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memorandum

WDP-TWPS: TRU WASTE PROJECT SUPPORT

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SUBJECT: EVALUATION OF LOW ACTIVITY TRANSURANIC (TRU)-MANAGED DRUMS FOR LOW LEVEL WASTE (LLW) DISPOSITIONING

A method has been identified for determining the specific activity for low activity drums currently managed as TRU waste for LLW disposition. Many of these drums have assayed on non-destructive assay (NDA) instruments (eg., HENC, Q2) as below 100 nCi/g or below the instruments detection limit. The method is described in the attached paper.

A handwritten signature in black ink, appearing to read 'John Veilleux'.

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Pu239 Minimum Detectable Activity (MDA) for Use in Low Level Waste Transportation

1. Background

Several drums currently classified as transuranic (TRU) waste have been measured on the High Efficiency Neutron Counters (HENC) or Q2 instruments and assayed below 100 nCi/g. Because these instruments^{1,2} have minimum detection concentrations (MDC) that are generally below 100 nCi/g, drums measuring less than 100 nCi/g can be reclassified as low level waste (LLW).

A problem arises when the assay and the TRU isotopes are below the lower limit of detection (LLD). The isotopes reported as "< LLD" do not contribute to the TRU specific activity and therefore are zeroed in the TRU and WIPP databases. When all the isotopes are zero and the results transferred to the LLW database, the transportation manifest created erroneously indicates that the drum is non-radioactive. To correct this problem, some nominal activity value is needed for the manifest to indicate that in fact the drum is radioactive.

One method for generating appropriate activity values when the TRU isotopes are all below the LLD is to use the minimum detectable activity (MDA) of the fiducial isotope used to quantify waste and then apply the quantity to generate the TRU specific activity (nCi/g). The fiducial isotope for low signal drums where the Pu isotopes are below the LLD can be assumed to be Pu239 and the MDA of this isotope can be used to generate a nominal value of TRU specific activity.

This memo describes the selection of a constant Pu239 MDA value for the HENC instruments that can be used to automate the generation of an appropriate TRU database value for the drum.

2. Requirement

Develop an appropriate Pu239 MDA for a drum when all reported TRU isotopes are below the lower detection limits. If at least one TRU isotope is above the LLD, then the sum of all TRU isotopes above the LLD will be used for determining the drum activity, otherwise the constant Pu239 MDA will be used.

3. Methodology

The two HENC instruments (HENC#1 and HENC#2) have been calibrated and the associated reports confirm that the instruments can perform the TRU/LLW sort. The MDA values for debris and homogenous solid matrices (sludge) in 55 gal drums have been determined and the results are summarized in Table 1 (See references 1 and 2).

Table 1 Pu239 Minimum Detectable Activities (Ci) for Debris and Homogenous Solids (Sludge)

| Matrix | HENC#1 | HENC#2 |
|--------|---------|---------|
| Debris | 1.27E-3 | 7.2E-4 |
| Sludge | 5.26E-3 | 2.87E-3 |

¹ Stanfield, S and J Wachter, Calibration Report for the HENC#1 Including Passive Neutron and Gamma Spectrometer Calibration and Confirmation, MCS-HENC#1-NDA-1002, Rev. 6, Oct 3, 2007

² Stanfield, S and J Wachter, Calibration Report for the HENC#2 Including Passive Neutron and Gamma Spectrometer Calibration and Confirmation, MCS-HENC#2-NDA-1002, Rev. 3, Sep 14, 2007

The instrument with the maximum MDA should be used to represent both HENC units. Consequently, the Pu239 MDA values should be set at 1.27E-3 Ci for debris matrices and 5.26E-3 Ci for sludge matrices. To quantify the TRU specific activity, the isotopic contribution must also be specified. Since these drums generally come from processes containing plutonium, a weapons grade isotopic distribution, such as material type 52, provides a convenient standard (see appendix). Using this distribution and the Pu239 MDA, for a drum to remain below 100 nCi/g, the minimum net matrix weights must therefore be 12.7 kg for debris and 52.6 kg for sludge.

There have also been cases when isotopes in addition to those in MT52 are detected. When this is the case, these isotopes will also be included along with the MT52 isotopes in determining the total activity and the TRU specific activity. This will ensure that at least 95% of the total activity in the drum is reported as specified by the WIPP WAC³.

The best detection technique for confirming low signal drums generally comes from the gamma system. However, high energy interfering isotopes (e.g., Cs137) sometime raise the background in the region of the Pu gammas such that the Pu239 MDA leads to a concentration exceeding 100 nCi/g. In these cases, if a neutron measurement exists, the neutron results may be used to provide additional evidence that the plutonium signal is low enough to provide credence that the drum indeed meets the LLW criteria.

To provide quality checks on making the TRU/LLW selection, all drums will be reviewed by an NDA technical expert to confirm that these minimum requirements are met and that the assay results are technically justifiable. A drum will NOT be transferred to LLW unless it meets the requirements summarized in the procedure steps below.

