Disposal of Greater Than Class C Low-Level Radioactive Waste in Andrews County, Texas

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ABSTRACT

The U.S. Nuclear Regulatory Commission (NRC) staff has recommended approval of an initiative to permit the Texas Commission on Environmental Quality (TCEQ) to license the disposal of commercial and comingled Greater Than Class C Low-Level Radioactive Waste (GTCC LLW) in Andrews County, Texas. Such a framework is clearly articulated in the Section 274 of the Atomic Energy Act of 1954, as amended. The NRC staff also recommended approval to proceed with a rulemaking to align the Waste Classification Tables in Title 10 of the Code of Federal Regulations (CFR), Part 61.55 with the §61.2 definition of "waste" to provide a disposal pathway for waste containing certain alpha-emitting transuranic elements with concentrations exceeding 100 nanocuries per gram (nCi/g).

A pathway for the disposal of commercial and comingled GTCC LLW, including waste with certain alpha emitting transuranic elements exceeding 100 nCi/g (TRU waste), might emerge if the initiative described in the Commissions' July 22, 2015 document, SECY-15-0094, *Historical and Current Issues Related to Disposal of GTCC LLW*, is approved. The NRC staff recommendations envisioned the NRC and TCEQ working together to review a site-specific performance assessment that would be submitted by Waste Control Specialists LLC (WCS) as part of an amendment to its existing Radioactive Materials License No. R04100.

The TCEQ's recommendations were prompted by a petition for rulemaking filed by WCS to allow the disposal of GTCC waste in Texas. On September 10, 2014, the TCEQ Commissioners directed their staff to engage stakeholders and request input from the NRC and the U.S. Department of Energy (DOE) regarding actions needed to proceed with any future rulemaking. On January 30, 2015, the TCEQ requested clarification from the NRC regarding their legal authority and jurisdiction to regulate GTCC, GTCC-like, and TRU waste. The deliberations that have transpired over the past year have raised important legal, policy, and technical matters. This initiative could provide a safe disposal pathway for certain waste streams that have been orphaned over the past 30 years.

One important realization that has emerged is the conservative assumptions used to establish the upper limits for Class C LLW when Part 61 was promulgated in 1981

would be much too restrictive when applied to a modern, highly engineered disposal facility located in arid west Texas. Waste that was not suitable for near surface disposal in 1981 could certainly be demonstrated to be safely disposed at the WCS Federal Waste Disposal Facility in Andrews County, Texas.

This paper will address the legal, policy, and technical matters supporting this important topic currently under consideration both nationally and within the State of Texas.

INTRODUCTION

Over the past year, significant strides have been taken that may provide a potential disposal pathway for commercially-generated waste exceeding the Class C concentration-based limits and waste produced by the federal government, denoted by the acronyms “GTCC” and “GTCC-like” waste.

On July 21, 2014, Waste Control Specialists LLC (WCS) submitted a Petition for Rulemaking to the Texas Commission on Environmental Quality (TCEQ) requesting changes to state regulations that would better align those regulations with the Texas Radiation Control Act and existing federal regulations established by the U.S. Nuclear Regulatory Commission (NRC) and codified in Title 10 of the Code of Federal Regulations, Part 61, *Licensing Requirements For Land Disposal Of Radioactive Waste* [1].

WCS recognized that the geological characteristics, and engineering design of its waste disposal facilities located in Andrews County, Texas, would be fully protective of workers and members of the public from the hazards of radiation attributable to low-level radioactive waste exceeding the Class C limits established in Part 61. A review of the applicable regulations and laws indicated that disposal of such radioactive waste was not prohibited by the NRC and was consistent with the Texas Radiation Control Act (TRCA). However, this review also concluded that changes to TCEQ regulations would be required because disposal of low-level radioactive waste exceeding the Class C limits was prohibited. Also, an apparent oversight had occurred during a previous NRC rulemaking, whereby the definition of Low-Level Radioactive Waste had not been changed in the manner that Congress intended when enacting the 1985 amendments to the Low-Level Radioactive Waste Policy Act (LLWPAA). While inadvertent, this omission effectively orphaned waste containing certain transuranic radionuclides with concentration exceeding 100 nanocuries per gram (100 nCi/g)

BACKGROUND

The U.S. Congress enacted the Low-Level Radioactive Waste Policy Act (LLWPA) of 1980 and defined Low-Level Radioactive Waste (LLW) as waste that is not High-

Level Waste (HLW), Spent Nuclear Fuel (SNF), Transuranic Waste (TRU waste), or byproduct materials, as defined in section 11.e(2) of the Atomic Energy Act of 1954, as amended [2].

