2]Texas Radioactive Material License No. R04100, Amendment 0, 9 September 2009

Pursuant to the Texas Radiation Control Act, provisions allow for other states to join the Texas Compact. More recent legislative changes have also created a framework that authorizes the importation of certain volumes and activities of waste generated in states not belonging to the Texas Compact. Waste imported for disposal by nonregional generators are charged a higher rate than those belonging to the Texas Compact. Additionally, the volumes of waste authorized for disposal are restricted to ensure adequate capacity will be available to waste generators belonging to the Texas Compact.

At present, Class B/C LLW generated in each of the 50 states across the country may be safely disposed of in one or more of the three regional facilities located across the county. Additionally, a framework currently exists allowing other states to join existing regional compacts pursuant to the LLWPA of 1980.

Waste Management Innovations Have Changed the Volumes of LLW Generated in the United States

Over the past several decades, the volumes of Class B/C LLW generated in the nation have steadily decreased. This decrease has been attributed to the high cost of waste disposal and previous concerns regarding the accessibility of disposal facilities for Class B/C LLW. As a result, waste generators and processors have created innovative solutions to reduce the volumes of such waste considerably. Recent studies by the Electric Power Research Institute (EPRI) have concluded that the volumes of Class B/C LLW generated in the commercial sector will continue to decline even more over the next decade (National Academy of Sciences, Engineering, and Medicine 2017).

Moreover, the nuclear industry began to develop capabilities for long-term storage of Class B/C LLW. This action was the only solution available to many waste generators in 36 states because of the prohibited access to the disposal facility in Barnwell. Such capabilities for long-term storage of Class B/C LLW continue to be exercised today.

The storage of disused sealed sources continues to pose concerns, especially because of their potential use as RDDs or REDs. A working group sponsored by the Low-Level Radioactive Waste Forum recently issued a report with many worthwhile recommendations regarding disused sealed sources titled *A Study of the Management and Disposition of Sealed Sources From a National Security Perspective* (Low-Level Radioactive Waste Forum 2014). An important recommendation was the need to require financial assurance that would ensure funds were set aside to pay for disposal of disused sealed sources as a condition of the radioactive material license granted to the user of such devices. Furthermore, the working group recommended limiting the time disused sealed sources could remain in storage without being used for their intended purpose.

The HPS supported an advanced notice of proposed rulemaking (ANPR) initiated by the U.S. Environmental Protection Agency (EPA) in 2003 that would have authorized the disposal of waste with very low levels of radioactivity in disposal facilities regulated under RCRA. While the EPA has not taken steps to proceed with the ANPR, the NRC has advanced its licensing processes that would authorize disposal of waste with very low levels of radioactivity in disposal facilities regulated under RCRA in accordance with Title 10 of the Code of Federal Regulation (CFR), §20.2002 (10 CFR 20.2002), *Method for Approval of Proposed Disposal Procedures*.

While this process has been effective in authorizing disposal of large volumes of waste largely attributed to decommissioning of commercial nuclear reactors and radioactive-material-licensed facilities, it typically has

required 9–18 months to receive approvals by the NRC or Agreement States. However, not all Agreement States chose to adopt a Part 20.2002-like regulation. To better ensure consistency in the process of approving such requests by the licensed community, the NRC issued a letter to all Agreement States describing its expectations to process such requests received from licensees (Nuclear Regulatory Commission 2012). The NRC has stated Agreement States that had not adopted a Part 20.2002-like regulation could approve such a request received by a licensee as a regulatory "exemption," which typically requires a demonstration that the request is not prohibited by law and is not inimical to public health and safety.

At present, the NRC is potentially considering a rulemaking that would authorize the disposal of waste with very low levels of radioactivity in RCRA landfills. Such a rulemaking would further endorse the disposal based on risk it posed to public health, as opposed to the waste's origin and statutory definitions. Moreover, it would serve to better ensure safe, but considerably lower-cost, decommissioning of the large number of commercial nuclear power plants that have been announced or are expected over the next decade.

1995 BTP on Concentration Averaging and Encapsulation

In 1995, the NRC published its BTP on concentration averaging and encapsulation, providing regulatory guidance to the licensed community on practices that could be used to average the concentration of activity over the volume of the waste package for the purpose of determining waste classification. The BTP focused primarily on disused sealed sources, irradiated components, and filters. The BTP placed constraints on preventing the use of "extreme measures" that would allow for the intentional mixing or blending of higher-activity waste or waste of lesser concentrations for the purpose of changing waste classification. The guidance also placed constraints to avoid stratification or generation of "hot spots" within the waste package that could potentially become problematic should the waste be exhumed by an inadvertent intruder after expiration of the 100-year institutional control period specified in 10 CFR 61.