A similar procedure will be applied to Q2 or far field gamma system data since these instruments can generally provide assays at least as sensitive as the HENCs' gamma system.

4. Procedure Steps

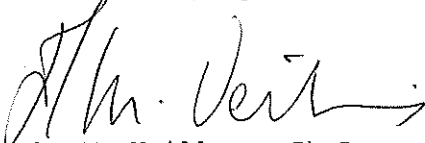
- 4.1. Identify a drum as "suspect LLW" if an instrument (e.g., HENC, Q2, far field gamma) indicates < 100 nCi/g or the assay is below the instrument's lower limit of detection (LLD).
- 4.2. Evaluate the assay at the reported gamma instrument Pu239 minimum detectable activity (MDA) for weapons grade Pu, using material type 52 (MT52) for the isotopic distribution (Note: the Pu239 MDA here is NOT the same as the values in Table 1).
 - 4.2.1. If result is < 100 nCi/g, the drum is confirmed LLW.
 - 4.2.2. If result is ≥ 100 nCi/g, continue evaluation.
- 4.3. When the Pu239 MDA indicates the assay is above 100 nCi/g and an assay is available from a neutron system (e.g., HENC), check the neutron results (e.g., the neutron "Ones" rate). If the neutron results indicate the assay is below the detection limit or < 100 nCi/g, confirm LLW. Otherwise, the drum remains in the suspect category and another process must be considered (e.g., load management, long assay period, or assay on a more sensitive instrument).

³ DOE/WIPP-02-3122, Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant, US Department of Energy, Carlsbad Field Office, October 29, 2007

- 4.4. For drums confirmed as LLW, the isotopic quantities will be populated using the nominal Pu239 MDA values (from Table 1) for MT52 plus the values of any other detected TRU isotope and the drum transferred to the LLW database.
- 4.5. For drums that remain in the "suspect LLW" category, the drum will continue to be managed as TRU.

5. Conclusion

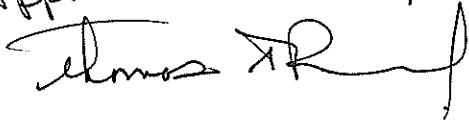
For those cases where all TRU isotopes are below the lower limit of detection (LLD) as measured by the HENC instruments, a nominal Pu239 MDA value of $1.27E-3$ Ci for debris and $5.26E-3$ for sludge (e.g., homogeneous solids) drums shall be used. Provided the drums contain at least 12.7 kg for debris or 52.6 kg for sludge (assuming a MT52 weapons grade isotopic distribution), the MDC will be below 100 nCi/g. In addition to the isotopes of MT52, all other isotopes will also be reported if they are above the LLD. This will ensure that at least 95% of the total activity in the drum is reported. Drums not meeting these criteria will remain on the suspect list; i.e., the TRU/LLW determination cannot be made. All drum assays must be reviewed by an NDA technical expert prior to transferring the drum from TRU to LLW management. Drums failing these criteria should be considered for alternative instruments (e.g., Q2 or a high efficiency HPGe detector with the SNAP or similar software) or processes such as load management.



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Appendix: Material Type 52 (MT52) Weapons Grade Plutonium

OK A

Approved for implementation, 3.7.08


Appendix

Material Type 52 (MT52) Weapons Grade Plutonium

Material type (MT) 52 weapons grade material has the isotopic composition⁴ shown in

Table 2. Material Type 52 Isotopic Distribution as a Percentage of Total Plutonium Mass and Comparison for A Container with 100 nCi/g of Pu Waste

| For a 100 nCi/g Waste Container | | | | |
|---------------------------------|-----------|---------------|-------------------------------|------------------------|
| Isotope | Weight % | Activity (Ci) | TRU Specific Activity (nCi/g) | Activity % to Total Pu |
| Pu238 | 0.01 | 2.12E-05 | 2.1 | 0.6123% |
| Pu239 | 93.78 | 7.24E-04 | 72.4 | 20.8792% |
| Pu240 | 6 | 1.69E-04 | 16.9 | 4.8846% |
| Pu241 | 0.2 | 2.55E-03 | 0.0 | 73.6235% |
| Pu242 | 0.02 | 9.75E-09 | 0.0 | 0.0003% |
| Am241 | 0.2 | 8.52E-05 | 8.5 | 2.4565% |
| U234 | 0.002 | 1.55E-09 | 0.0 | 0.00004% |
| U235 | 0.1 | 2.69E-11 | 0.0 | 0.00000% |
| Cs137 | 0.0000004 | 4.32E-09 | 0.0 | 0.00012% |
| Sr90 | | 4.32E-09 | 0.0 | 0.00012% |
| Totals | | 3.55E-03 | 100.0 | |

The trace isotopes (U234, U235, Cs137, and Sr90) in a container with 100 nCi/g are an insignificant contributor to the total plutonium activity, each being less than 0.0001%. Sr90 is assumed to be in equilibrium with Cs137 and have equal activity.

⁴ CCP-AK-LANL-006, TA-55 Mixed Transuranic Waste, Los Alamos National Laboratory, November 30, 2007