SAND2007-3515P

Radioactive Waste Classification

KHNP Training Program

Module 3: Waste Classification and Characterization

June 11, 2007

Susan D. Carson, Ph.D.
Principal Member of the Technical Staff
Sandia National Laboratories

SAND 2007-

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company,
for the United States Department of Energy's National Nuclear Security Administration
under contract DE-AC04-94AL85000.

Outline

I. Need for Radioactive Waste Classification

II. Radioactive Waste Classification in the U.S.

III. The International Atomic Energy (IAEA) Radioactive Waste Classification System

IV. Radioactive Waste Classification in South Korea

What Is Radioactive Waste and Why Do We Need to Classify It?

The Department of Energy (DOE) defines radioactive waste as: "Solid, liquid, or gaseous material that contains radionuclides regulated under the Atomic Energy Act of 1954, as amended, and of negligible economic value considering costs of recovery."

Why do we need to classify radioactive waste?

- **Provide effective, consistent waste management.**
- **Simplify waste management actions, rules and regulations while protecting human health.**
- **Waste class dictates treatment, handling, storage and disposal requirements.**

Radioactive Waste Classification in the U.S.

Until the 1970's, the U.S. had only two types of waste:

1. **High level waste, defined as "aqueous waste from the first cycle solvent extraction in spent nuclear fuel reprocessing".**
2. **Everything else.**

Radioactive Waste Classification in the U.S., continued

- **In the 1970's, three regulatory agencies were created:**
  - **The Atomic Energy Commission was split into the Nuclear Regulatory Commission (NRC) and the Energy Resource and Development Administration (ERDA), which eventually became the Department of Energy (DOE). The NRC is responsible for the licensing and regulation of nuclear power plants, while the DOE is responsible for nuclear research and development, including nuclear weapons.**
  - **The Environmental Protection Agency (EPA) was created to regulate hazardous waste disposal and environmental cleanup.**

Sandia National Laboratories

Radioactive Waste Classification in the U.S., continued

- The DOE has its own waste classification system and is responsible for the radioactive waste generated at all DOE sites.
- The NRC regulates all other radioactive waste produced in the U.S. The NRC waste classification system is similar to, but distinct from, the DOE waste classification system.
- The EPA regulates hazardous components that may be present in radioactive waste.

- THERE IS NO “DE MINIMUS” LEVEL BELOW WHICH RADIOACTIVE WASTE MAY BE DISPOSED OF IN AN ORDINARY LANDFILL IN THE U.S.

Radioactive Waste Classification in the U.S., the DOE Classification System

Waste Class	Definition
High-Level Waste (HLW)	(1) Highly radioactive liquid and solid material resulting from the reprocessing of spent nuclear fuel. (2) Other highly radioactive material that the NRC determines, consistent with existing law, requires permanent isolation; e.g., spent nuclear fuel.
Spent Nuclear Fuel	Fuel withdrawn from a nuclear reactor following irradiation that has not been reprocessed. Regulated as HLW.
Transuranic Waste (TRU)	Waste contaminated with alpha-emitting transuranium radionuclides with half-lives greater than 20 years and concentrations greater than 100 nCi/g (3700 Bq/g). [Examples: neptunium (Np), plutonium (Pu), americium (Am), and curium (Cm).]
Uranium Mining and Mill Tailings	The wastes (byproduct materials) produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content.

Radioactive Waste Classification in the U.S., the DOE Classification System, continued

Waste Class	Definition
Low-Level Waste (LLW) *	Radioactive waste that is not HLW, TRU, spent nuclear fuel, or byproduct material.
Naturally Occurring and Accelerator-produced Radioactive Materials (NORM/NARM)	Regulated as LLW.

*** LLW is divided into two broad categories:**

1. **Waste that qualifies for near-surface disposal: external exposure to a member of the public is ≤ 25 mrem/yr (≤0.25 mSv/yr).**
2. **Waste that requires deeper disposal: dose to an inadvertent intruder after loss of institutional control (100 years) is ≤ to a one-time dose of 500 mrem (5 mSv) or an annual dose of 100 mrem (1 mSv) for the first 1000 years after disposal.**

Radioactive Waste Classification in the U.S., the DOE Classification System, continued

- **Waste in any of the DOE classes can be either remote-handled (RH) or contact-handled (CH):**

- **RH Waste – Materials or packages with a surface exposure rate >200 mR/hr (>1.75 mGy/hr) must be handled remotely.**