In 2007, the NRC published its intent to revise the BTP to provide the licensed community with greater flexibility to better classify waste in a more risk-informed manner as part of the *Strategic Assessment of its Low-Level Waste Radioactive Waste Program* (Nuclear Regulatory Commission 2007a). The NRC proposed revising the BTP to allow the licensed community to intentionally blend high-activity waste with lower-activity waste for the purpose of changing waste classification. Such a revision would result in a significant reduction in the volumes of Class B/C LLW generated across the country. Moreover, Class B/C LLW that was blended to levels below the limits for Class A LLW could be disposed of in Clive, Utah. The proposed revisions to the BTP would provide a disposal pathway for some Class B/C LLW that was stranded in 36 states affected by the prohibited access to the disposal facility in Barnwell.

Several stakeholders noted that disposal of waste blended to the upper limit established for Class A LLW had not been evaluated when 10 CFR 61 was initially promulgated in 1982. The NRC was encouraged to require an intruder analysis as part of a rulemaking that would ensure the disposal of waste at the upper bounds of the limits for Class A LLW would not result in unacceptably high radiation doses to an inadvertent intruder. Other stakeholders also encouraged flexibility in allowing concentration averaging over a waste package with a volume of no more than 9.5 m^3, instead of a 0.21-m^3 container, as was the package limit in the 1995 BTP.

During deliberations regarding revisions to the BTP, the NRC Commissioners directed staff to allow intentional blending of waste for the purpose of changing waste classification with the constraints proposed in the BTP (Nuclear Regulatory Commission 2008). The NRC Commissioners also accepted staff recommendation to include in the rulemaking a revision of 10 CFR 61 for long-lived radionuclides (formerly referred to as the *Site-Specific Analysis Rulemaking*), a regulatory requirement for disposal facility operators to conduct an intruder assessment intended to better protect public health and safety.

The NRC established constraints to limit the radioactivity that could be present in individual waste packages for select radionuclides in the 1995 BTP. Such constraints were established to minimize radiation doses should an intruder exhume waste containing intact durable discrete items, such as sealed sources. The NRC was encouraged to reexamine the technical bases that were used to establish the activity constraints using more realistic assumptions to ensure an inadvertent intruder would not receive a dose of radiation exceeding 5 millisieverts (mSv) in a year . Many stakeholders noted such approaches could provide a disposal pathway for disused sealed sources that were currently orphaned as part of the Source Collection and Threat Reduction Program established by the U.S. DOE/National Nuclear Security Administration and the Conference of Radiation Control Program Directors.

Other stakeholders encouraged the NRC to provide additional flexibility for waste-disposal facility operators to use "alternative" approaches for concentration averaging and encapsulation that would allow greater levels of activity to be present in a waste package. Such approaches are intended to allow site-specific considerations, such as the depth of waste emplacement and/or enhanced waste packages that could be employed during waste emplacement and would impede an intruder from exhuming discrete items after expiration of the 100-year institutional control period.

The NRC published its guidance titled *Concentration Averaging and Encapsulation Branch Technical Position, Revision 1*, in February 2015 (Nuclear Regulatory Commission 2015a). The revised BTP provided guidance to licensees regarding blending of radioactive waste that would allow its reclassification as Class A LLW for disposal in a risk-informed manner. The revised BTP also provided considerably greater flexibility in concentration averaging disused sealed sources that pose a potential threat to national security in the event such sources were used for malevolent purposes. Application of the BTP by the licensed community is expected to significantly reduce the volumes of Class B/C LLW that they generate (National Academy of Sciences 2017).

CHALLENGES AHEAD

While many innovative solutions have emerged since 2005 that provide safe and cost-effective disposal options for Class A, B, and C LLW, other challenges remain in providing disposal pathways for waste streams that are currently orphaned (Kirk 2017). Over the past several years, significant strides have been made to provide a disposal pathway for GTCC LLW and commercially generated transuranic (TRU) waste.

Policy makers, regulatory agencies, and other stakeholders have encouraged establishing a framework to better classify and dispose of radioactive wastes based on the risk posed to public health and safety and not on its origins and statutory definitions. While some progress has been made, additional work will be required to accomplish this goal, especially for GTCC LLW and commercial and nondefense-related waste containing TRU

radionuclides with concentrations exceeding 3,700 becquerels per gram (Bq g^{-1}). Such efforts require rulemaking(s) by the federal agencies.

