Approved by:		
	General Manager	Radiation Safety Officer

STANDARD OPERATING PROCEDURE

15.WAC.01

RADIOACTIVE MATERIALS ACCEPTANCE

1.0 OBJECTIVE

Define procedures to determine acceptability of radioactive materials at the Clean Harbors Deer Trail (CHDT) facility for the purposes of treatment and/or disposal.

2.0 SCOPE

This standard operating procedure (SOP) applies to the radioactive materials allowed for disposal under State of Colorado Radioactive Materials License 1102-1, which include radionuclides associated with naturally-occurring radioactive materials (NORM), technologically-enhanced NORM (TENORM), and radium processing wastes.

3.0 POLICY

Wastes will be evaluated for acceptability at CHDT according to the procedures in this SOP.

4.0 RESPONSIBILITIES

Responsibilities of the CHDT Radiation Safety Officer (RSO), management, and staff are defined in the CHDT Radiation Protection Plan (SOP 15.RPP.01).

5.0 WASTE ACCEPTANCE CRITERIA

Chemical and physical properties of wastes that can be accepted for treatment, storage and disposal at CHDT are defined in the Colorado Hazardous Waste Act Permit No. CO-05-12-21-01. The radiological component, if any, of waste is regulated by the permit, License 1102-01, and this SOP. Any received radioactive materials must meet the following additional acceptance criteria.

5.1 Acceptable Radionuclides

Acceptable radionuclides are limited to naturally-occurring radionuclides only, including the radionuclides in the decay series for uranium-238 (U-238), uranium-235 (U-235), and thorium-232 (Th-232), and potassium-40 (K-40). No man-made radionuclides above expected background levels from radioactive fallout are acceptable at CHDT.

5.2 Activity Limits

The total activity per gram of all radioactive materials (including all decay progeny) shall not exceed 2,000 pCi, and the radium-226 (Ra-226) activity per gram shall not exceed 222 pCi. Natural Potassium below background levels of 40 pCi/g will not be used in calculating the total activity. In addition, uranium and thorium may not be present at source material levels. The limits for the CHDT facility for specific radionuclides are summarized in Table 1.

Table 1. Summary of Accepted Activity Levels

Radionuclide	Limit (pCi/g)	Rationale
Natural Uranium (48.83% U-238, 48.83% U-234, 2.34% U-235)	340[ab]	License condition 6.B
Natural Uranium expressed as U-238 concentration	165[ab]	License condition 6.B
Natural Uranium expressed as a mass percentage	0.05%[ab]	License condition 6.B
Natural or Processed Thorium (Th-232 (50%) and Th-228 (50%))	110[ab]	License condition 6.B
Natural Thorium expressed as Th-232 concentration	55[ab]	License condition 6.B
Natural Thorium expressed as a mass percentage	0.05%[ab]	License condition 6.B
Ra-226	222[b]	License condition 6.A
Pb-210	666[b]	License condition 6.A

Notes:

a – Concentration limits are expressed as a sum of fractions for uranium and thorium as calculated in the following equation:

$$\frac{Conc_{Uranium}}{Limit_{Uranium}} + \frac{Conc_{Thorium}}{Limit_{Thorium}} \leq 1$$

The result of the calculation must be less than unity (1) for the waste to be acceptable at CHDT.

b – In secular equilibrium with shorter lived progeny.

If the waste does not exceed the limits presented above for individual radionuclides, the radionuclides listed above are summed for compliance to the 2000 pCi/g overall limit for acceptance at CHDT. A shipment of materials may have isolated areas of activity exceeding the limit, but the overall average of the shipment may not exceed the limits presented above. Concentration limits are based on an "as received" (wet weight) basis.

5.3 Lower Limits of Radioactive Material Subject to the License

Wastes that have measured activity at or below the levels providing for unrestricted disposal in the *Interim Policy and Guidance Pending Rulemaking for Control and Disposition of Technologically Enhanced Naturally Occurring Radioactive Materials in Colorado* shall not be subject to this License and shall be under the jurisdiction of the RCRA Permit, provided they are disposed of at CHDT.

5.4 Acceptable Physical Form

The acceptable physical form of the material includes but is not limited to soils, sludge's, process residues, resins, etc., that are compatible with the design criteria for the impoundment and approved materials processing requirements at CHDT.

6.0 PRE-ACCEPTANCE PROCEDURES

A waste generator must provide documentation of its chemical, physical, and radiological properties, its regulatory status, and a pre-acceptance sample.