- **CH Waste – Materials or packages with a surface exposure rate <200 mR/hr (<1.75 mGy/hr) may be handled without shielding for workers.**

Radioactive Waste Classification in the U.S., the NRC Classification System

Waste Class	Definition
High-Level Waste /Spent Nuclear Fuel	Same as DOE.
Low-Level Waste	NRC divides LLW into four classes, three that qualify for near-surface burial, and one that does not: Class A: Waste has low levels of radiation and heat, no shielding required to protect workers or the public, should decay to acceptable levels within 100 years. Class B: Has higher concentrations of radioactivity than Class A and requires greater isolation and packaging (and shielding for operations) than Class A waste. Class C: Requires isolation from the biosphere for 500 years. Must be buried at least 5 meters below the surface and must have an engineered barrier (container and grouting).

Radioactive Waste Classification in the U.S., the NRC Classification System, continued

Waste Class	Definition
Low-Level Waste	<u>Greater Than Class C (GTCC):</u> LLW that does not qualify for near-surface burial. This includes commercial transuranics that have half-lives greater than 5 years and activity >100 nCi/g (3700 Bq/g).

- The NRC does not regulate NORM/NARM. Responsibility for this waste type is left to State and Federal agencies.

- NRC-regulated waste is subject to the RH and CH waste definitions.

Radioactive Waste Classification in the U.S., Summary of NRC LLW Classes

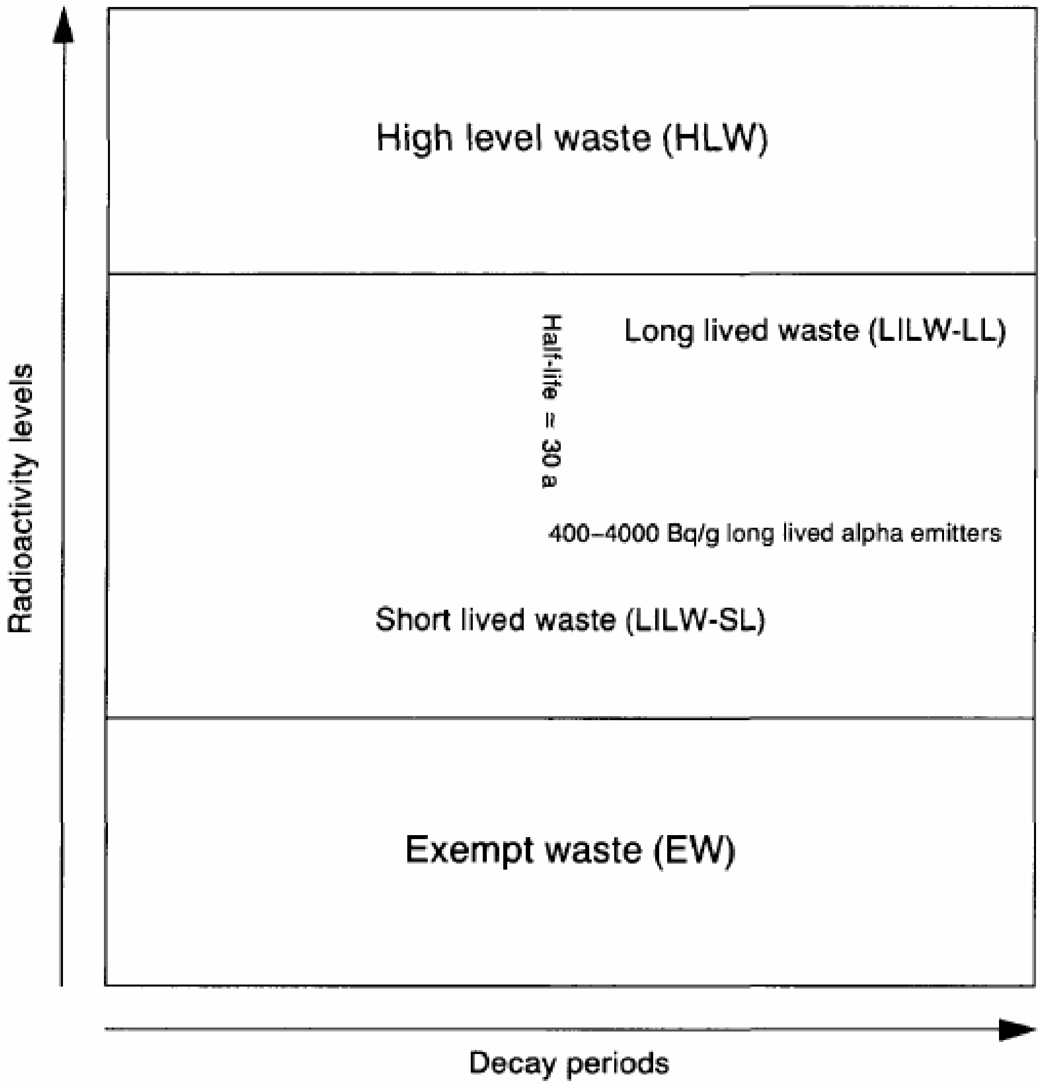
	Class A	Class B	Class C	Greater Than Class C
Form	Trash, soil, rubble, depleted uranium, mildly contaminated equipment and clothing.	Reactor components, sealed radioactive sources, filters and resins from nuclear power plants.	Same as Class B but higher in radioactivity.	Reactor components and filter resins from reactor decommis-sioning.
Specific activity	Near background to 700 Ci (26 TBq) per cubic meter.	0.04 to 700 Ci (1.5 GBq to 26 Tbq) per cubic meter.	44 to 7,000 Ci (1.6 to 260 TBq) per cubic meter.	Greater than Class C
Maximum waste concentra-tion basis	100-year decay to acceptable hazard level to intruder.	100-year decay to acceptable hazard level to intruder.	Exceeds 100-year acceptable hazard level; 500-year protection provided by deeper disposal or intruder barriers.	Unspecified by regulation.