This important legislature was amended in 1985 to induce states to develop new disposal facilities. States were charged with the responsibility for providing for the disposal of Class A, B, and C LLW. The federal government was charged with providing for, among other things, the disposal of LLW owned or generated by the U.S. Department of Energy (DOE). At that time, Congress provided no regional facility would be required to accept for disposal any material that was not low-level radioactive waste as defined in 10 CFR Part 61.55 as in effect on January 26, 1983 [3].

In 1985, LLW was defined as waste that is not HLW, SNF, or byproduct as defined in section 11.e.(2) of the AEA of 1954. This definition remained unchanged until Congress enacted the Energy Policy Act of 2005 [4], which required the NRC to establish regulations for discrete sources of ^{226}Ra and accelerator produced radioactive materials as part of the rulemaking titled, *The Expanded Definition of Byproduct Material* [5]. This legislation also required the DOE to prepare an Environmental Impact Statement (EIS) to help facilitate the disposal of commercial GTCC LLW [6]. According to Brown [7], the definition of LLW was also changed by Congress in 1985 to ensure that the federal government, not the States, would be responsible for providing for the disposal of TRU waste. Specifically, the TRU waste exclusion was removed for the definition of LLW in the LLWPAA of 1985.

In 1989, the NRC promulgated changes to codify its responsibilities over regulating the disposal of commercial GTCC LLW as directed by Congress in the LLWPAA of 1985 (referred to as the GTCC Rulemaking) [8]. The NRC envisioned that commercial GTCC LLW disposal in a geologic repository would be the required preference. However, the Commissioners did not intend to foreclose an alternative that would allow for the DOE to construct and license an “intermediate depth” disposal facility for commercial GTCC LLW at some time in the future [9].

Prior to 1989, licensees seeking to dispose of commercial GTCC LLW could propose an alternative waste classification pursuant to 10 CFR 61.58 that would describe the manner in which they proposed to safely dispose of GTCC LLW. Following promulgation of the GTCC rule in 1989, the following changes were made to 10 CFR 61.55(a)(2)(iv) that codified the Commission’s preference for disposal of GTCC LLW in a geologic repository, while leaving alternatives available to the licensed community with specific approval by the NRC:

> *Waste that is not generally acceptable for near-surface disposal is waste for which form and disposal methods must be different, and in general more stringent, than those specified for Class C waste. In the absence of specific*

> *requirements in this part, such waste must be disposed of in a geologic repository as defined in part 60 or 63 of this chapter unless proposals for disposal of such waste in a disposal site licensed pursuant to this part are approved by the Commission.*

FRAMEWORK ESTABLISHED BY TEXAS LEGISLATURE

In 2003, the Texas legislature amended the TRCA that would ultimately provide a disposal facility for Class A, B, and C LLW generated within the commercial sector and for such waste owned or generated by the federal government [10]. Under the amended statute, the State of Texas would own the disposal facility and take title to commercial waste disposed in the Texas Compact Waste Disposal Facility (CWF). Additionally, the resulting regulations required the DOE to: (1) enter into an agreement with the State of Texas to take title to waste owned or generated by the federal government and disposed in the Federal Facility Waste Disposal Facility (FWF) and (2) agree to take perpetual ownership of this facility at the time of closure.

The Texas legislature created a framework that could potentially provide for a disposal pathway for GTCC, GTCC-like and TRU waste. The TRCA stipulated that only low-level radioactive waste that is the responsibility of the federal government pursuant to the LLWPAA of 1985 is authorized for disposal at the FWF. Such waste includes Class A, B, C, and GTCC-like LLW that is owned or generated by the federal government. Moreover, it includes commercially generated GTCC LLW pursuant to Section 3.b of the LLWPAA of 1985.

