From:	Kliczewski, Theresa
To:	RulemakingComments Resource
Cc:	Senderling, Mark; Tonkay, Douglas; Marble, Justin; Maupin, Cardelia; Koenick, Stephen; McKenney, Chris; Bower, Bryan (WV)
Subject:	[External_Sender] EM-4.2 Edits on NRC"s Draft Regulatory Basis
Date:	Tuesday, November 19, 2019 2:11:30 PM
Attachments:	11-19-19 EM Comments NRC Regulatory Basis_EM42.pdf

NRC,

The attached PDF provides the Department of Energy (DOE), Office of Environmental Management (EM), Office of Waste and Materials Management's (EM-4.2, and includes edits from WVDP office and DOE AU-22) comments on the NRC's Draft Regulatory Basis for Disposal of Greater-Than-Class C Waste and the accompanying Technical Analysis of the Hazards of Disposal of Greater-than-Class C and Transuranic Waste.

We agree with the Nuclear Regulatory Commission (NRC) that near-surface disposal is a suitable option for greater-than-Class C (GTCC) low-level radioactive waste (LLW) disposal when waste acceptance criteria are developed based on a site-specific performance analysis that considers actual site conditions and characteristics of the waste to be disposed.

As shown in the attachment, we support NRC's efforts to develop regulatory requirements for disposal of GTCC LLW, and we are providing for your consideration comments and suggested clarifications on the Draft Regulatory Basis and the accompanying Technical Analysis. Key overall comments include recommendations to:

* Clarify and maintain consistency with the basis for 10 CFR Part 61.
* Provide opportunity for site-specific analysis regarding disposal 5 meters below the top surface of the cover.
* Provide analyses for a more arid site that is representative of potential disposal locations.
* Provide improved perspective on intrusion scenarios.
* Use specific site and waste streams analyses to determine inventory.
* Correct potential inconsistencies in the NRC's listed GTCC LLW inventory.
* Removal of waste stream(s) from analysis for near-surface disposal viability.
* Provide proper context of accident analyses.

We appreciate the NRC considering our comments and look forward to continued dialogue on the Draft Regulatory Basis. If you have any questions, please contact Mark Senderling, Deputy Assistant Secretary for Waste & Materials Management, EM-4.2, at (202) 586-0785 or Mr. Douglas Tonkay, Director of the Office of Waste Disposal, EM-4.22, at (301) 903-7212.

Theresa J. Kliczewski
Office of Waste & Materials Management, EM-4.2
Environmental Management
U.S. Department of Energy
Telephone: (202)586-3301

U.S. Department of Energy (DOE) Office of Environmental Management's Office of Waste and Materials Management[1] (EM-4.2) Comments on The Nuclear Regulatory Commission's (NRC) Draft Regulatory Basis for Disposal of Greater-Than-Class C (GTCC) and Transuranic Waste (November 19, 2019)

These comments respond to NRC's July 22, 2019 Federal Register Notice (84 FR 35037), Section III, Specific Request for Comments, Question #8: "Are there any other issues, not identified in the above questions that the NRC should have considered in the Draft Regulatory Basis?"

Summary Comments

1. Differences between Draft Regulatory Basis's supporting Technical Analysis and Part 61 analyses

EM-4.2 suggests that the assumptions in the technical analysis in the Draft Regulatory Basis be modified to be more consistent with and/or add similar calculations to those considered by NRC in the prior analyses that supported the development of 10 CFR Part 61, Licensing Requirements for Land Disposal of Radioactive Waste (Part 61) in the 1980s. Also, to provide more perspective on the low likelihood of the scenarios considered, we suggest NRC include discussion of the actual sequence of events and assumptions that must occur for the consequences of the assumed intrusion scenario to be realized.

Consistent with the approach used in NUREG-4370 (IMPACTS methodology) and NUREG-0945 (Part 61 Final Environmental Impact Statement (FEIS)), stable waste and robust barriers should preclude inadvertent intrusion into the waste for 500 years. The current GTCC low-level radioactive waste (LLW) analysis does not acknowledge those features. Results are presented starting at 100 years, though Part 61 assumes that a stable waste form and robust barriers would prevent inadvertent intrusion for 500 years. By including results at 100 years, the analysis implies that GTCC LLW would be disposed as Class A LLW.

The NRC staff implies use of Part 61 methodologies in the calculations for the GTCC LLW analysis, but there are some distinct differences with regard to the intruder analysis.

A few examples of key differences include:

(1) Part 61 analyses assumed inadvertent intrusion occurs into waste that is indistinguishable from soil; however, EM-4.2's view is that GTCC LLW would be clearly distinguishable from soil at 100 years;
(2) Part 61 analyses assumed intrusion was precluded for 500 years with intruder barriers for Class C waste. (Since GTCC LLW will be protected at least as much as Class C LLW, it is reasonable to exclude results before 500 years.);

[1] Including input from the West Valley Demonstration Project office and the DOE Office of Environmental Protection and ES&H Reporting (AU-22).

(3) Part 61 analyses assumed a 3 m deep foundation hole (p. G-58 in NUREG-00782), yet the Draft Regulatory Basis states that a 5 m excavation was assumed;
(4) The values in the tables for Class C LLW in 10 CFR 61.55 reflect a factor of 10 increase in the limits to take some credit for a variety of mitigating conditions (see quote from Part 61 FEIS, NUREG-0945 below); and
(5) Part 61 analyses assumed a mud pit was used for drilling, but this case was not considered for this Draft Regulatory Basis.

Each of these items is discussed below.

Part 61 classification table values were based on analyses that excluded the possibility for an excavation scenario into Class C LLW before 500 years; thus, it is not clear why intrusion prior to 500 years is considered relevant for GTCC LLW for this Draft Regulatory Basis. This difference appears to imply that GTCC LLW could be disposed less rigorously than Class C LLW. Also, excavation is completely mitigated when NRC staff are proposing that both mitigating features of Part 61 for Class C LLW disposal are implemented for GTCC LLW (i.e., 500 year barriers and disposal 5 meters (m) below the surface of the cover). Current approaches for disposal of Class C LLW include, for example, the use of robust reinforced concrete canisters that would be expected to serve as a significant deterrent to inadvertent intrusion for many hundreds of years.