Final Environmental Impact Statement Issued by DOE for GTCC and GTCC-like LLW

Congress charged the DOE with the responsibility of providing a disposal pathway for commercially generated GTCC LLW pursuant to Section 3.b of the LLWPAA of 1985. DOE was also assigned the responsibility of disposing of LLW it owned or generated.

Pursuant to the EPAct of 2005, DOE issued its final environmental impact statement (EIS) for GTCC LLW and selected a commercial disposal facility and the Waste Isolation Pilot Plant (WIPP) located near Carlsbad, New Mexico, as the preferred alternatives for disposal (Department of Energy 2016). It must also submit a report to Congress describing the actions needed to fulfill responsibilities to disposition commercially generated GTCC LLW.

Transuranic Waste

DOE currently manages both defense-related and nondefense-related TRU waste. It also manages commercially and federally owned or generated disused sealed sources containing isotopic plutonium, americium, and other TRU radionuclides that will require a disposition pathway pursuant to the LLWPAA of 1985.

In the LLWPA of 1980, Congress intended to clearly define the types of waste for which the states and the federal government were required to provide a disposal pathway. As such, Congress originally defined LLW to mean:

> *Radioactive waste not classified as high-level radioactive waste, transuranic waste, spent nuclear fuel, or byproduct material as defined in section 11e.(2) of the Atomic Energy Act of 1954.*

The NRC similarly defined "waste" in 10 CFR 61.2 consistent with the provisions of the LLWPA of 1980. However, the NRC sought public comment on the best way to classify waste containing TRU radionuclides when 10 CFR 61 was promulgated in 1982. Some stakeholders urged the Commission to classify waste with certain TRU radionuclides exceeding 370 Bq g^{-1} as a subset of GTCC LLW. Others argued against establishing such a limit because it may create enforcement issues given the difficulties in detecting transuranic radionuclides with the radiation detection instrumentation available at the time. The NRC chose to define waste containing TRU radionuclides with half-lives greater than 20 years and at concentrations exceeding 3,700 Bq g^{-1} as GTCC LLW as specified in 10 CFR 61.55. However, the NRC did not define "TRU waste" in a rulemaking because only small quantities were generated in the commercial sector, and DOE was responsible for such waste it owned or generated (Nuclear Regulatory Commission 2007b).

Soon after 10 CFR 61 was promulgated in 1982, NRC considered raising the limits of transuranic GTCC LLW from 3,700 Bq g^{-1} to 11,100 Bq g^{-1} (11.1 kBq g^{-1}) under its authority established in the Atomic Energy Act of 1954 (AEA) (Brown 1986). During deliberations regarding the LLWPAA of 1985, Congress changed the definition of LLW by removing the "TRU" exclusionary language. This action was taken to ensure waste containing TRU radionuclides exceeding 370 Bq g^{-1} or as otherwise defined by the NRC would remain defined as LLW. This change would ensure waste with certain transuranic radionuclides exceeding 3,700 Bq g^{-1} were considered GTCC

LLW and charged DOE, not the states, with the responsibility of providing a disposal pathway. The intent of Congress was to ensure either DOE or the states would be responsible for providing a disposal pathway; otherwise such waste generated in the commercial sector would be orphaned.

Accordingly, Congress revised the definition of LLW in the LLWPAA of 1985 as follows:

> *. . . "low-level radioactive waste" means radioactive material that is not high-level radioactive waste, spent nuclear fuel, or byproduct material (as defined in section 11e.(2) of the Atomic Energy Act. . .).*

In 1989, the NRC initiated a rulemaking to incorporate provisions of the LLWPAA of 1985 into 10 CFR 61 (Federal Register 1989). While the NRC included provisions that charged it with the responsibility to license the disposal of GTCC LLW generated by the commercial sector, it inadvertently did not revise the definition of waste in 10 CFR 61.2 to remove the TRU exclusionary language (National Academy of Sciences 2017). Consequently, commercially generated waste containing TRU radionuclides with half-lives longer than 20 years and at concentrations exceeding 3,700 Bq g^{-1} is not LLW—such waste is currently orphaned with no disposition pathway available (Kirk 2015).

Defense vs. Nondefense TRU

The DOE is responsible for LLW it owns or generates, but it does not use the same waste-classification tables as those established by the NRC (i.e., DOE does not classify waste as Class A, B, C, or GTCC LLW). DOE has generated significant quantities of TRU radionuclides in support of both its defense and nondefense missions.