6.1 Documentation

6.1.1 Waste Material Profile Sheet

The waste generator will supply a Waste Material Profile Sheet to CHDT. Other forms or documents may be used as long as the required information is provided.

6.1.2 Supplemental Radioactive Material Questionnaire

The generator will supply a Supplemental Radioactive Material Questionnaire to CHDT. Documentation of the radionuclides present and their specific activity shall be supplied. Certification there is no byproduct material, manmade radionuclides, or Special Nuclear Material present must be provided. The generator will describe the process whereby the waste was generated. The generator will supply the NRC or Agreement State license number if applicable. The generator will document the characterization method and sampling protocol for remediation wastes. A copy of this questionnaire is presented in Attachment A. Other forms or documentation may be used as long as the required information is provided.

6.1.3 Lab Analysis Data

The generator will supply analytical data from a suitable laboratory that supports the description of radionuclides present on the Supplemental Radioactive Material Questionnaire. Other information may be submitted in order to document the radiological information.

6.2 Pre-Acceptance Testing

CHDT will analyze pre-acceptance samples of each new waste stream. Analytical testing must be sufficient to determine the species and activity of radionuclides present. It must also be sufficient to demonstrate that the license waste acceptance limits on radium-226, mass thorium, mass uranium and total activity are met. Standard analysis will include: total uranium and total thorium (concentration mass/mass of sample) radium-226 activity (pCi/g), a gamma spectrum reported in pCi/g with radionuclide identification). Isotopic uranium and isotopic thorium activity (pCi/g) analysis may be used in place of total uranium and total thorium. Lead-210 analysis in pCi/g will be required in wastes where lead-210 is the only parent radionuclide such as waste from natural gas production. Other analysis may be used, with approval by CDPHE, if the analysis provides sufficient data to ensure waste acceptance criteria are met.

6.3 Pre-Acceptance Evaluation

Before a waste stream is approved to come to CHDT, it will be carefully evaluated to ensure that its physical and chemical characteristics meet the design criteria of the disposal unit and its radiological characteristics meet License limits. Generator documentation and pre-acceptance

lab analysis will be used to determine acceptability of the waste. Waste will be evaluated for the following elements:

6.3.1 Regulatory Information - Regulatory information will be reviewed in order to ensure that the facility has the proper permits and licenses to accept the waste.

6.3.2 Profiled Isotopes and Activities. The isotopes and activities listed on the profile will be reviewed to determine if the facility is permitted to accept them.

6.3.3 Sampling Information. Sampling information will be reviewed in order to ensure that sampling has been done properly.

6.3.4 Laboratory Analysis. Laboratory analysis will be reviewed to determine the accuracy of the profiled information and to confirm that the waste is acceptable at CHDT.

6.3.5 Capability of the Facility to Manage the Waste. CHDT will make sure that it has the resources and ability to properly manage the waste.

6.3.6 Waste Management Byproducts. CHDT will review treatment and/or landfill operations to ensure that the management of the waste produces no deleterious byproducts.

6.3.7 Treatment Method. If applicable, CHDT will determine the treatment method and treatment formula prior to accepting the waste.

6.3.8 Safety Requirements. The waste will be evaluated in order to determine proper safety precautions, monitoring, and protective equipment.

6.3.9 Laboratory Analysis Requirements. The waste will be evaluated to determine laboratory analysis requirements both upon arrival at the facility, after treatment, and upon recertification.

6.4 Documentation of Acceptance

Documentation of acceptance will be maintained on the Pretreatment and Disposal Recommendation (PDR) form. This is presented in Attachment B. Once a waste stream has been evaluated in the pre-acceptance process and found to meet the Waste Acceptance Criteria and this SOP, it will be approved for acceptance at the CHDT facility.

6.5 Annual Recertification

An acceptable waste stream is approved to come into the facility for a one-year period. After one year, the waste stream must be reevaluated. The waste generator must certify that the waste stream has not changed or must document any changes. The original radiological analysis will be repeated. At the RSO's discretion a waste sample from an ongoing shipment at CHDT may be analyzed to meet this requirement. The generators certification and the results of the radiological analysis will be evaluated. If the waste is consistent with the previous characterization, the waste will be re-approved for another year. If the waste has changed, the profile will be modified and the original waste pre-acceptance procedure will start over again.

6.6 Profile Deactivation

If at any time the waste stream is found not to meet the Waste Acceptance Criteria, the profile will be deactivated.