For inadvertent intrusion, DOE recommends that NRC move towards consistency with international recommendations for the use of an optimization-based standard.

Section B.3.3, Page B-10 of the Draft Regulatory Basis states that the Part 61 analysis considered shallow excavation down to 5 m. The 1980s analysis for Part 61 was based on a 3 m deep foundation hole with an excavation 1 foot into waste (Page G-58, NUREG-0782). We recommend that NRC assume a 3 m deep foundation consistent with the Part 61 analyses, rather than a 5 m deep excavation involving 1.25 m of waste. The potential for deeper excavations was specifically mentioned in the Part 61 FEIS, but NRC determined that a depth of 3 m was appropriate for the purposes of the analysis (i.e., to generically determine the suitability of waste for near-surface disposal and establish requirements for waste disposal).

The Draft Regulatory Basis does not include the factor of 10 adjustment that was applied to Class C limits in Part 61. The mitigating conditions that resulted in the use of a factor of 10 are also relevant for GTCC LLW (to varying extents). When the adjustment applied for Class C LLW is applied to the NRC Technical Analysis of The Hazards of Disposal of Greater-Than-Class C and Transuranic Waste, it will change conclusions regarding whether waste streams exceed the 500 millirem (mrem) standard. The mixing consideration discussed below is not as significant given the assumptions in the technical analysis, but the other factors impacting the likelihood of a full intrusion scenario occurring are relevant and justify the use of the adjustment factor. Quotes related to 10X factor for Class C LLW from the Part 61 FEIS NUREG-0945 Vol 1 – Page 5-31, Limits for Class C Waste Disposal: "The second item concerns the limits for Class C waste disposal. A number of comments were received on the calculated limits, including the following:

- Rather than setting restrictive limits based on protection of a potential-inadvertent intruder, NRC should consider requiring warning devices which would warn an intruder against excavating into the disposal facility
- NRC should consider and incorporate a probability that intrusion will occur.
- NRC should consider that at the end of 500 years, Class C waste disposed under 5 meters of cover would still be difficult to contact; and that if someone did contact the waste, it would be considerably diluted by lower activity waste.
- NRC should consider that actual waste concentrations will typically exhibit an activity distribution with average concentrations well below the maximum permissible concentration.
- The fact that Class C waste will be in an improved waste form will help to lessen the likelihood that-extensive intrusion activities will occur; and if they do occur, will lessen the potential for airborne dispersion or uptake by plant roots.
- Since Class C limits have been raised by a factor of 10 for Cs-137, why not do the same for other radionuclides?

NRC staff has evaluated these comments and has concluded that an increase in the Class C limits by a factor of 10 is warranted for all radionuclides except for Cs-137." (Note that the limit for Cs-137 had already been increased by a factor of ten based on other arguments.)

On page 5-33 of the Part 61 FEIS states, – after some discussion of factors influencing limits:

> "In conclusion, the Class C limits have been raised by a factor of 10. This is due to consideration of (1) the reduced likelihood of: significant intruder exposures with incorporation of passive warning devices at the disposal facility, and (2) the difficulty of contacting waste disposed at greater depths. Another consideration is that the average concentrations in waste would be expected to be less than the peak concentrations, although it is difficult to totally account for this given the other factors discussed above."
>
> It is not clear why the mud pit scenario was not included in the Draft Regulatory Basis, especially given the prevalent use of mud pits for drilling activities in many parts of the United States, including disposal facilities being considered for GTCC LLW.
>
> EM-4.2 recommends that NRC staff consider including assumptions in the NRC Technical Analysis of The Hazards of Disposal of Greater-Than-Class C and Transuranic Waste or in the Draft Regulatory Basis that are fully consistent with the technical basis of the current Part 61 regulations or further clarify the reasons for the differences. The assumed intruder scenario does not include a case using a mud pit, as considered in NRC staff analyses for the drilling scenario supporting implementation of 10 CFR Part 61. Also, when establishing acceptable waste concentration limits in 10 CFR Part 61, a factor of 10 was applied to calculated results to take credit for a number of factors (e.g., likelihood, nature of waste forms, effectiveness of barriers, mixing and other factors). EM-4.2 recommends NRC staff include an explanation for the exclusion of these considerations in the Draft Regulatory Basis.
>
> Both of these are examples of overly-conservative assumptions which may lower acceptable concentrations to limit doses to the inadvertent intruder and cause potential

inconsistencies between acceptable GTCC LLW concentrations as compared to existing concentration limits in 10 CFR Part 61.

2. Disposal 5 m below the top surface of the cover

EM-4.2 believes that changing the "or" to an "and" for generic application of the mitigating factors specified for Class C LLW in 10 CFR 61.52(a)(2) for disposal of GTCC LLW (i.e., disposal "5 m below the top surface of the cover" and inclusion of a 500-year intruder barrier) is reasonable for a generically applicable rule, but there should also be an opportunity for site-specific analysis to demonstrate that any given waste stream meets the applicable performance objectives for a facility. Five meters provides defense-in-depth to address sites where there may be potential for significant erosion and direct contact with waste during excavation of a 3 m deep foundation hole for a house. Consistent with Class C LLW, the 500-year intruder barriers also provide defense-in-depth to allow time for decay of short-lived radionuclides.

Note, in addition, there is inconsistency in terminology used in the Draft Regulatory Basis versus Part 61. Part 61 uses the term "top surface of the cover," but the Draft Regulatory Basis used multiple different terms for the same requirement, including "surface of the cover," "surface of the earth," and "earth's surface." It is recommended for clarity to use "top surface of the cover" consistent with the terminology in Part 61.

We recommend that NRC carefully review consistency in terminology throughout the Draft Regulatory Basis.

3. Humid Site

The intruder analysis for the Draft Regulatory Basis appears to use conditions at a humid site as the underlying assumption for the well depth. It is not clear why results were not provided for a more arid site that would be representative of potential disposal locations where the well would have to be drilled deeper to access groundwater and should result in reduced doses for a chronic intruder scenario. It is useful to acknowledge and add some perspective about locations where there is no viable groundwater pathway for a near-surface disposal facility.