The DOE classifies radioactive waste it owns or generates consistent with the Nuclear Waste Policy Act of 1982 (NWPA). When this legislation was enacted, Congress delegated responsibility to establish regulations governing the disposal of high-level radioactive waste (HLW), spent nuclear fuel (SNF), and TRU waste to the EPA. However, Congress did not alter the definition of LLW, and the definition remained consistent with language in the LLWPA of 1980. As such, DOE waste-management programs were established to manage HLW, SNF, and TRU waste it owned or generated.

In 1985, EPA established regulations to protect the environment from disposal of such waste in 40 CFR 191, *Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes.* In support of establishing requirements for the disposal of waste containing TRU radionuclides, EPA provided exceptions regarding whether waste containing TRU radionuclides with half-lives greater than 20 years and at concentrations exceeding 3,700 Bq g^{-1} would require disposal in a geologic repository or, otherwise, be dispositioned in a disposal facility as LLW.

Under the exceptions specified in 40 CFR 191.02(i), waste containing transuranic radionuclides at concentrations exceeding 3,700 Bq g^{-1} and with half-lives greater than 20 years is not TRU waste if it is (1) HLW, (2) wastes the DOE has determined, with concurrence from EPA, do not need the degree of isolation required in 40 CFR 191, or (3) wastes the NRC has approved on a case-by-case basis in accordance with 10 CFR Part 61.

In 1992, Congress enacted the WIPP Land Withdrawal Act to establish requirements governing the disposal of defense-related TRU waste at the WIPP. Pursuant to this legislation, the definition and exceptions for TRU were made consistent with the provisions in 40 CFR 191.

At present, only defense-related TRU waste owned or generated by DOE is authorized for disposal. DOE's nondefense-related TRU waste is currently orphaned with no disposal option available.

Degree of Isolation

Over the past few decades, progress has been made to better classify radioactive waste based on the risk posed to public health and safety and not based on its origins and the manner in which it is defined in federal legislation. As discussed, EPA had defined TRU waste based on the "degree of isolation" that would be required for the disposal of such waste. The NRC and DOE also established processes that could be used to reclassify HLW determined to be waste incidental to reprocessing SNF and managed as LLW.

The NRC considered a rulemaking titled *Definition of "High Level Waste"* to include levels of radioactivity to distinguish HLW from LLW in its ANPR in 1987 (Federal Register 1987). The Commission also adopted regulations related to land disposal of LLW based on an analyses of potential human health hazards that are routinely acceptable for near-surface disposal. The NRC recognized that Class C limits did not denote a maximum concentration limit for LLW. HLW was currently defined by source (rather than concentration or hazard) and was limited to reprocessing wastes and spent fuel. Thus, concentrations of LLW have no regulatory limit, and some LLW (exceeding Class C concentrations) may have concentrations approaching those of HLW. These were wastes the Commission considered evaluating for possible classification as HLW. However, the NRC recognized that HLW would require "permanent isolation" if it could not be disposed of in a facility less secure than a geologic repository. If such waste did not require disposal in a geologic repository licensed by the NRC pursuant to 10 CFR Part 60 and could be managed safely in a near-surface disposal facility, then it would be considered LLW.

Later in 1993, the NRC denied a petition for rulemaking requested by the states of Washington and Oregon to define HLW based on the levels of radioactivity and decay heat generated from radioactive material that had been placed in storage in double-shell tanks in DOE's reservation in Hanford, Washington (Nuclear Regulatory Commission 1993). Both Washington and Oregon argued the definition of HLW should be revised in a rulemaking to delineate whether some or all of the waste should be subject to the NRC licensing authority based on strict criteria limiting the levels of radioactivity and heat generated.

The NRC denied the petition for rulemaking, concluding that the principles for waste classification were well established and could be applied on a case-by-case basis without a revision to regulation. The NRC agreed with DOE that the residual fraction of waste[3] considered as waste incidental to processing could be considered LLW instead of HLW, if the waste (1) had been processed to remove key radionuclides to the maximum extent practical, (2) would be incorporated in a solid physical form at concentrations that would not exceed

[3]The residual fraction of such waste that may be considered as "waste incident to reprocessing" and dispositioned as LLW is often referred to as "low-activity waste."

concentration-based limits for Class C LLW, and (3) would be managed so the safety requirements specified in the performance objectives of 10 CFR 61 were met.

This important policy decision to distinguish HLW from waste incidental to reprocessing of SNF that could be managed as LLW and disposed of in a near-surface disposal facility was later incorporated into DOE Order 435.1, *Radioactive Waste Management,* in 1999.