An important aspect of the legislation is that it aligns and distinguishes between the responsibilities of the states and the federal government for providing a distinct and separate disposal pathway for commercial and federal waste as required under the LLWPAA of 1985.

SECY-15-0094

On July 21, 2014, Waste Control Specialists LLC (WCS) submitted to the TCEQ a petition for rulemaking proposing certain changes to the regulations that could allow for the disposal for GTCC, GTCC-like and TRU waste [11].

On September 10, 2014, the TCEQ Commissioners directed their staff to engage stakeholders and request input from the NRC and the DOE regarding actions needed to proceed with any rulemaking that may or may not occur in the future [12]. On January 30, 2015, the TCEQ sent a letter to the NRC requesting a clarification regarding its jurisdiction and authority to license and regulate the disposal of such waste in Andrews County, Texas [13].

On July 17, 2015, the NRC published a report titled, *Historical and Current Issues Related to the Disposal of GTCC LLW* (SECY-15-0094) [14]. The NRC Staff analyzed the historical records governing the regulatory authority granted to Agreement States to license and regulate GTCC, GTCC-like, and TRU waste. The NRC staff also analyzed the following three options for the Commissioners consideration:

- Option 1: The NRC would license and regulate the receipt and disposal of GTCC waste at WCS and would pursue rulemaking to amend Part 61 to address TRU waste disposition.
- Option 2: The NRC would allow the State of Texas to license and regulate the disposal of GTCC waste and NRC staff would pursue a rulemaking to address TRU waste disposal in Part 61.
- Option 3: No-action.

The NRC Staff recommended that the Commissioners approve Option 2 that would authorize the State of Texas to license and regulate the disposal of GTCC and GTCC-like LLW. They also recommended a rulemaking to align the definition of "waste" specified in 10 CFR 61.2 with the Waste Classification Tables in 10 CFR 61.55 for the purpose of providing a regulatory disposal path for TRU waste. The NRC staff acknowledged that a policy decision and response was needed to address the important questions raised by the TCEQ regarding their authority and jurisdiction to license and regulate GTCC, GTCC-like LLW and TRU.

They recognized that this recommendation offered the benefit of providing generic regulatory requirements for disposal of GTCC and TRU waste and was consistent with the NRC's historical desire to allow States to regulate GTCC waste disposal. It would provide greater regulatory flexibility because Texas had acquired considerable experience in licensing the facility for other types of LLW and would establish clear-cut Federal and State licensing pathways for disposal of GTCC LLW.

On August 13, 2015, the staff briefed the NRC Commissioners and other stakeholders from TCEQ, DOE, other industry and public interest groups, including WCS [15]. The Commissioners are currently preparing a Staff Requirements Memorandum (SRM) to articulate their preferred policy. Some have suggested that the NRC expand the scope of the proposed amendments to Part 61 to include a pathway for disposal of TRU waste and perhaps general standards for other types of GTCC LLW.

CLASS C LIMITS AND PROTECTING THE INADVERTENT INTRUDER

At the Commissioners' briefing, WCS described the general assumptions that underpinned the technical bases that were used to establish the Class C limits when Part 61 was promulgated in January 1982. The overarching message was that

original assumptions used to establish the Class C limits in 1982 should be reexamined to assess whether a well-sited, highly-engineered facility located in an arid region of the U.S. disposing of waste exceeding the Class C limit would be capable of safely protecting public health.

When this rule was first promulgated, waste that was characterized as exceeding the Class C limits was generally not suited for near surface disposal (i.e., within the upper 30 meters of the earth's surface). The Class C limits were derived for the purpose of protecting an intruder from inadvertently residing on the waste disposal facility or exhuming and bringing the waste to the surface. The limits were established to ensure that an inadvertent intruder would not be exposed to a radiation dose in excess of 5 mSv y^{-1} (500 mrem y^{-1}), equivalent to the regulatory limits in 10 CFR Part 20 for protecting members of the public at the time the rule was established.