The rationale for including humid conditions for the groundwater analysis is not clear. Including such conditions complicates the interpretation of any generic results, especially for a probabilistic analysis. The value of any conclusions based on such a generic probabilistic analysis is questionable and EM-4.2 recommends removing any results or conclusions based on the probabilistic groundwater analysis. Nevertheless, the generic screening provides confidence that it is reasonable to conclude that it is possible to dispose of GTCC LLW in the near surface in cases with relatively low precipitation and a relatively deep water table. It would also be informative to include some discussion of considerations for a site without a credible groundwater pathway. In any case, additional site-specific analysis would be needed to confirm performance for any location.

It seems reasonable to simply state that disposal of GTCC LLW in humid conditions would need a rigorous site-specific analysis. Including some groundwater analyses to demonstrate that disposal of GTCC LLW at a more semi-arid or arid location is potentially viable seems reasonable. Also, given the highly site-specific nature of groundwater analyses, any specific conclusions from the generic probabilistic analysis are questionable, and we recommend removing those results and any related conclusions from the Draft Regulatory Basis.

4. **Improved perspective about likelihood of intrusion scenarios**

EM-4.2 recommends providing more perspective regarding the durability of robust waste forms and well-constructed barriers and the likelihood that the waste and barriers would actually be indistinguishable from soil even at 500 years. The consideration of waste forms and barriers was part of the rationale for the factor of 10 reduction in doses (increase in table values) that was applied for Class C LLW. It is also important to provide perspective about what actually has to happen for a full inadvertent intrusion scenario to occur. This perspective is only briefly mentioned in the Draft Regulatory Basis and deserves a more complete discussion in the NRC discussion of the key assumptions.

The probabilistic intruder analysis is conducted with ranges of values for many inputs, but many factors are not considered and it is not clear why these were not included in the analysis. Factors ignored in the probabilistic analysis loss of institutional controls, loss of memory, drilling at the exact location of the GTCC LLW, drilling at the exact location of the higher activity packages, drilling depth is held constant but may be much deeper for a western site, assuming a driller will continue drilling when cuttings look like waste, a person would mix waste-like cuttings into their garden, actual timing of when barriers would cease to be effective (likely longer than 500 years), actual timing of when GTCC LLW would be indistinguishable from soil (longer than 500 years for many wastes), particle size of cuttings (would waste cuttings be small enough to behave like dust for inhalation), transfer factors waste in drill cuttings behaving like dust for inhalation pathway (distributions assume dust, when cuttings may actually be larger particles), transfer factors behave like soil (ranges for transfer factors are based on soil, but many of the wastes would not be expected to behave like soil for long time frames).

5. Use of generic analysis to rule out specific waste streams

While EM-4.2 recognizes that NRC attempted to use relevant GTCC LLW characteristics and volume data available as well as performed complex technical analysis of a generic disposal facility, we recommend that the Draft Regulatory Basis focus on a set of performance requirements that must be demonstrated in a license application for a specific site and specific waste streams. We note the NRC concluded that 15 of 17 waste streams are potentially suitable for near-surface disposal. EM-4.2 is concerned that NRC is proposing to exclude two GTCC LLW streams for near-surface disposal based on the Final GTCC EIS documentation which is made up of bounding estimates. For the two NRC proposed excluded GTCC LLW waste streams, commercial sealed sources associated with neutron irradiators and remote-handled other waste from decontamination activities at the West Valley Demonstration Project (WVDP), NRC has stated in the Draft Regulatory Basis that

this waste stream is "not suitable for near-surface disposal" (page vii). However in the NRC Technical Analysis of The Hazards of Disposal of Greater-Than-Class C and Transuranic Waste, it states that this waste stream "would be difficult to disposal of in near-surface" (page 66), "may not be suitable for near-surface disposal" (page 82), and "could potentially be found suitable for disposal with a site-specific intruder assessment". Therefore there appears to be some inconsistencies between the Draft Regulatory Basis and the NRC Technical Analysis of The Hazards of Disposal of Greater-Than-Class C and Transuranic Waste. EM-4.2 recommends that the Draft Regulatory Basis instead place more emphasis on key assumptions and technical requirements that NRC used to include or exclude waste, e.g., dose limitations to the general public, dose to an inadvertent intruder, depth of waste disposal, cover thickness, intrusion barrier, etc. Such a focus would be easier for the public and stakeholders to understand and would more clearly communicate the level of defense-in-depth built into the intrusion analysis.

EM-4.2 has surveyed the currently existing remoted handled other waste at WVDP and compiled the packaging and TRU characteristics. EM-4.2 found that 678 of 808 containers (about 84% of containers or 93.6% of the volume) do not exceed NRC's limit of 10,000 nCi/g and are likely suitable for near-surface disposal at a generic site. The packages that do not exceed 10,000 nCi/g have an average container concentration of 1,519 nCi/g. and average volumetric concentration of 902 nCi/g., well below the overall waste stream averages. If site-specific conditions are modeled, EM-4.2 believes nearly all, if not all the GTCC LLW and GTCC-like waste containers, could be suitable for near-surface disposal.

In addition, EM-4.2 recommends NRC establish a performance objective, such as the dose to the intruder at 500 years, allowing a site-specific analysis to establish the waste acceptance criteria for a TRU waste concentration limit.

Because of the limitations of generic analysis, EM-4.2 recommends NRC focus more on development of technical criteria for safe disposal in the Draft Regulatory Basis, rather than on conclusions about what waste streams are not suitable based on the results of a generic analysis. We recommend conducting a site-specific analysis using the technical criteria for safe disposal before excluding a specific waste stream such as the sealed sources or WVDP wastes from near-surface disposal.

6. Inventory Concerns

EM-4.2 analyzed the inventory tables NRC provided and found some inconsistencies. For example, Table 3-4 appears to focus primarily on the GTCC LLW inventory and only shows some of the GTCC-like waste inventory – those waste streams located in the WVDP. DOE sites with GTCC-like waste streams from Oak Ridge, Idaho National Laboratory, and Los Alamos National Laboratory appear to be missing. In addition, GTCC LLW "other waste" currently stored at Waste Control Specialists and at BWXT also appears to be missing from Table 3-4. EM-4.2 recommends that NRC either analyze all of the GTCC LLW and GTCC-like waste inventory documented in the 2016 Final GTCC EIS, or only focus on GTCC LLW inventory in which case the WVDP GTCC-like waste would need to be deleted from the NRC analysis.