6.7 Alternate Means of Compliance

Alternate means of compliance with the Waste Acceptance Criteria may be sought on a case-by-case basis. Piping or equipment containing radium scale contamination, SOP 15.WAC.03, *Survey of Radium Scale Waste*, may be used by the generator to demonstrate compliance. Other examples include the performance of gamma fluence modeling or in situ gamma spectroscopy measurements in lieu of discrete sampling. Alternate means of compliance that are outside of the current CDPHE-approved CHDT radiation protection program will be subject to CDPHE Radiation Program approval.

7.0 ON-SITE ACCEPTANCE PROCEDURES

When approved waste arrives at the facility, the properties of the waste will be verified and the shipment documentation will be reviewed. If the waste shipment matches the properties determined in the pre-acceptance process and has the proper documentation, it will be accepted for treatment, storage and disposal at CHDT. If a discrepancy is found, the waste generator will be contacted to explain the discrepancy. If the discrepancy can be resolved and the waste meets the Waste Acceptance Criteria, the waste may be accepted for disposal. If the discrepancy cannot be resolved, or the shipment does not meet the Waste Acceptance Criteria, the shipment will be rejected back to the original generator, or at his request, to an alternate waste facility.

7.1 Exposure Rate Survey

All waste shipments will be screened for exposure rate at the outside of the package. Procedures for using exposure rate meters are found in SOP 15.OPS.07, *Exposure-Dose Rate Meters.* Expected ranges of exposure rate will be determined by the RSO. Exposure rates above normal ranges will be evaluated by the RSO to ensure the shipment is in compliance with license limits.

7.2 Weights

All waste shipments will be weighed on a certified scale.

7.3 Gamma Isotopic Survey

Each shipment will be surveyed for radionuclide identification using an approved portable gamma spectroscopy unit per SOP 15.OPS.03, *Operation of Portable Gamma Spectroscopy Unit*. If man-made radionuclides are detected above background, the waste shipment will be rejected to the waste generator. If the observed radionuclide activity or composition is different than stated on the profile, the RSO will attempt to resolve the discrepancy.

7.4 Samples

Waste shipments will be sampled if needed according to the requirements of Attachment C. Some waste streams such as large debris type wastes are not sampled. A visual description of the waste and measurements with hand-held instruments may be used in place of a sample.

7.5 Documentation Review

Documentation accompanying the shipment will be reviewed in order to make sure that it is proper and complete.

7.6 On-Site Tracking

On site tracking forms will be generated as necessary for each waste shipment. These forms are prepared based upon the instructions in the PDR form. These forms will provide instructions for workers and will document the disposition of each waste shipment.

ATTACHMENT A

Supplemental NORM Questionnaire

Clean Harbors Deer Trail Facility

General Information

Waste Name: _____

Profile Number: _____

Generator Name: _____

EPA ID: _____

Site Address: _____

Regulatory Information

Is the Waste Subject to an NRC, State or other Radioactive Materials License?	Yes ☐	No ☐
Does the Waste contain NORM (Naturally Occurring Radioactive Material)?	Yes ☐	No ☐
Does the Waste contain TENORM (Techologically Enhanced NORM)?	Yes ☐	No ☐
Does the Waste contain Source Material?	Yes ☐	No ☐
Does the Waste Contain Byproduct Material?	Yes ☐	No ☐
Does the Waste Contain Man Made or Artificial Radionuclides?	Yes ☐	No ☐
Does the Waste Contain Special Nuclear Material?	Yes ☐	No ☐

Please describe the process which produced the waste: _____

Radiological Information

What is the maximum dose rate at the surface of the waste (microR/hour)? _____

Please list the isotope, average specific activity, and maximum specific activity for each radionuclide present

Isotope	Ave (pCi/g)	Max (pCi/g)	Isotope	Ave (pCi/g)	Max (pCi/g)

Generators Certification

I Hereby certify that all information submitted in this and attached documents is correct to the best of my knowledge. I also certify that any samples submitted are representative of the actual waste.