Several environmental coalitions litigated whether waste determined to be incidental to reprocessing should be reclassified as LLW by DOE as specified in revisions to DOE Order 435.1. At issue was whether Congress had intended to authorize DOE to make such determinations pursuant to the NWPA or if such policy decisions should reside with the NRC. The U.S. Court of Appeals, Ninth Circuit, dismissed the case supporting DOE's position that it could make the determination to manage waste incidental to reprocessing as LLW in accordance with DOE Order 435.1 (United States Court of Appeal 2004). Soon thereafter, Congress enacted Section 3116 of the Ronald Reagan National Defense Reauthorization Act of 2005, which established a framework for determining whether HLW could be classified and managed as LLW in accordance with the requirements mandated under Subpart C of 10 CFR 61. This process requires that the Secretary of Energy, in consultation with the NRC, must make a determination whether certain waste considered as waste incidental to reprocessing could be managed as LLW provided the waste does not require permanent isolation in a geologic repository; has had key, highly radioactive radionuclides removed to the maximum extent technically and economically practicable; and is either Class C or GTCC LLW, but will be disposed of in a manner that complies with the performance objectives specified in 10 CFR 61. The legislation also requires that disposal of GTCC LLW must be in accordance with plans established by the DOE in consultation with the NRC and approved by one of the covered states. The covered states include South Carolina and Idaho.

The DOE has recently revisited possible revisions to Order 435.1 to provide greater flexibility in determining whether HLW should be reclassified and disposed of as defense-related TRU waste at WIPP or as LLW at a federal or commercial LLW facility. The GAO reported that such approaches could greatly improve the manner in which DOE may disposition certain radioactive wastes in a more risk-informed and cost-effective manner (Government Accountability Office 2017). Moreover, GAO recommended, among other things, that Congress should consider clarifying DOE's authority to determine, in consultation with NRC, whether portions of supplemental "low-activity waste" can be managed as a waste type other than HLW.

Petition for Rulemaking

In July 2014, Waste Control Specialists LLC filed a petition for rulemaking seeking a pathway for the disposal of GTCC LLW and TRU waste at its disposal facility in Andrews County, Texas, with the TCEQ (Waste Control Specialists 2014). The petition sought to repeal regulations established by the TCEQ that prohibited the disposal of GTCC LLW and TRU. The petition recognized inconsistencies between state regulations and those established in Texas statutes and federal regulations. It also noted disposal of GTCC LLW is authorized in accordance with 10 CFR 61.55 and disposal of certain TRU exceeding 3,700 Bq g^{-1} could be approved on a case-by-case basis by the NRC. However, the petition recognized a discrepancy that the NRC had not revised the definition of "waste" in its regulations consistent with the definition of LLW as defined in the LLWPAA of 1985.

The petition sought to better align state regulations with Texas statutes regarding the disposal of waste defined as "federal facility waste." Pursuant to Chapter 401 of the Texas Radiation Control Act, federal facility waste is waste for which disposal is the responsibility of the federal government as defined in the LLWPAA of 1985. This provision of the legislation adopted in Texas ensures that only GTCC LLW generated by the commercial sector, as well as Class A, B, C, and GTCC-like LLW owned or generated by DOE, may be disposed of at the Federal Waste Disposal Facility in Andrews County, Texas. The legislation also required the DOE to take title of such waste in perpetuity at the time of site closure. This framework was established to ensure either Texas or the federal government would be responsible for waste disposal as articulated in the LLWPAA of 1985.

The TCEQ commissioners unanimously approved the petition in September 2014 (Texas Commission on Environmental Quality 2014). The Commission directed its staff to seek clarification regarding its authority and jurisdiction to regulate the disposal of GTCC LLW and TRU waste with its federal counterparts, before initiating a rulemaking to remove the prohibition on disposal of such wastes in Texas. Soon thereafter, TCEQ submitted a letter seeking such clarifications from the NRC on 30 January 2015 (Texas Commission on Environmental Quality 2015).

Historical and Current Issues Related to the Disposal of GTCC LLW

In July 2015, in response to the letter from Texas requesting clarification regarding its authority and jurisdiction to regulate the disposal of GTCC LLW, the NRC published a report (SECY-15-0094) with recommendations titled *Historical and Current Issues Related to the Disposal of GTCC LLW* (Nuclear Regulatory Commission 2015b). In its report, NRC staff recommended that Texas, as an Agreement State that has adopted compatible regulations governing the disposal of LLW pursuant to Section 274 of the AEA, should be authorized to regulate the disposal of GTCC LLW. The NRC may retain exclusive licensing authority over the disposal of byproduct, source, or special nuclear materials that it determines by regulation or order should not be disposed of without a license issued from the NRC pursuant to Section 274.c of the AEA because of the hazard posed to public health.