The NRC developed various conservative radiation exposure scenarios that were used to ensure that an intruder inadvertently intruding into radioactive waste at the Class C limits (NRC, 1979) would not be exposed to radiation levels exceeding the regulatory limits [16]. The intruder scenarios assumed that the intruder resided or exhumed waste at a disposal facility located in a humid environment on the east coast of the U.S. This assumption was based on the belief that several nuclear power plants on the east coast would be decommissioned and the waste disposed at a facility similar in design and siting characteristics to the disposal facility in Barnwell, South Carolina.

The NRC also assumed that 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 stuff 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 use of engineered barriers were assumed to be sufficient to prevent inadvertent intrusion into the waste. However, waste management practices have matured considerably over the past 40 years and a hard look is needed to evaluate the appropriateness of the assumptions at a more robust facility located in an arid region of the U.S

AN ENHANCED NEAR SURFACE FAULT DISPOSAL FACILITY

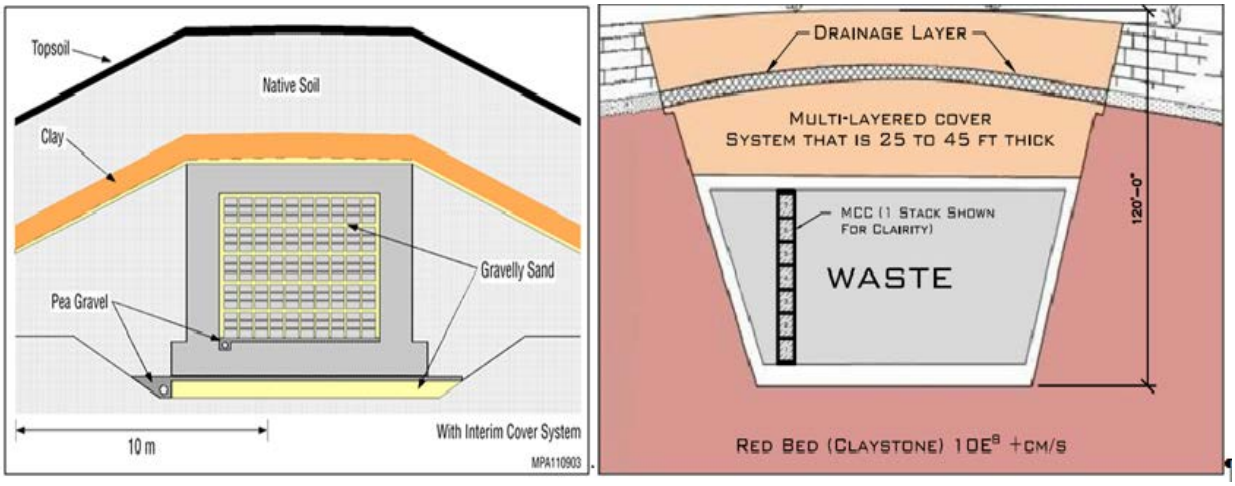
The DOE issued a draft Environmental Impact Statement (EIS) titled, *Disposal of Greater-Than Class C (GTCC) Low-Level Waste and GTCC-like Waste* (DOE/EIS-0375) in February 2011 pursuant to the Energy Policy Act of 2005 [7]. In their draft EIS, the DOE analyzed the environmental impacts attributable to disposal of GTCC and GTCC-like LLW in a facility located in both an arid and a humid

environment. During the NRC Commissioners' briefing on GTCC (SECY-15-0094), DOE acknowledged their analysis concluded that disposal of such waste in a facility located in a humid environment would cause more significant impacts than one located in an arid environment [17].

The DOE also evaluated the performance of various designs of facilities that could be used to dispose of GTCC and GTCC-like LLW in their EIS. The EIS noted that disposal of such waste in a facility that included features such as robust engineered barriers, deeper depth of disposal, and enhanced waste packaging would further reduce the environmental impacts. The design of a near surface vault facility was indentified a one such facility that could be used to safely dispose of GTCC and GTCC-like LLW.

