

**KHNP Training Program
Module 3: Waste Characterization and Classification
Final Course Outline
SAND 2007-**

Day 1, Waste Types and Examples

1. U.S. Department of Energy (DOE)
 - 1.1 Low-Level Waste (LLW)
 - 1.2 Mixed Low-Level Waste (MLLW)
 - 1.2.1 Listed
 - 1.2.2 Characteristic
 - 1.3 Greater-Than-Class C Low-Level Waste (GTCC)
 - 1.4 Transuranic Waste (TRU)
 - 1.5 High-Level Waste (HLW)
 - 1.6 Spent Nuclear Fuel (SNF)
2. U.S. Commercial Radioactive Waste
 - 2.1 Class A
 - 2.2 Class B
 - 2.3 Class C
 - 2.4 MLLW
 - 2.5 GTCC
 - 2.6 HLW
 - 2.7 SNF
3. Other Countries (IAEA)
 - 3.1 Low and Intermediate-Level Waste (LILW)
 - 3.1.1 Short-Lived
 - 3.1.2 Long-Lived
 - 3.2 HLW
 - 3.3 SNF

Day 2, Regulatory Framework

1. Waste Classification Review
2. DOE Order 435.1 (LLW, TRU, HLW)
3. Resource Conservation and Recovery Act (MLLW)
 - 3.1 Listed Mixed Waste
 - 3.2 Characteristic Mixed Waste
 - 3.3 Concentration Averaging

4. Code of Federal Regulations (CFR) Title 10, Part 61 (Class A, B, C, GTCC)
5. Disposal Waste Acceptance Criteria
 - 5.1 Nevada Test Site
 - 5.2 Envirocare of Utah
 - 5.3 WIPP

Day 3, Waste Characterization

1. Go over homework; review of Day 2 material
2. Process Knowledge
3. Physical Characterization (Real-time radiography)
4. Radiological Characterization (Alpha, beta, gamma spectroscopy)
5. Chemical Characterization
 - 5.1 Sample Preparation; QA/QC
 - 5.2 Listed Mixed Waste
 - 5.3 Characteristic Mixed Waste
 - 5.3.1 Corrosivity
 - 5.3.2 Reactivity
 - 5.3.3 Ignitability
 - 5.3.4 Toxicity

6. Data Quality Objectives

Day 4, Waste Characterization Examples

1. Radioisotope Thermoelectric Generators
2. Waste Oil
3. Waste Septage
4. Review of topics covered, Days 1-4
5. Go over homework – Teams A and B Presentations
6. Evaluation of course module

KHNP Training Program
Module 3: Waste Characterization and Classification
Course Homework Assignments
SAND 2007-

Homework Assignment for Monday, June 11

1. If you have not already done so, read the following references for waste classification:

A. Andrews, "Radioactive Waste Streams: Waste Classification for Disposal," CRS Report for Congress, Congressional Research Service, December 13, 2006.
<http://www.ncseonline.org/NLE/CRS/abstract.cfm?NLEid=470>

"Classification of Radioactive Waste, A Safety Guide," Safety Series No. 111-G-1.1, International Atomic Energy Association, 1994.
www.pub.iaea.org/MTCD/publications/PDF/Pub950e_web.pdf

M.D. Lowenthal, "Radioactive Waste Classification in the United States: History and Current Predicaments," Lawrence Livermore National Laboratory, July 1997.
www.osti.gov/bridge/servlets/purl/16339-ZtRZDZ/native/16339.pdf

2. Create a table that illustrates the similarities and differences between waste classification in the United States and waste classification in South Korea. Do the two classification systems meet the requirements for a good classification system listed on the summary slide from Monday's lecture? Why or why not? How do differences in waste classification affect the way waste is managed in the two countries?
3. Should South Korea have a waste category equivalent to mixed waste? Why or why not?
4. What are the consequences for the United States of not having a standard for exempt low-level radioactive waste?

Homework Items 2, 3 and 4 will be discussed at the beginning of Tuesday's lecture.

Radioactive Waste Characterization and Classification

Homework Assignment for Tuesday, June 12

1. A waste generator has one 55-gallon container of soil contaminated with Pu-238, Ra-226, U-234, U-235, U-238, Cs-137 and Sr-90. The radionuclide concentrations in the container are shown in the following table:

Radionuclide	Container Concentration (pCi/g)	Container Concentration (Ci/m ³)*	Table I Class A Concentration Limit (pCi/g)	Table II Class A Concentration Limit (Ci/m ³)
Pu-238	3,000	4.8 E-03	10,000	-
Ra-226	6,000	9.6 E-03	10,000	-
U-238	5,000	8.0 E-03	-	-
U-235	1,100	1.8 E-03	-	-
U-234	5,000	8.0 E-03	-	-
Sr-90	5,000	8.0 E-03	-	0.04
Cs-137	8,000	1.3 E-02	-	1

* The soil density (1.6 g/cm³) is used to convert from pCi/g to Ci/m³.

Can this waste be disposed of at Energy Solutions? Problem will be discussed on Wednesday.

2. If you are interested, good background articles on Love Canal and Times Beach are:

E.C. Beck, "The Love Canal Tragedy," EPA Journal, January 1979,
<http://www.epa.gov/history/topics/lovecanal/01.htm>.

M. Leistner, "The Times Beach Story," <http://www.greens.org/s-r/078/07-09.html>.

USEPA Superfund Redevelopment Program, "Times Beach One-Page Summary,"
<http://www.epa.gov/superfund/programs/recycle/success/1-pagers/timesbch.htm>.