The NRC staff recognized that the definition of "waste" specified in 10 CFR 61.2 was inconsistent with LLWPAA of 1985. It acknowledged that waste with commercially generated transuranic radionuclides with half-lives longer than five years and with concentrations exceeding 3,700 Bq g^{-1} was currently orphaned, and it recommended proceeding with a rulemaking to resolve the discrepancy.

The NRC staff recognized that the inventory of GTCC LLW generated within the commercial sector was comprised of distinctly different types of waste with varying radionuclides. Some wastes were activated metals, others contained TRU radionuclides, and some contained fission products that could generate considerable heat through radioactive decay, such as disused radioisotope thermoelectric generators. It was recognized that some of the categories of GTCC LLW may be suitable for disposal in a near-surface disposal facility regulated under Part 61. However, other types of GTCC LLW, such as those containing TRU radionuclides, should be controlled for nuclear nonproliferation purposes, as well for radiation protection.

On 13 August 2015, the NRC Commissioners conducted a briefing on GTCC LLW. The DOE discussed the environmental impacts that were analyzed in its final EIS. It recognized that the environmental impacts associated with the disposal of GTCC LLW in an arid environment were considerably less than those associated

with a disposal facility located in a more humid environment. Others encouraged a reconsideration of the technical basis that was used to establish the limits for Class A LLW when Part 61 was promulgated in 1982.

When 10 CFR 61 was initially promulgated, it established requirements for disposal of Class A, B, and C LLW. It also recognized that disposal of GTCC LLW was not generally suitable for near-surface disposal and disposal of such waste would require different and more stringent waste forms and disposal requirements. While the general preference for disposal of GTCC LLW was in a geologic repository licensed for HLW and/or SNF, the NRC did not desire to foreclose the option to allow the disposal of such waste in an intermediate-depth waste disposal facility (IDWDF). At present, a consensus definition of the design or criteria for an IDWDF does not exist either domestically or in the international community. The IAEA suggests intermediate-level waste be disposed of at depths ranging from tens to hundreds of meters (m), as specified in its safety standards titled *Classification of Radioactive Waste* (International Atomic Energy Agency 2009).

The EIS that was developed to support promulgation of Part 61 established limits for Class C LLW intended to ensure an inadvertent intruder would not receive a dose of radiation exceeding 5 mSv in a year (Nuclear Regulatory Commission 1981). The exposure scenarios considered by the NRC at that time had assumed the disposal facility was located in a humid environment on the east coast of the United States. The limits for Class A, B, and C LLW were also established using radiological biokinetics and dosimetry published in the International Commission on Radiological Protection's (ICRP) Report 2, *Permissible Dose for Internal Radiation*, published in 1959. This assumption was based on the belief that several nuclear power plants on the east coast would be decommissioned and their waste disposed of at a facility similar in design and siting characteristics to the disposal facility in Barnwell, South Carolina.

The NRC had assumed a future resident would unknowingly construct a dwelling over a waste-disposal facility and install a drinking-water well at the margins of the disposal units. Water used for drinking water and to irrigate food was assumed to be contaminated from the nearby radioactive-waste-disposal facility.

The NRC established the Class C limits requiring that waste be disposed of at a depth of at least 5 m below ground or require the use of engineered intruder barriers that could be relied upon for 500 years. Disposal at such depths or the use of engineered barriers were assumed to be sufficient to prevent inadvertent intrusion into the waste. The basis of such requirements was conservatively established for Class C LLW and should be reexamined, especially in light of revised radiological biokinetic models and dosimetry published by the ICRP, site characteristics, and modern disposal practices. Currently, a modern disposal-facility design will generally include multiple engineered intruder barriers to last at least 500 years, disposal at depths up to 36 m, and disposal in an arid environment that is far removed from potable water supplies. Moreover, waste that was generally considered not suitable for near-surface disposal facilities designed more than 40 years ago could be suitable using technologies and practices currently employed (National Academy of Sciences, Engineering, and Medicine 2017).

In December 2015, the NRC Commissioners published a staff requirement memorandum (SRM-15-0094) directing its staff to proceed with a rulemaking to resolve the inconsistency regarding the removal of TRU exclusionary language in the definition of LLW as mandated by the LLWPAA of 1985 (Nuclear Regulatory Commission 2015c).