Authorized Signature	Name (Print)	Title	Date

ATTACHMENT B

Pretreatment and Disposal Recommendation

Profile # **Generator**

Waste Name

Profile Review:

Documentation is complete?	Y	N
The site has the capabilities to manage the waste?	Y	N
Physical and chemical characteristics reviewed?	Y	N
Waste is compatible with HDPE landfill liner system?	Y	N
Waste management byproducts reviewed?	Y	N
Waste is not prohibited?	Y	N
LDR status and documentation complete?	Y	N

Required LDR documentation:

Waste Management Method:

CH Process Final Code Process Type

EPA Waste Codes

EPA Handling Codes:

Incompatability and special handling:

Physical Properties:

Physical State: Color

Density: pH

% Solids: %Aqueous Liquids: % Organic Liquids

Other:

Safety Precautions:

Required PPE:

Monitoring:

Fire Fighting:

Other Comments:

Laboratory and Treatment Instructions

Incoming Lab Analysis

Randon Sample Analysis

Post Treatment Analysis

Handling, Survey, and Decon Instructions

Inbound Survey

Inbound Sampling

Sample Area Survey

Disposal Isntructions

Exit Survey Requirements

Decon Requirements

Approvals:

Operations Date:

RSO Date:

Attachment C

Sampling Methods

1.0 INTRODUCTION. An important consideration in the development of a waste characterization program is the methodologies employed for waste sampling. It is imperative that the sample be as representative of the waste stream as possible, since the reliability of all subsequent analytical and evaluation efforts will be limited by this factor. Procedures and general guidelines for obtaining representative samples of wastes from drums, and bulk loads are discussed in the following sections. A Sample Log Book will be used as a tool by samplers to document the waste sampling. The Sample Log Book shall be maintained as part of the Operating Record. Prior to taking a sample, the Waste Profile Sheet and the PDR forms will be reviewed and safety procedures will be implemented.

2.0 DRUM SAMPLING. Drums or other approved waste containers are likely to contain materials that vary in form and consistency, such as liquids, sludges, or dry solids, all generated either separately and/or in mixtures. The sampling methodologies employed will generally depend upon the specific form and type of waste contained in a drum. Sampling must be representative of the material in the drums and account for any layering or stratification that may occur for any wastes having various liquid/liquid or liquid/solid phases. Containers will be sampled in such a manner as to obtain a vertical profile of the material, unless the physical properties prohibit penetration of the sampling devises.

2.1 LIQUID DRUM SAMPLING. Liquids should be sampled using a clean glass or plastic "thief'. A thief is a hollow glass or plastic tube approximately 3/8" internal diameter and greater than a drum in Length. After the sample is obtained, replace the bung on the drum and tighten. The use of a dedicated thief for each drum sampled eliminates the need for cleaning and the possibility of cross-contamination and/or incompatible mixing of wastes.

2.2 SLUDGE DRUM SAMPLING Sludges in drums range in consistency from slurries to near-solid materials. The sampling device employed will be dependent upon the consistency of the sludge material. Loose slurry material will be sampled using a thief. Material that will not enter the thief will need to be sampled by other means. If the sludge contains a large amount of coarse or compacted material, it will be sampled with a core sampler. Semi-solids in open-top drums containing a low concentration of moisture will be sampled as a solid. Samples of sludges in drums can also be collected using various types of core samplers, such as sampling triers or soil augers. A typical sampling trier is long tube with an open slot extending nearly the entire length. The tip and edges of the slot are sharp and allow the trier to cut a core of waste material to be sampled when inserted and rotated in the material. Sampling triers usually have a stainless steel tube and a wooden handle. They are usually 24 to 40 inches in length and 1/2 to 1 inch in diameter.

2.3 SOLID DRUM SAMPLING: Solids generally arrive in open-top drums. Waste solids can easily be sampled with a core sampler (i.e. sampling trier or soil auger) through the open top. Sampling trowels can be used in some cases when sampling dry, granular or powdered materials from drums. A sampling trowel (ordinarily zinc-plated) is small tool with a pointed, scoop-shaped blade having a plastic or wooden handle. The sharp-tipped blade measures approximately 3” X 5”.

3.0 BULK SOLID SAMPLING. Bulk solid wastes generally arrive in dump trucks or roll-off boxes. Dump trucks and roll-off boxes containing solids and sludges will be sampled with trowels, shovels or other sampling devices with extended handles. Specific locations will be sampled by

taking surface and subsurface grab samples. At least one grab sample location per 10 yd^3 of waste is required. The grab samples will be composited in order to provide a representative sample of the shipment.

4.0 LIQUID/SLUDGE TANKER SAMPLING. Each tanker will be sampled via the manhole entrance port on the top of the tankers or through a sampling valve located on the bottom-rear of the tanker. The tanker contents will be sampled using a pond sampler or dipper. If necessary, a weighted bottle or equivalent sampling device will be utilized.

5.0 DECONTAMINATION OF SAMPLING EQUIPMENT. When practical, disposable sampling equipment will be used and disposed of in the same container from which the sample was taken. All reusable equipment will be cleaned, visually inspected for residues and surveyed for radiation prior to the reuse of such equipment. Equipment that has not been decontaminated will be appropriately labeled and stored.