7. **Removal of Waste Stream(s) from Analysis for Near-Surface Disposal Viability**

   Regarding "Other GTCC LLW from Mo-99 Production," DOE's estimate of GTCC LLW from molybdenum-99 (Mo-99) production in the Final GTCC EIS was based on best available data in 2016. Since that time, DOE has learned that potential Mo-99 producers are developing processes that are estimated to produce little to no GTCC LLW. To date, no Mo-99 producers have produced GTCC LLW. The Medical Isotope Production System (MIPS) and the Missouri University Research Reactor projects referenced are no longer being pursued by commercial Mo-99 producers. EM-4.2 therefore recommends NRC take this into account when considering its Draft Regulatory Basis analysis, recommendations, and conclusions. When referencing Mo-99 waste streams, EM-4.2 recommends NRC reference them as "TBD" in terms of volume and producers identified.

8. **Appropriate Use of Accident Analyses**

   The accident analyses, although informative regarding potential hazards, should not be over-interpreted regarding potential disposal of GTCC LLW. The standard safety analysis process includes steps to identify potential hazards, which may be based on conservative or even bounding scenarios. The next step is to identify physical and administrative measures that can be taken to mitigate the hazards and assess the feasibility and effectiveness of implementing those measures. As low as reasonable achievable (ALARA) principles must also be addressed to optimize the process with regard to potential hazards to the workers and the public. The fact that a significant hazard exists does not alone imply that an activity cannot be safely conducted.

Other Specific Draft Regulatory Basis Comments:

1. On page iv, the NRC defines "Near-Surface Disposal Facility - A land disposal facility in which radioactive waste is disposed of in or within the upper 30 meters of the Earth's surface." However on page B-2 there is a lengthy explanation that the distinction between near and not near surface with respect to 30 m is not significant. This could potentially lead to confusion over the near-surface definition. The Draft Regulatory Basis further states, "The 10 CFR Part 61 regulations apply to land disposal of radioactive waste. Most land disposal of LLRW in the United States is in the near-surface (approximately the uppermost 30 meters [100 feet] of the Earth below the land surface). The site suitability requirements provided in 10 CFR 61.50(a) are for near-surface disposal. The site suitability requirements for other than near-surface disposal were never developed because disposal of waste deeper than 30 meters was envisioned as being possible but not probable. The distinction of 30 meters depth between near-surface and other than near-surface is not significant. This depth (30 meters) was generally believed to be a practical limit as to how deep excavation would occur for disposal of waste. In general, it has held true, with the exception of the WCS facility in Andrews County, Texas where some cells for waste disposal extend beyond 30 meters even though the disposal method is an excavated pit type of facility." EM-4.2 suggests that NRC clarify whether or not it views the entire WCS facility as a near-surface disposal facility.

2. On page iv of the Draft Regulatory Basis, revise the definition of "GTCC-like waste" to read as follows: "A term used by DOE to refer to radioactive waste that is owned or generated by DOE (including LLW and non-defense-generated transuranic waste (TRU)), has no identified path to disposal, and has characteristics similar to those of GTCC LLW such that a common disposal approach may be appropriate. The term, 'GTCC-like waste' is not a classification of radioactive waste."

3. On page vii of the Draft Regulatory Basis, the Analysis of GTCC Waste Hazards section, and in general, EM-4.2 suggests including further transparency about the conservatism associated with assumptions on which the analyses are based. We suggest that built-in conservative assumptions should be clearly and transparently discussed to provide proper perspective. This is especially true for the intruder analysis where many conservative assumptions are built-into the calculations. Some of the conservative assumptions are the following: complete loss of institutional controls and memory of the facility, a relatively moderate depth to water that is not applicable for many arid locations in the western United States, construction of a home or drilling a well at the exact location of the disposal facility and over GTCC LLW in the disposal facility, waste indistinguishable from soil at 100 or 500 years (unlikely for typical packaging and waste forms for GTCC LLW), barriers would be unrecognizable and ineffective at 100 or 500 years, drill cuttings would be mixed in garden soil without recognizing it is different, assuming waste in drill cuttings would behave like dust for resuspension and would be of a size that is respirable, etc.

4. On page 3, the Draft Regulatory Basis states: "A distinction is made between GTCC waste generated by NRC licensees and Agreement State licensees, which is referred to as 'commercial' GTCC waste, and DOE GTCC-like waste. However, DOE's definition of GTCC-like waste also includes recovered sealed sources that the agency has taken title to from NRC and Agreement State licensees." Where DOE acquires material such as sealed sources recovered for public health and safety or national security reasons pursuant to its authorities under the Atomic Energy Act of 1954, as amended, and not for purposes of implementing its disposal responsibility under section 3(b)(1)(D) of the Low-Level Radioactive Waste Policy Act (LLRWPA), and those sources are determined to be LLW, DOE may dispose of such material in the same manner as it does other LLW owned or generated by DOE. Thus, the recovered sealed sources are considered to be GTCC-like waste.

5. On page 4, the Draft Regulatory Basis states that section 3(b)(1) of the LLRWPAA directs that the Federal government is responsible for regulating the disposal of GTCC waste streams. We note that section 3(b)(1) provides that the Federal government is responsible for GTCC LLW disposal. Section 3(b)(2) addresses regulation of the GTCC LLW disposal facility.

6. On page 8, NRC states that "the current 10 CFR 61.2 definition of 'waste' excludes TRU waste (see Section 4.2.1 for further details on the definition of TRU waste). With the enactment of the LLRWPAA in 1985, the 1980 Act was superseded in its entirety. The LLRWPAA's definition of LLRW does not expressly exclude TRU waste, thus allowing a

rulemaking to revise the 10 CFR 61.2 "waste" definition to include TRU waste." EM-4.2 supports updating the Part 61 definition of "waste" so that it no longer excludes TRU waste (see also page 15, second full paragraph).