The NRC Commissioners also directed their staff to conduct a regulatory analysis to determine the quantity of GTCC that may be suitable for near-surface disposal within six months of publishing a 10 CFR 61 final rulemaking related to the disposal of large quantities of depleted uranium.[4] This analysis was intended to determine whether the NRC should retain exclusive licensing authority over GTCC LLW or if such authority could be delegated to Agreement States in accordance with Section 274 of the AEA.

The NRC Commissioners acknowledged that disposal of GTCC LLW is currently authorized on a case-by-case basis in accordance with 10 CFR 61.55. The staff was also directed to proceed with a rulemaking to specify disposal criteria for GTCC LLW if the regulatory analysis concluded that some or the entire inventory of such waste was suitable for near-surface disposal.

BASIS FOR THE REVISED 2017 POSITION STATEMENT ON LOW-LEVEL RADIOACTIVE WASTE

The changes discussed herein support the position that there has been a coordinated overhaul of the manner in which LLW is managed and disposed of, with more work still ahead for certain wastes that have been effectively orphaned for decades.

Position 1 – The goal of managing LLW is to ensure the safety of workers and the public and to protect the environment. To achieve this goal, disposal, not long-term storage, is the best and safest long-term approach.

This position is carried forward from previous versions of the position statement. The Health Physics Society shares the position of the NRC that disposal, not long-term storage, is the preferred approach to managing the disposition of LLW. The final disposal of waste in centralized, properly designed and secured disposal facilities is safer and presents a higher level of security than thousands of temporary, widely distributed storage facilities. In addition, temporary storage facilities impose an increased cost on the generators and increase the likelihood of loss of control if facilities close and go out of business without transferring the waste to another facility.

The Society commends the actions taken by policy makers, regulatory agencies, and other stakeholders to ensure established controls governing the management and disposal of disused sealed sources. Actions taken to impose time limitations for storage and to require financial assurance for licensed, disused sealed sources from the outset will better assure such radioactive materials may be safely and better dispositioned.

Position 2 - The Health Physics Society believes that accessible disposal options should be available to waste generators nationwide.

Waste generators in each of the 50 states across the country currently have disposal options for Class A, B, and C LLW. Moreover, as discussed herein, innovations in the management of LLW have significantly reduced the volumes and increased the disposal options for Class B/C LLW. However, the waste-management landscape may change, as demonstrated in the past, and disposal pathways for LLW could again be inaccessible to some waste generators across the country. Accordingly, the Society continues its position that actions remain necessary to ensure waste generators across the country have accessible disposal options for Class B/C LLW.

[4]Depleted uranium means the source material uranium in which the isotope ^{235}U is less than 0.711 weight percent of the total uranium present. Depleted uranium does not include special nuclear material.

Position 3 – Risk-informed waste-disposal requirements for radioactive materials should be based on sound science and consistent with the risk posed to public health; requirements should not be based on waste origins and statutory definitions.

RECOMMENDATIONS

Based on Position 3, the Health Physics Society makes the following recommendations:

1. **Recommendation 1 – We recommend and endorse the establishment of radioactive-waste-disposal practices based on a site-specific analysis to demonstrate protection of public health for compliance periods consistent with the regulations established by the NRC pursuant to 10 CFR 61. Such constraints should also include defense-in-depth measures, such as site features and engineered barriers, to further protect public health and safety.**

On 15 September 2016, the NRC published its final rule, titled *Final Rule: Low-Level Radioactive Waste Disposal* (SECY-16-0106), for consideration by the Commissioners. The rulemaking was originally intended to establish requirements for the disposal of large quantities of depleted uranium as specified in *Response to Commission Order CLI-05-20 Regarding Depleted Uranium* (SECY-08-0147), published on 18 March 2009. The Commissioners' directive included a requirement for licensees to conduct a site-specific analysis to determine whether disposing of large quantities of depleted uranium would be protective of public health and safety.

On 8 September 2017, the NRC Commissioners directed their staff to establish, among other things, a "period of compliance" of 1,000 years based on a quantitative analysis and to evaluate peak doses for a longer period of time based on site-specific considerations for licensees that intend to dispose of large quantities of depleted uranium. During the 1,000-year period of compliance, disposal-facility operators are required to demonstrate that a member of the public and an inadvertent intruder will not receive an annual dose of radiation exceeding 0.25 mSv and 5 mSv, respectively.

The final rule also would include a requirement to conduct an intruder analysis to ensure that waste blended[5] to just below the limits for Class B LLW and waste containing certain long-lived radionuclides will not pose undue risk. Limits on the radiological source term, engineered features, and natural features of the disposal site will further reduce radiation doses and mitigate the effects of large uncertainties identified during the performance assessment. The safety case would include the requirement to conduct a quantitative performance assessment, as supplemented by considerations of defense-in-depth measures.