3. Read Reference 8 in the course bibliography for Day 2.
4. Success! South Korea is building two radioactive waste disposal facilities, a near-surface facility and a geologic repository! Divide your group into two teams. Team A will develop an outline of Waste Acceptance Criteria for the near-surface disposal facility, and Team B will develop an outline of Waste Acceptance Criteria for the geologic repository. Feel free to incorporate data from the Nevada Test Site, Energy Solutions, and WIPP waste acceptance criteria or other sources, as appropriate. Another helpful reference is IAEA-TECDOC-1537, "Strategy and Methodology for Radioactive Waste Characterization,"
http://wwwpub.iaea.org/MTCD/publications/PDF/te_1537_web.pdf. Due Thursday.

5. In conjunction with the Waste Acceptance Criteria outlines, develop a draft Waste Profile Form for your disposal site. This is also due Thursday.

Radioactive Waste Characterization and Classification

Homework Assignment for Wednesday, June 13

1. Continue working on Waste Acceptance Criteria outlines and Waste Profile forms.
2. If you have not already looked at this document while working on #1 above, review IAEA-TECDOC-1537, "Strategy and Methodology for Radioactive Waste Characterization," http://www-pub.iaea.org/MTCD/publications/PDF/te_1537_web.pdf.

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Final Bibliography
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Day 1

1. Andrews, "Radioactive Waste Streams: Waste Classification for Disposal," CRS Report for Congress, Congressional Research Service, December 13, 2006.
<http://www.ncseonline.org/NLE/CRS/abstract.cfm?NLEid=470>
2. "Classification of Radioactive Waste, A Safety Guide," Safety Series No. 111-G-1.1, International Atomic Energy Association, 1994.
www.pub.iaea.org/MTCD/publications/PDF/Pub950e_web.pdf
3. M.D. Lowenthal, "Radioactive Waste Classification in the United States: History and Current Predicaments," Lawrence Livermore National Laboratory, July 1997.
www.osti.gov/bridge/servlets/purl/16339-ZtRZDZ/native/16339.pdf

Day 2

1. "Radioactive Waste Management," DOE Order 435.1, Change 1, United States Department of Energy, August 28, 2001.
www.directives.doe.gov/pdfs/doe/doetext/neword/435/o4351c1.pdf
2. "Radioactive Waste Management Manual," DOE M435.1-1, Change 1, United States Department of Energy, August 28, 2001.
www.directives.doe.gov/pdfs/doe/doetext/neword/435/m4351-1c1.pdf
3. "Waste classification," United States Code of Federal Regulations, Part 61, Subpart D, Section 61.55. <http://www.nrc.gov/reading-rm/doc-collections/cfr/part061/part061-0055.html>
4. "Waste characteristics," United States Code of Federal Regulations, Part 61, Subpart D, Section 61.56. <http://www.nrc.gov/reading-rm/doc-collections/cfr/part061/part061-0056.html>
5. E.C. Beck, "The Love Canal Tragedy," EPA Journal, January 1979,
<http://www.epa.gov/history/topics/lovecanal/01.htm>.
6. M. Leistner, "The Times Beach Story," <http://www.greens.org/s-r/078/07-09.html>.
7. USEPA Superfund Redevelopment Program, "Times Beach One-Page Summary,"
<http://www.epa.gov/superfund/programs/recycle/success/1-pagers/timesbch.htm>.

8. A.W. Fentiman, T. L. Leyerle, and R. J. Velely, "Legislation Governing Disposal of Low-Level Radioactive Waste," http://www.ag.ohio-state.edu/~rer/rerhtml/rer_60.html.
9. Energy Solutions Waste Acceptance Criteria:
http://www.energysolutions.com/Disposal/clive_waste_acceptance.php
10. Nevada Test Site Waste Acceptance Criteria:
www.nv.doe.gov/library/publications/emrwap/DOENV_325_Rev6-02.pdf
11. WIPP Waste Acceptance Criteria:
www.wipp.energy.gov/library/wac/CH-WAC.pdf

Day 3

The Radwaste.org web site for waste characterization, <http://www.radwaste.org/char.htm>, provides links to articles on waste characterization in general, characterization programs, characterization techniques and facilities, characterization of specific wastes, waste clearance, and waste acceptance criteria. Specific document links from this site that will be discussed/used in this course are:

Challenges of Non-Destructive Assay Waste Measurement
 Management of Data Quality of High-Level Waste Characterization
 Non-Destructive Waste Assay Using Gamma Ray Active and Passive Computed Tomography
 Characterization of Remote-Handled Transuranic Waste for WIPP
 An Evaluation of Remote-Handled Transuranic Waste Inventories, Characterization Radioassay Methods and Capabilities
 SW-846, Test Methods for Evaluating Solid Waste
 Application of the Concepts of Exclusion, Exemption and Clearance Safety Guide
 Clearance Levels for Radionuclides in Solid Materials
 NUREG 1640
 Strategy and Methodology for Radioactive Waste Characterization (IAEA)

Real-time Radiography:

<http://www.ndt-ed.org/TeachingResources/Downloadable/Real-Time%20Radiography/Real-time%20Radiography%20Booklet.htm>

Day 4

1. S.D. Carson, "WERF Waste Profile Executive Summary for MLLW Tritiated Oils," Sandia National Laboratories.
2. S.D. Carson, "Sampling and Analysis Plan for Characterization of Liquid Tritiated Oils," PLA 99-08, Sandia National Laboratories, May 1999.

3. S.D. Carson, "Waste Classification Change and RCRA Code Removal Justification," Sandia National Laboratories.
4. S.D. Carson, "WERF Waste Profile Executive Summary for Mixed Low-Level Waste Septage," Sandia National Laboratories.