ATTACHMENT D

Analytical Test Methods and Evaluation of Waste Acceptance Criteria.

1.0 LAB ANALYSIS

Waste generators will provide laboratory analysis data along with their waste profile. A variety of test methods are available. Preferred methods used will be those listed in Table 1, Acceptable Test Methods. Equivalent test methods may be used as long as they provide the same data quality. Detection limits must be sufficient to determine waste acceptability. CHDT will evaluate the generator's lab analysis. If the data is incomplete or not sufficient to determine acceptance criteria, CHDT will send a sample of the waste to a qualified lab for additional analysis. Both analytical testing and/or process knowledge may be used to demonstrate that the waste meets the Waste Acceptance Criteria.

Table 1. Acceptable Test Methods

Analytical Tests	Method	Sample Size
Gamma Emitters - Activation and fission products - screen only	EPA 901.1M	500g
Gamma Emitters - Natural Products	EPA 901.1M	500g
Lead-210 by GFP	ASTM-D5811-95M	100g
Radium Tot. Alpha Emitting Isotopes	EPA 903.0M/ EPA 9315M	1L
Radium-226 by Alpha scintillation (Radon emanation)	EPA 903.1M	115g
Radium-226 by GFP (Total Radium Alpha)	EPA 9315	1L
Radium-226, 228 (Bi/Pb-214 ingrowth)	EPA 901.01M	500g
Radium-226, 228 by gamma spec (screening)	EPA 901.0M	500g
Radium-228	EPA 9320	1.5L
Thorium Isotopic Th 228, 230, 232 by alpha spec	ASTM D3972-90M	100g
Thorium Total (ICP)	EPA 6010	4oz
Thorium Total (ICPMS)	EPA 6020	4oz
Uranium Total	ASTM D3972-90M	100g
Uranium Total (ICP)	EPA 6010	4oz
Uranium Total (ICPMS)	EPA 6020	4oz
Uranium Total (Kinetic Phosphoresence Analysis)	ASTM D5174-91M	100g
Uranium isotopic-U-234, 235, 238, by alpha spec	ASTM D3972-90M	100g

2.0 PROCESS KNOWLEDGE

Waste generators must provide detailed process information for each waste stream as part of the pre-acceptance process. They must certify that there are no man-made radionuclides present, and certify the regulatory status of the waste. They may provide calculations or manufacturer's data to support the waste characterization. CHDT will evaluate this information in conjunction with lab analysis data to make sure the waste meets the acceptance criteria. Process knowledge may be substituted for lab test data, where appropriate, with approval from CDPHE.

3.0 EVALUATION OF WASTE ACCEPTANCE CRITERIA.

CHDT must have data on each waste stream that document that the license limits on acceptance of radium-226, mass thorium, mass uranium and total activity are met. CHDT must also be able

to ensure the absence of manmade radionuclides. CHDT must have sufficient knowledge about a waste to protect workers and the public.

3.1 Identification of Radionuclides and Their Activity

CHDT must have suitable documentation that identifies the radionuclides present and their activity. Uranium and Thorium activities can be determined by isotopic analysis using alpha spectroscopy. Once the isotopic data is known, the activities of the Uranium and Thorium progeny can be determined by inference. In the absence of isotopic data, mass concentration Uranium and mass concentration Thorium can be used to determine identity and activity. Uranium Isotopes in the Uranium, Thorium and Actinium decay series will be presumed to be present in their natural equilibrium concentrations in this case. Gamma spectrum analysis will identify and quantify shorter-lived progeny in the decay series and will also quantify Radium isotopes in the waste. Gamma spectrum analysis can also provide insurance against the presence of manmade radionuclides. Table 2, NORM Radionuclide Determination shows the various methods used for identification of naturally occurring radionuclides and determination of their activities.