7. On page 18, NRC described reliance on three "key" assumptions, including the assumptions that GTCC LLW must meet Part 61 requirements, that GTCC LLW must be disposed at least 5 m below surface of the earth (different wording from Part 61 "surface of the cover"), and that 500 year intruder barriers must be in place. EM-4.2 recommends that analysis and results be consistent with these three key assumptions and questions whether results should be presented for calculations assuming the waste was indistinguishable from soil at 100 years (not packaged like Class C LLW and no accounting for waste forms), no intruder barrier at 100 years (in spite of a requirement for 500 year barriers), and a basement excavation would contact the waste (which implies a depth of less than 3 m rather than 5 m or more, as would be required for Class C LLW disposal).

8. On page 20, Section 3.1.2, NRC implies that TRU concentrations of 10,000 nCi/g could be interpreted as a limit for potential suitability for near-surface disposal due to operational and inadvertent intruder considerations. EM-4.2 suggests this discussion be revised to reflect a more risk-informed perspective focusing on the results of the generic assessments of intrusion and operational hazards. The discussion should also reflect perspective regarding where additional operational controls may be required, if feasible, and how conservatisms built into the generic inadvertent intrusion assumptions may over-predict consequences for robust waste forms in areas with deep water tables and where mud pits are used for drilling.

9. On page 20, Section 3.1.3, second paragraph, NRC states some wastes "will remain hazardous beyond 500 years." This statement is consistent with requiring a 500-year intruder barrier, yet the results presented in the NRC Technical Analysis of The Hazards of Disposal of Greater-Than-Class C and Transuranic Waste start at 100 years. EM-4.2 recommends for consistency that all results for the intruder begin at 500 years.

10. On page 20, Section 3.1.3., third paragraph, the following assumption is stated in a paragraph rather than in the list of key assumptions: "The NRC has assumed for the well-drilling scenario that the GTCC LLW would be disposed as a single layer of waste packages (i.e., an inadvertent intruder would only drill through a single waste package). If GTCC LLW is disposed in multiple layers of waste packages, then the estimated doses are expected to increase due to the additional amount of waste that would be brought to the surface by the drilling activity." EM-4.2 suggests adding this to the list of assumptions.

11. On page 27, NRC recommend a requirement for depth to make an excavation scenario highly unlikely. EM-4.2 agrees that 5 m will preclude an excavation scenario even considering potential erosion, so that should be protective. However, as noted above, terminology used is inconsistent.

12. Page 28, second full paragraph, NRC state that current Part 61 technical analysis requirements are broad enough to cover GTCC LLW. However, NRC specifically mention incorporating clarifications to scope based on the draft "final" Part 61 update. EM-4.2 has

previously expressed specific concerns with provisions of the draft final Part 61 and draft guidance last published by NRC. EM-4.2 notes these specific concerns would also apply to application of the draft final Part 61 updates to GTCC LLW disposal.

13. On page 37, Table 7-1, EM-4.2 suggests adding as another disadvantage that the NRC has not licensed a U.S. disposal facility and that previous licensing experience resides with the Agreement States.

14. On page 48, in the discussion of the Final GTCC EIS, we recommend the text that states that the Final GTCC EIS "suggested two disposal pathways," be clarified to state that "DOE identified as its preferred alternative(s) disposal of the GTCC LLW and GTCC-like waste inventory in a generic commercial disposal facility and/or WIPP," and that a statement be added to clarify that DOE's site-specific Environmental Assessment of the WCS facility in Texas is not a decision document and that DOE has not yet made a decision on a disposal facility for GTCC LLW and GTCC-like waste.

15. On page B-13, top of page, the calculated doses for these two waste streams are predicated on the generic assumptions used for the screening analysis. EM-4.2 recommends stating that these results may not be valid for site-specific analysis. In addition because the factor of 10 was applied raising the Class C limits for Cs-137 for Part 61, the modeling of GTCC LLW may be more restrictive than limits in place for Class C.

16. Page B-13, first full paragraph, states that "results would be unacceptable," but it is not clarified that this is based on a generic screening analysis. If a site-specific analysis is conducted, different conclusions may be obtained.

17. On page B-13, bottom of the page, intruder dose "limit" of 500 mrem is recommended. The use of a limit for intrusion is inconsistent with ICRP and IAEA recommendations and DOE requirements, where the intruder is addressed as an optimization situation (ICRP and IAEA recommend that optimization be applied for intrusion doses up to 1,000 -2,000 mrem. DOE establishes performance "measures" as opposed to strict "objectives" for inadvertent intrusion.

18. On page B-14, Section B.3.4, a key assumption in this analysis is that a viable groundwater pathway exists at the facility. This is not always the case.

EM-4.2 TECHNICAL COMMENTS ON THE NRC TECHNICAL ANALYSIS OF THE HAZARDS OF DISPOSAL OF GREATER-THAN-CLASS C (GTCC) AND TRANSURANIC WASTE (dated July 22, 2019)

General Comment – Role of Site Specific Calculations for Decision Making: EM-4.2 appreciates the value of conducting a range of generic calculations, but cautions that such calculations should not be interpreted as a replacement for a site-specific analysis. EM-4.2 supports the conclusion that site-specific calculations should be conducted before concluding whether each waste stream is or is not suitable for near-surface disposal (see Page 82 of the technical analysis, where NRC state that "[t]hose waste streams could potentially be found suitable for disposal with a site-specific intruder assessment."). EM-4.2 recommends that this conclusion, emphasizing the need for a site-specific analysis to address potential disposal of the two waste streams, be more clearly communicated in the regulatory basis.

General Comment – Focus on Technical Criteria Rather than Results of Generic Analysis: Because of the limitations of generic analyses, EM-4.2 recommends that NRC focus on the development of technical criteria for safe disposal in the regulatory basis, rather than on conclusions about what wastes are not suitable for near-surface disposal based on the results of a generic analysis. EM-4.2 recommends that a site-specific analysis using the technical criteria for safe disposal should be conducted before excluding a specific waste stream from near-surface disposal.

General Comment – Update Drilling Scenario to Address Site with Deeper Water Table: EM-4.2 recommends some corrections in the generic drilling scenario calculations. NRC should consider modeling a well depth aligned with the water table depth for a low infiltration, deeper water table site rather than a humid site. The 55 m deep well that was assumed is representative of a humid site. EM-4.2 recommends that the technical analysis address conditions at a site with lower infiltration and a deeper water table (e.g., a midpoint of the generic water table depths of 135 – 200 m as discussed on Page 74 of the technical analysis). The relatively small assumed spreading area for cuttings from the 55 m deep well should also be scaled-up consistent with the increased volume of cuttings resulting from a deeper well.