According to Kirk and Jacobi [18], the enhanced near surface disposal vault waste disposal facility described in the EIS is very similar in design to WCS FWF (Fig.1). This disposal facility is located in a tectonically stable, semi-arid region in Andrews County, Texas. The average rainfall in the region is approximately 41 cm y^{-1} (16 in y^{-1}). The geology of the site consists primarily of the Dockum Formation comprised of very low permeability clays that are approximately 183 m (600 ft) to 243 m (800 ft) thick, with a hydraulic conductivity of approximately 1E-8 to 1E-9 cm sec^{-1}. The depth to the nearest water table of sufficient yield to provide water for irrigation or consumption ranges from 183 m (600 ft) to 305 m (1000 ft). However, this water is not potable and is unsuitable for human consumption.

Fig. 1. Comparison of DOE and WCS Enhanced Near Surface Vault Facilities.



DOE Enhanced Near Surface Vault Facility (DOE, 2011) WCS Enhanced Near Surface Vault Facility

The FWF has an engineered cover system that is approximately 7.6 m (25 ft) to 13.7 m (45 ft) thick and is designed to prevent infiltration of precipitation. Geotechnical studies that were conducted to support the initial license application concluded that the system has an evapotranspiration potential of up to 152 cm (60 in) of water annually. An analysis was conducted, as part of the performance assessment, which evaluated 24-hour rainfall events that had been recorded since the 1950s. WCS also evaluated the affect of potential future climate change by increasing the annual rainfall to 152 cm (60 in). The results of the analysis, which assumed that the cover system had been degraded, concluded that water infiltration would have negligible impacts on the performance objectives.

Waste that is classified as B, C, and Class A LLW with dose rates greater than 5 mSv h^{-1} (100 mrem h^{-1}) must be placed inside of Modular Concrete Canisters (MCC) and grouted. The canisters serve as enhanced waste packages and may either be cylindrical or rectangular. While either canister could potentially be used for disposing of GTCC and GTCC-like LLW, such waste would most likely be disposed of in cylindrical MCCs. The cylindrical MCCs are approximately 2.74 m (9 ft) in height and 2.13 m (7 ft) in diameter. Waste that is placed in an MCC is grouted rendering the final waste form resistant to human intrusion and impeding the environmental transport of radionuclides. The weight of a grouted MCC is approximately 45.46 kgs (100,000 lbs). A photograph of an MCC being transported for disposal is presented in Fig. 2.

WCS fabricates MCCs on-site and has the capability to increase the density of the concrete as needed, thus providing for greater shielding of radioactive sources. Additionally, a steel insert may also be placed inside the MCCs to further protect workers responsible for waste handling operations. Over the past several years, WCS has acquired the experience and designed such MCCs to dispose of irradiated hardware (IH) with dose rates exceeding 250 Sv h^{-1} (25,000 rem h^{-1}) at its facility limiting the maximum dose to any worker to less than approximately 0.10 mSv (10 mrem). The systems used to handle and transfer IH into the custom fabricated MCCs were recently evaluated by Sandia National Laboratories for consideration of deep borehole disposal of High Level Waste in a report titled, *Handling and Emplacement Options for Deep Borehole Disposal Conceptual Design*, published in July 2015 [19].

Fig. 2. Transporting a Modular Concrete Canister

After waste is placed and grouted inside an MCC, it may be disposed at depths up to 36.6 m (120 ft) below grade at the FWF. These intruder resistant MCCs are designed to be stacked on top of each other up to seven high, a configuration that may be ideal to ensure protection of an inadvertent intruder from GTCC and GTCC-like hazards. A photograph of the FWF is provided in Fig. 3.