Table 2 NORM Radionuclide Determination

Uranium Series

Nuclide	T1/2	Emmisions	Analysis	Other Analysis	Comments
U-238	Very Long	Alpha	Alpha spec uranium isotopic	Total Uranium	
Th-234	24.1d	Low energy beta and gamma	Infered by U-238 activity	Total Thorium	Usually in equilibrium
Pa-234m	1.17m	High energy beta and gamma	Gamma spec	Infered by U-238 activity or Total Uranium	Part of gamma spectrum Analysis
Pa-234(0.13%)	6.75hr	Very small percentage			
U-234	long	Alpha	Alpha spec uranium isotopic	Total Uranium	
Th-230	long	Alpha	Alpha spec thorium isotopic	Total Thorium	
Ra-226	1602y	Alpha and low energy gamma	Alpha scintillation	Gamma spec	Use gamma screening unless high (>200pCi/g) is likely
Rn-222	3.823d	Alpha	Infered by Ra-226 activity		
Po-218	3.05m	Alpha	Infered by Ra-226 activity		
Pb-214	26.8m	Beta, Gamma	Gamma spec	Inferred by Ra-226 activity	Part of gamma screen
Bi-214	19.7m	High energy beta and gamma	Gamma spec	Inferred by Ra-226 activity	Part of gamma screen
Po-214	164us	Alpha	Infered by Bi-214 activity	Inferred by Ra-226 activity	
Pb-210	21y	Low energy beta	GFP counting	Inferred by Ra-226 activity	Analyze for Pb-210 if radon has been lost or if Pb-210 waste
Bi-210	5.01d	High energy beta	Infered by Pb-210 activity		
Po-210	138.4d	Alpha	Infered by Pb-210 activity		

Thorium Series

Nuclide	T1/2	Emmisions	Analysis	Other Analysis	Comments
Th-232	very long	Alpha	Alpha spec	Total Thorium	
Ra-228	6.7y	Low energy beta	Infered by Th-232, Ac-228, and Th-228 activity	Ra-228 by GFP	
Ac-228	6.13hr	High energy beta and gamma	Gamma spec	Inferred from Ra-228 activity	Part of gamma screen
Th-228	1.91y	Alpha	Alpha spec	Total Thorium	
Ra-224	3.64d	Alpha	Infered by Th-228 activity		
Rn-220	55s	Alpha	Infered by Th-228 activity		
Po-216	0.15s	Alpha	Infered by Th-228 unless there is loss of radon		
Pb-212	10.64hr	Beta, Gamma	Gamma spec		Part of gamma screen
Bi-212	60.6m	Alpha, beta, gamma	Gamma spec		Part of gamma screen
Po-212 (64%)	304ns	Alpha	Infered by Th-228 unless there is loss of radon		
Tl-208 (36%)	3.1m	High energy beta, gamma	Gamma spec		Part of gamma screen

Actinium Series

Nuclide	T1/2	Emmisions	Analysis	Other Analysis	Comments
U-235	long	Alpha, gamma	`	0.7% ot total Uranium	Part of gamma screen
Th-231	25.5hr	Beta, low energy gamma	inferred by U-235	< or = to activity of U-235	
Pa-231	long	Alpha, low energy gamma	inferred by U-235	< or = to activity of U-235	
Ac-227	21.6y	Alpha, low energy gamma	inferred by U-235	< or = to activity of U-235	
Th-227 (98%)	18.2d	Alpha, gamma	inferred by U-235	< or = to activity of U-235	
Ra-223	11.43d	Alpha, gamma	inferred by U-235	< or = to activity of U-235	
Rn-219	4.0s	Alpha, gamma	inferred by U-235	< or = to activity of U-235	
Po-215	1.78ms	Alpha	inferred by U-235	< or = to activity of U-235	
Pb-211	36.1m	Beta, Gamma	inferred by U-235	< or = to activity of U-235	
Bi-211	2.15m	Alpha, gamma	inferred by U-235	< or = to activity of U-235	
Tl-207	4.79m	Beta, Gamma	inferred by U-235	< or = to activity of U-235	

Potassium

Nuclide	T1/2	Emmisions	Analysis	Other Analysis	Comments
K-40	Very Long	Beta, Gamma	Gamma Spec	Calculated by % natural abundence from total K	

3.2 Determination of Total Activity

Acceptable waste must have total activity of less than 2000 pCi/g. Lab Analysis data will be used to determine total activity. Total activity will be calculated by the summation of the activity of the nuclides measured and the activity of nuclides not directly measured but known to be in equilibrium with measured nuclides. Process knowledge may be used as well.

3.3 Radium-226 Activity

Acceptable waste must have less than 222 pCi/g Radium-226. Radium-226 can be measured by a variety of methods, including gamma spectrum analysis, alpha scintillation, etc.

3.4 Mass Uranium and Thorium

Mass Uranium and Thorium combined must be less than 0.05%. Determination of this may be made from mass-based uranium and thorium analytical data. It may also be calculated from isotopic uranium and thorium data by using the specific activity of the isotopes. Process knowledge may also be applied.