General Comment – Differences Between Assumptions in NRC Technical Analysis of The Hazards of Disposal of Greater-Than-Class C and Transuranic Waste and Assumptions for Part 61 and IMPACTS methodology: EM-4.2 found some differences between assumptions for the technical analysis and assumptions for analyses conducted by NRC prior to and as a follow-up to the promulgation of 10 CFR Part 61. At a minimum, EM-4.2 recommends that the scenarios and assumptions included for the analyses in the 1980s should be considered in the technical analysis (e.g., a drilling scenario with use of a mud pit as used in the IMPACTS methodology and inclusion of a factor of 10 reduction in dose as was done for Class C waste when setting the values for the tables in 10 CFR 61.55). Some of the conservative assumptions made in this technical analysis are specifically discussed as rationale for the factor of 10 adjustment that was applied for 10 CFR 61.55 (see page 5-31 in NUREG-0945), e.g., actual probability of intrusion, role of improved waste forms in reducing the potential for airborne dispersion, and inhalation exposures.

General Comments – EM-4.2 recommends removing the calculations for the excavation scenario for inadvertent intrusion and the deep borehole and moderate depth disposal cases as well as the probabilistic analysis for the groundwater pathway.

- The excavation scenario for Part 61 used in this analysis assumed a 3 m deep foundation hole is excavated directly into waste buried only 2 m below the surface of the cover and was indistinguishable from soil (no waste form or barrier). EM-4.2 questions whether that excavation scenario is relevant for GTCC LLW with the generic 5 m depth assumption. The discussion of inputs/assumptions, calculations, and results for the excavation scenario distract attention from the risk-significant drilling scenario. All of the text and tables addressing the excavation scenario could be easily condensed into a short summary of how the generic 5 m depth requirement effectively mitigates the potential excavation scenario consistent with the assumptions used for Part 61.

- EM-4.2 recommends removing results presented for intrusion prior to 500 years. Such results imply that GTCC LLW would be disposed in a manner less robust than Class C waste for which the limits in Part 61 are calculated based on doses at or beyond 500 years.

- EM-4.2 recommends that the discussion of results for the groundwater pathway for a moderate depth disposal and deep borehole concept be removed from the analysis. EM-4.2 questions whether these types of disposal are relevant since the intended focus of this regulatory analysis is near-surface disposal.

- EM-4.2 is concerned that any conclusions based on the generic probabilistic risk analysis are questionable because of the bias introduced by the assumptions including those for hydrological and waste form conditions. EM-4.2 questions whether meaningful conclusions can be obtained from a generic probabilistic analysis. EM-4.2 recommends removing the probabilistic analyses, results and conclusions.

General Comment – EM-4.2 recommends that the NRC's probabilistic inadvertent intruder analysis be removed or updated to illustrate the impact of uncertainty in many of the inputs that were not considered in the analysis. This probabilistic analysis missed an opportunity to illustrate the significance of many of the major uncertainties that are often ignored when calculating doses for an inadvertent intruder. As presented, the value and meaningfulness of the results from the probabilistic intruder calculations are of concern considering that a worst case (i.e., 100% chance) was assumed for many of the greatest uncertainties in the scenarios. Examples of real uncertainties that could have been addressed, but are not accounted for in the probabilistic uncertainty analysis include, for example: probability that memory of the facility will be lost, probability that someone would drill a well in an area without a viable aquifer (or would it be an oil well which is very deep and would greatly dilute the cuttings), probability of a well being drilled within the footprint of the facility, probability of intrusion into a GTCC LLW package within the footprint of the facility, probability that a mud pit would be used for drilling in a given region rather than an air based drilling method (thus mitigating any inhalation impacts which dominate the doses in the technical analysis), probability that an improved GTCC LLW form would be readily dispersible for uptake and inhalation, probability that drill cuttings from the waste would behave like dust for resuspension rather than denser particles, probability that

the waste drill cuttings particle size would be respirable, probability that a driller would stand in the dust cloud created where cuttings are blown onto the ground surface rather than standing somewhere upwind or away from the dust (or if standing in the dust cloud, a driller would wear a dust mask), probability that someone would mix waste cuttings in a garden before the waste is indistinguishable from soil (which may be many thousands of years), probability that waste cuttings would behave like soil for plant uptake, etc.

Page 6, Table 2-1 – Editorial: WWDP should be WVDP

Page 19. First paragraph. The technical analysis states that "…based solely on present day observations, one may argue that direct disturbance scenarios are not credible. However, this viewpoint may not reflect the dynamic nature of societal development over long timeframes. Technology to identify and recover natural resources is continually evolving. Technologies employed today (e.g. laser-guided sonic drilling) were not even imagined 100 years ago." EM-4.2 recommends that additional context be provided to clarify the statement.

Page 19. First paragraph: The technical analysis states: "Cautious but reasonable intruder scenarios play an important role in the management of LLRW. The intruder assessment is not a prediction of what is going to happen in the future, rather it is a regulatory tool to ensure, should disturbance occur, that public health and safety will be protected." EM-4.2 finds the use of the term "ensure" in the second sentence of the above quote to be inappropriate. The purpose of a performance assessment is to provide "reasonable expectation" (or in Part 61 terms, "reasonable assurance") rather than "ensuring" protection. As mentioned in the first sentence, "reasonable" is a critical term when discussing the intent of requirements related to inadvertent intrusion and NRC selected a specific set of scenarios during the 1980s to avoid undue speculation.

Page 19. First paragraph: EM-4.2 recommends that additional discussion be provided regarding the many conservative assumptions built into an inadvertent intruder analysis. Such discussion will help provide perspective for the public regarding how many layers of defense-in-depth are already assumed to occur with 100% probability under the pretense of a "reasonable" analysis (e.g., assuming drilling occurs within the footprint of the facility and at the specific location of each waste stream, assuming at 500 years the driller would not take reasonable actions when drilling through GTCC LLW that is different from soil, assuming a driller would choose to stand in the dust cloud where the cuttings are blown out on the ground rather than upwind or away from that area (also would not wear a dust mask if standing near the dust cloud while drilling), assuming that a resident would mix GTCC LLW in their garden (metal, grout, etc.), assuming plants grow in a mixture of 25% GTCC LLW, assuming that GTCC LLW would behave like dust rather than denser particles for resuspension, assuming that drill cuttings from waste would be size fractions small enough to be respirable, assuming drill cuttings will be spread on the ground rather than disposed in a mud pit, etc.).