Radioactive Waste Classification in the U.S., Mixed Waste

- **The EPA:**
  - **Has authority to set standards for routine emissions of radioactive materials into air and water.**
  - **Regulates cleanup of contaminated sites.**
  - **Has authority over the hazardous constituents in mixed waste.**

- **Mixed waste is waste that contains both radioactive and hazardous constituents, as defined in the Resource Conservation and Recovery Act (RCRA).**

The IAEA Radioactive Waste Classification System



The IAEA Radioactive Waste Classification System, Exempt Waste

- **Exempt Waste (EW) contains so little radioactivity that it may be safely disposed of without considering its radioactive properties.**
- **Waste that provides an annual dose to members of the public of $\leq$ 0.01 mSv ($\leq$1 mrem).**
- **Recommended activity concentrations are radionuclide-dependent, and range from about 0.1 Bq/g (0.27 nCi/g) to about 10E4 Bq/g (2.7 mCi/g).**

The IAEA Radioactive Waste Classification System, Low and Intermediate Level Waste

- Low and intermediate level waste (LILW) has activity levels above EW levels and thermal power below about 2 kW/cubic meter. LILW is divided into short-lived (LILW-SL) and long-lived (LILW-LL waste.

- LILW-SL: Contains low concentrations of long-lived radionuclides. Long-lived alpha emitters must be $\leq$4000 Bq/g (11 μCi/g) in individual waste packages, with an overall average of 400 Bq/g (1.1μCi/g) per waste package.

- LILW-LL: Long-lived radionuclide concentrations exceed LILW-SL limits. Waste requires geologic disposal.

The IAEA Radioactive Waste Classification System, High-Level Waste

- High-level waste (HLW) contains thermal power above 2 kW/cubic meter and long-lived radionuclides whose concentrations exceed LILW-SL limits.

- Typical activity levels are 5E4 to 5E5 Tbq (1.4 to 14 MCi) per cubic meter, corresponding to a heat generation rate of 2 to 20 kW/cubic meter for decay periods up to about ten years after discharge of spent fuel from a reactor.

- HLW requires geologic disposal.