Fig. 3. Photograph of Federal Facility Waste Disposal Facility

REVISITING THE TECHNICAL BASIS OF CLASS C LLW

During the Commissioners' briefing on GTCC LLW (SECY-15-0094), WCS encouraged the Commissioners to reconsider the technical bases that were used to establish the Class C limits in light of the performance of a well sited, engineered facility located in an arid or semi-arid environment with an enhanced, near surface vault disposal facility [20]. WCS stated that many of the underlying conservative assumptions used to establish the concentration-based limits for Class C LLW are not applicable at its facilities in Andrews County, Texas. Specifically, the exposure pathways from drinking water or from foodstuff contaminated by irrigation of crops is not feasible given the thickness and very low permeability of the Dockum Formation, as well as the depth to water, all of which is non-potable, and the thickness of the cover system overlying the disposal units at the FWF. Moreover, the intruder is protected by use of MCCs constructed with re-enforced concrete that are stacked up to seven high, with a depth of disposal up to 36.6 m (120 ft.) below grade.

As previously reported, the preliminary results of WCS' performance assessment indicated that radiation doses associated with the disposal of DOE' inventory of GTCC LLW were less than the 5 mSv y^{-1} (500 mrem y^{-1}) constraint required for protecting an inadvertent intruder [18]. These results underscore the degree to which disposal practices have matured since the NRC promulgated 10 CFR 61 in 1982.

ANTICIPATED DEVELOPMENTS FOR 2016

Under the Energy Policy Act of 2005, DOE was charged not only with preparing an EIS for GTCC LLW, they were also required to issue a report to Congress describing any actions that may be necessary to provide a disposal pathway for such wastes as stated in the LLWPAA of 1985. The DOE is anticipating issuance of its final EIS on GTCC and GTCC-like LLW in the first quarter of 2016. The DOE has stated that it may recommend use of a commercial disposal facility (such as WCS) as one of its preferred alternatives. At the Commissioners' briefing on GTCC LLW, they acknowledged that the environmental impacts were substantially less for sites located in arid regions when compared to facilities located in humid environments.

The NRC Commissioners are preparing their direction to staff on any actions that may be required to provide a disposal pathway for GTCC, GTCC-like, and TRU. At least one of the Commissioners questioned whether or not the proposed rulemaking on Part 61 should be expanded to resolve the discrepancy between the Waste Classification Tables and the definition of "waste" in Part 61 to ensure that waste with certain transuranic radionuclides exceeding 100 nCi/g may be disposed of as GTCC LLW. Other stakeholders have suggested that the Commissioners may direct staff to develop a separate disposal standard for GTCC LLW. Any directions that the

Commissioners may give staff on this matter are speculative until the Commissioners issue a SRM on GTCC, GTCC-like LLW, and TRU.

It is also anticipated that the NRC will provide clarification to the State of Texas regarding its authority to license and regulate the disposal of GTCC, GTCC-like, and TRU. Only after providing such clarification is it anticipated that the TCEQ will begin a rulemaking that may ultimately provide a national solution and disposal option for such waste streams, ending a stalemate that has effectively orphaned these waste streams for over 30 years.

CONCLUSIONS

The leadership and actions by the TCEQ, NRC, and DOE to establish a framework that may provide a disposal pathway for GTCC, GTCC-like LLW, and TRU are commendable. The TCEQ's request for clarification of its authority and jurisdiction to regulate the disposal of such waste at the WCS facilities in Andrews County, Texas prompted the NRC staff to prepare an important report on this topic. The NRC Staff's recommendation to allow the State of Texas to license and regulate the disposal of these waste streams makes sense. Texas has acquired over 10 years of experience in licensing and regulating the WCS disposal facilities. This recommendation would provide for regulatory efficiencies, is authorized by law, and ensures NRC's oversight through its Integrated Materials Performance Evaluation Program.

Waste management practices in the U.S. have matured considerably over the past 40 years. The NRC established the Class C limits for the purpose of protecting an inadvertent intruder from residing over and perhaps unknowingly exhuming the radioactive waste at a former disposal facility at some time in the future. These limits were established based on conservative assumptions at a disposal facility presumably located in a humid environment similar to the facility located in Barnwell, South Carolina. While the underlying assumptions were based on practices established in the late 1970s, they do not reflect those at the WCS waste disposal facilities in Andrews County, Texas. The geological characteristics and engineering design of this facility are well suited for safely disposing of GTCC, GTCC-like, and TRU.

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