Page 19. First paragraph: EM-4.2 recommends that the excavation scenario and also any results for intrusion into GTCC LLW before 500 years be removed. Such inadvertent intrusion was assumed to be precluded for Class C LLW by the stability requirements, and the 5 m depth /500 year inadvertent intruder barrier requirement. EM-4.2 expects GTCC LLW disposal requirements will be at least as rigorous as for Class C LLW.

Page 19, second paragraph: NRC state: "The form of the waste can be an important consideration when evaluating potential impacts to an inadvertent intruder. Doses to an inadvertent intruder are directly dependent on exposure time. If the waste material, when disturbed, is clearly distinguishable as something different (and dangerous) then exposure times may be less. This type of exposure scenario is termed a discovery scenario." EM-4.2 agrees that this point is very important, but suggests that more additional context be provided. This paragraph should be expanded to discuss how the nature of GTCC LLW would be expected to influence the likelihood/timing of GTCC LLW being indistinguishable from soil, the likelihood of mixing waste in garden soil, the likelihood of metal/grouted waste cuttings behaving like dust particles for inhalation, etc. This will provide perspective about the level of conservatism and defense-in-depth built-into the assumption that an intrusion scenario would occur even at 500 years rather than much later. This is also a consideration for the factor of 10 adjustment applied to the Class C limits in 10 CFR 61.55, which reinforces the applicability of such an adjustment factor for this regulatory analysis.

Page 24, Next to last paragraph: EM-4.2 questions whether excavation calculations in the technical analysis are relevant for GTCC LLW that will be disposed more than 5 m. below the top surface of the cover (notwithstanding the further defense-in-depth provided by the robust nature of the barriers, containers, and waste forms that would be expected). Five meters of depth provides a substantial safety margin for the 3 m excavation of a foundation hole considered in the analyses for 10 CFR Part 61, thus the 3 m excavation scenario would yield no consequences for GTCC LLW.

Page 24: NRC state: "The staff approach started with the calculations used to develop the waste classification tables. The basis for using the original calculations is to provide an 'apples to apples' comparison of results for GTCC with Class A, B, and C LLRW." Drilling was not significant for the 10 CFR Part 61 analysis since the excavation scenario assumed waste was placed 2 m below the top of the cover (i.e., direct excavation of 1 m of waste when digging a 3 m deep foundation bounded any drilling scenario). However, drilling as considered in the IMPACTS NUREG from the 1980s (NUREG/CR-4370), is clearly the relevant scenario for GTCC disposed more than 5 m below the top surface of the cover. In addition, NRC staff did not follow the IMPACTS approach for the drilling scenario (i.e., IMPACTS used a mud pit versus the technical analysis which uses cuttings spread on the ground surface). Although the IMPACTS NUREG was issued after Part 61 was promulgated, the technical analysis should not ignore that a mud pit scenario was considered as Part 61 was being implemented. Mud pits are commonly used for drilling in many regions of the United States. EM-4.2 recommends that a mud pit based drilling scenario be included in the technical analysis. Such a scenario would provide important perspective for the public about impacts under those conditions.

Page 27, first line, NRC states "When waste is disposed less than 5 meters … the scenario evaluated is a potential excavation scenario." EM-4.2 recommends rephrasing this sentence to: "The excavation scenarios for Part 61 assumed that waste was disposed only 2 m below the top surface of the cover and a 3 m deep foundation hole was excavated that would include removal of some waste. If GTCC waste is disposed deeper than 5 m below the top surface of the cover, the excavation scenario is not credible, and thus, is not considered in this technical analysis." If

GTCC LLW is disposed at least 5 m deep, which provides a generic safety margin for a 3 m excavation, the excavation scenario is irrelevant for this analysis. From a risk-significance perspective and in order to focus on the relevant scenarios, EM-4.2 recommends making the point that generically specifying at least 5 m deep disposal provides a sufficient safety factor to mitigate the potential risk from the excavation pathway. Thus, there is no need for the detailed discussion and calculations for the excavation scenario. EM-4.2 recommends a significant reduction of this discussion and removal of all the excavation calculations and results. This will help to focus the technical analysis on the drilling scenario that is significant for GTCC LLW.

Page 37, first full paragraph: This paragraph provides some perspective about the significance of the waste form when considering an intrusion scenario. EM-4.2 recommends that NRC provide additional discussion on the variety of specific waste forms that will be used for GTCC waste (e.g., sources grouted into containers, reinforced concrete canisters, or stainless steel canisters) and the sensitivity to waste form on intruder scenario predictions in a site-specific analysis.

Page 37: The generic analysis appears to ignore the contribution of the waste form in the intruder analysis. EM-4.2 recommends that NRC state this in discussions of "key assumptions" in the technical analysis and regulatory basis document.

Page 37, last paragraph: EM-4.2 recommends the technical analysis specifically discuss routine drilling practices near potential disposal sites. The first sentence states that the scenario involves a well drilled to an average depth of 55 m, which is based on the assumption of a humid, eastern site as described in the list on p. 36. EM-4.2 finds this assumption and the associated range identified on p. 38 to be overly conservative for disposal that could potentially occur at a western site. The average and range of depths of the well assumed should be representative of the depths of viable aquifers at potential western sites or, in the case of no viable aquifer, typical depths of wells drilled in those locations.

Page 37: the use of a mud pit scenario by NRC for the IMPACTS methodology (NUREG/CR-4370) should be acknowledged here. EM-4.2 recommends that a similar mud pit scenario be added to the technical analysis for consistency with previous NRC analyses.

Page 37: At the end of the page, NRC state that if the same spreading area is used as was used for the excavation scenario "then the contaminated layer would only be 0.5 mm thick and could not persist for a year." This highlights conservatism in the analysis for the relatively small amount of cuttings to be eroded away over time as modeled. EM-4.2 recommends that NRC document this conservatism in "key assumptions." NRC assumed cuttings from the 55 m deep well would be spread in a relatively small radius of 5-15 m, but deeper wells may be necessary at arid western sites and would likely involve a wider area of spreading for the larger volume of cuttings. EM-4.2 recommends that the spreading area be modified to be more representative of well depths at expected western sites.