The Health Physics Society recognizes the need to comply with radiation dose limits to protect members of the public and to ensure long-term site stability. We also believe that the rulemaking adequately protects public health and safety. A similar framework requiring a site-specific analysis could be applied to determine whether the disposal of GTCC LLW, GTCC-like LLW, and waste containing certain transuranic radionuclides with concentrations exceeding 3,700 Bq g^{-1} could be managed safely consistent with the performance objectives specified in 10 CFR 61.

[5] The Commissioners directed their staff to include a new requirement to ensure that waste blended to levels at the upper bound of Class A LLW would not expose an inadvertent intruder to a radiation dose exceeding 5 mSv in a year in SECY-10-0043, *Blending of Low-Level Radioactive Waste*, published on 7 April 2010.

Recommendation 2 – We encourage policy makers and federal and state regulatory agencies to establish or enhance regulatory processes, waste-processing treatment requirements, and disposal criteria that support making risk-informed decisions to disposition HLW, TRU, and LLW based on the degree of isolation that would be required to protect public health.

Significant progress has been made, as described herein, by policy makers and regulatory agencies to establish a framework to disposition radioactive waste depending upon the degree of isolation that is required to ensure protection of public health and safety. The EPA has established criteria allowing disposal of waste containing transuranic radionuclides with half-lives longer than 20 years and at concentrations exceeding 3,700 Bq g^{-1} in a near-surface disposal facility if such waste is determined by appropriate federal regulatory authorities to not require the degree of isolation provided by a geologic repository. Similarly, both the DOE and NRC have established processes allowing radioactive waste considered as waste incidental to reprocessing of SNF to be dispositioned as LLW for disposal in a near-surface disposal facility.

These processes were established based on the recognition that if the waste had been processed to remove the high-activity radionuclides to the maximum extent practicable and if the disposal would comply with the safety requirements specified in 10 CFR 61, such waste would not need the same degree of isolation as provided by a geologic repository. Moreover, this framework was used to enact Section 3116 of the Ronald Reagan National Defense Authorization Act of 2005 that would apply to Class C or GTCC LLW determined to be waste incidental to reprocessing by the DOE, supported with consultations with the NRC.

The Health Physics Society strongly supports such risk-informed approaches to manage the disposition of waste streams based on the degree of isolation that would be required to protect public health and safety. Waste streams containing high levels of radioactivity that require isolation from the biosphere for either radiation safety or nuclear nonproliferation concerns should be disposed of in a geologic repository. Conversely, the DOE and NRC have demonstrated their ability to make waste determinations to disposition waste in a near-surface disposal facility if the waste does not present the same level of radiological hazards as TRU waste or HLW.

Recommendation 3 – We strongly encourage the U.S. NRC to proceed with actions necessary to establish disposal criteria for GTCC LLW.

The Health Physics Society is encouraged by the efforts of federal and state regulators to proceed regarding disposition options that may potentially result in criteria to disposition GTCC LLW. Such waste has been effectively orphaned for decades. As a matter of national importance, we support efforts to establish disposal criteria for GTCC LLW based on the degree of isolation required to protect public health and safety.

Recommendation 4 – We encourage the U.S. NRC to proceed with revisions to Title 10, Code of Federal Regulations, Part 61 (10 CFR 61), to:

a. **Remove the TRU exclusionary language from the definition of waste in 10 CFR 61.2, consistent with the LLWPAA of 1985, and**
b. **Establish disposal criteria for waste containing TRU radionuclides with half-lives longer than five years and concentrations greater than 3,700 Bq g^{-1} based on the degree of waste isolation that is required to protect public health.**

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*The Health Physics Society is a nonprofit scientific professional organization whose mission is excellence in the science and practice of radiation safety**.** Since its formation in 1956, the Society has represented the largest radiation safety society in the world, with a membership that includes scientists, safety professionals, physicists, engineers, attorneys, and other professionals from academia, industry, medical institutions, state and federal government, the national laboratories, the military, and other organizations. Society activities include encouraging research in radiation science, developing standards, and disseminating radiation safety information. Society members are involved in understanding, evaluating, and controlling the potential risks from radiation relative to the benefits. Official position statements are prepared and adopted in accordance with standard policies and procedures of the Society. The Society may be contacted at 1313 Dolley Madison Blvd., Suite 402, McLean, VA 22101; phone: 703-790-1745; fax: 703-790-2672; email: HPS@BurkInc.com.