Page 39+, Section 3.2 and Page 68+, Section 4.2: Groundwater pathway:

- The groundwater pathway is highly dependent on characteristics of the site, disposal concept, container, and waste form. Thus, it is difficult to determine what a reasonable

assumption is or draw any major conclusions from a generic groundwater analysis because ranges and distributions for a site-specific analysis may differ significantly.

- A probabilistic analysis in this context has the potential to imply more knowledge and meaningfulness for decision making than truly exists for a generic analysis. It is recommended to remove this analysis.

- Although no specific conclusions can be made, the results from the generic groundwater analysis highlight the benefits of a site with relatively low infiltration and a deeper water table and give some indication that a near surface facility in those conditions may be suitable for GTCC LLW disposal, subject to specific analysis of the site and actual waste forms and conditions at a given facility.

- EM-4.2 recommends addition of discussion of the implications on off-site exposures for a case of a near-surface disposal facility where there is no viable aquifer for a groundwater pathway

Pages 74-76, Table 4-7 and Figure 4-11: Groundwater pathway results are provided for moderate depth and deep borehole disposal, Scenarios 4-6. EM-4.2 recommends removing all data and analysis of moderate depth and deep borehole analyses, since these are irrelevant to a technical analysis to determine suitability of near-surface disposal for GTCC LLW.

Page 52+, Section 3.3 and Page 78+, Section 4.3: To be meaningful operational accident calculations need to be specific to a given facility and waste form(s). Thus, no significant conclusions about suitability of GTCC LLW for near-surface disposal should be derived from a generic analysis. It is standard practice to assess potential operational accidents as part of the operational safety assessment for any nuclear facility to identify potential hazards. Once hazards are identified, measures to mitigate the hazards are identified, evaluated, and implemented as appropriate. Such assessments would consider the likelihood of specific dispersible and/or flammable waste forms and likelihood of occurrence of specific accidents.

Page 55, Section 4.1: EM-4.2 recommends that the presentation of results be revised in this section to provide clear perspective about the likelihood of the exposures and the assumptions on which the results are based:

- When discussing the results for the excavation scenario, there is no mention that the Part 61 excavation scenario is predicated on GTCC LLW being disposed 2 m below the top surface of the cover and the assumption that the waste will be indistinguishable from soil. Given the NRC intent to require disposal at least 5 m below the top surface of the cover for GTCC LLW, the modeled excavation scenario would never occur. Therefore, EM-4.2 recommends removal of the excavation analysis/calculations and inclusion of a statement that the generic requirement for burial at least 5 m below the top surface of the cover effectively mitigates the potential excavation scenario. The statement at the end of the first paragraph in Section 4.1.1 could be reworded to reflect the exact situation.

- The third paragraph in Section 4.1.1 provides the results for the drilling scenarios but misses an opportunity to put the calculated doses in perspective. For example, a 500 year

intruder barrier would preclude any of the results calculated for the first 500 years. Given that NRC intent to require a 500 year barrier, EM-4.2 recommends that doses for the time from 100-500 years not be included in the results and removed from Table 4-1.

- EM-4.2 notes that the dose after 500 years is largely associated with impacts via the inhalation pathway. Therefore, EM-4.2 recommends that the assumptions for the inhalation pathway considered in the analysis be fully and transparently discussed. For example: what is the likelihood of a well being drilled in the footprint of the facility?; would the well be drilled deeper than 55 m.?; what is the likelihood of drilling directly through any specific waste stream?; what is the likelihood a driller would stop drilling if drilling through something that was not soil or rock?; what is the likelihood drillers use mud pits (if so it would essentially eliminate inhalation impacts)?; would a driller stand downwind or in the dust cloud where cuttings are deposited on the surface or stay upwind and away from the dust cloud?; would the driller wear a dust mask if working in the dust cloud?;would cuttings from GTCC waste be resuspended like dust or be heavier particles and less likely to be resuspended?; and what fraction of the cuttings would be a particle size that is respirable? These are examples of many built-in assumptions if quantified would lead to reduced consequences of such a scenario. EM-4.2 recommends that NRC clearly discuss those and other key assumptions to provide some perspective for the likelihood of calculated doses.

- EM-4.2 recommends updating the drilling scenario to use a well depth more representative of a drier site (e.g., a well that extends below a 135-200 m water table). By adjusting the average well depth and range of well depths to be more reflective of a drier site and scaling the spreading area accordingly, the doses from the inhalation pathway would be significantly reduced.

- EM-4.2 recommends that the drilling scenario be updated to include an assumed mud pit (as assumed in the IMPACTS analysis and reflecting common practice in many regions of the United States). This is expected to essentially eliminate the dose consequences for the inhalation pathway.

Section 4.1.2, Contractor results: While the contractor results section has a list of assumptions which is helpful, the list does not capture the major uncertainties that are not addressed. Although the contractor results are based on a probabilistic analysis, which provides some perspective on the range of potential outputs, the meaningfulness of the results from probabilistic analysis is limited because of the major uncertainties not considered.

Section 4.1.2, Contractor results: Probability distributions that were used add significant uncertainty since they are based on waste cuttings behaving like dust or soil. The distributions ignore the potential that the cuttings would not behave like dust or soil.

Section A., Page 88, last sentence: Replace “West Valley in the State of New York” with “Western New York Nuclear Service Center in West Valley, New York”.

Section A., Page 88, Waste Availability: EM-4.2 recommends that NRC discuss potential uncertainties in using bounding values for the generic analysis for existing and potential waste as described in Final GTCC EIS. The Final GTCC EIS is now at least 3 years old by reference. As discussed, a portion of the existing waste in the Final GTCC EIS was projected waste volumes and characteristics.

Section A.2.3.1, Page 98, GTCC Other Waste from Decontamination Activities at WVDP. Page 5, #5 provides an overview of EM-4.2's concern. EM-4.2 is available to meet with NRC to discuss additional information on the excluded WVDP waste stream and questions NRC may have in general.

Section A.3.3.2, Page 108, same concern as comment as page 6, #7.