Radioactive Waste Classification in South Korea

South Korea follows the IAEA classification system:

- **HLW is waste containing alpha-emitting radionuclides having a half life >20 years and:**

  - Activity $\geq$ 4000 Bq/g (11 μCi/g)
  - Heat generation $\geq$ 2 kW/cubic meter

- **LILW is identical with the IAEA definitions for LILW-SL and LILW-LL.**

- **EW is defined as waste such that annual dose to an individual is <10 μSv/year (1 mrem/year) and the total collective dose is < 1 person-Sv/year (<100 person-rem/year).**

Radioactive Waste Classification Summary

Waste Type	DOE	NRC	IAEA	S. Korea
HLW	X	X	X	X
TRU	X			
GTCC	X	X		
LILW-LL			X	X
LILW-SL			X	X
LLW	X			
LLW(A,B,C)		X		
EW			X	X

Radioactive Waste Classification Summary, continued

An ideal radioactive waste classification system should:

- **Cover all radioactive waste types.**
- **Relate waste classes to the associated potential hazard.**
- **Be flexible, simple and easy to understand.**
- **Be universally applicable.**

Radioactive Waste Classification Regulatory Framework

KHNP Training Program

Module 3: Waste Classification and Characterization

June 12, 2007

Susan D. Carson, Ph.D.
Principal Member of the Technical Staff
Sandia National Laboratories

SAND 2007-

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company,
for the United States Department of Energy's National Nuclear Security Administration
under contract DE-AC04-94AL85000.

Outline

I. Background

II. DOE Order 435.1 (LLW, TRU, HLW)

III. Resource Conservation and Recovery Act (RCRA; MLLW)

IV. Code of Federal Regulations (CFR) Title 10, Part 61 (Class A, B, C, GTCC)

V. Disposal Waste Acceptance Criteria (Nevada Test Site, Energy Solutions, WIPP)

Regulatory Framework Background

1946	The McMahon Atomic Energy Act creates the Atomic Energy Commission (AEC).
1954	Atomic Energy Amendments Act (AEA) defines and restricts access to nuclear materials, makes possible a civilian nuclear power program, and is the law by which Congress endows agencies with the authority to manage and regulate nuclear materials.
1971	AEC restricts disposal of TRU waste.

Regulatory Framework Background, continued

1978 Uranium Mill Tailings Radiation Control Act provides for disposal, long-term stabilization, and control of mill tailings and remedial action at abandoned mill tailings sites.

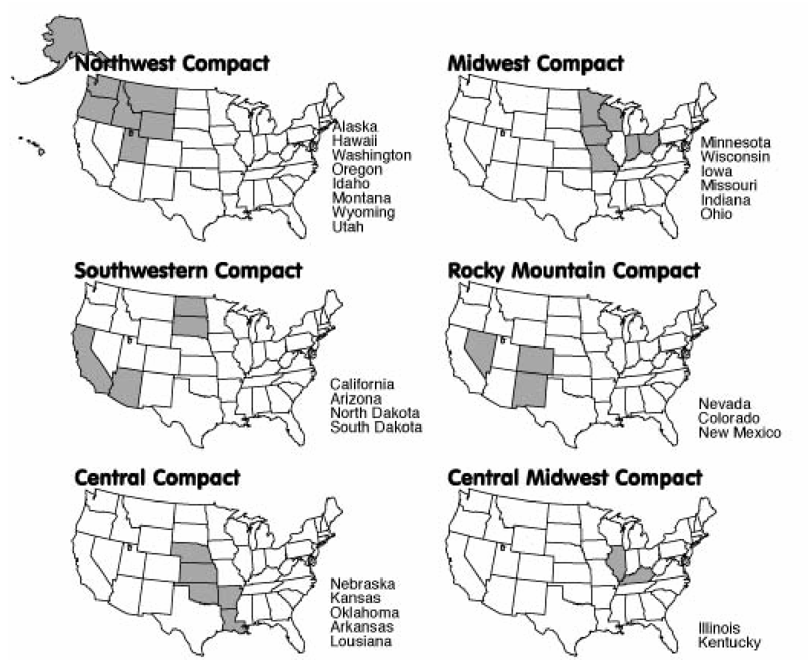
The Atlas Site in Moab, Utah

Tailings Cover, Gas Hills, Wyoming

Sandia National Laboratories

Regulatory Framework Background, continued

1980 **Low-level Radioactive Waste Policy Act defines LLW and encourages states to form compacts, or regional associations, for LLW disposal.**



1985 **Act amended to extend the deadline for compact formation, and makes DOE responsible for disposal of GTCC waste.**

Regulatory Framework Background, continued

1982 **The Nuclear Waste Policy Act :**
- **Establishes a framework for siting, characterizing, constructing and operating two geologic repositories for HLW disposal.**
- **Provides for siting and constructing a monitored retrievable storage facility for HLW.**
- **Establishes the Office of Civilian Radioactive Waste Management in DOE.**

1987 **Amendment to the Act directs DOE to characterize only the Yucca Mountain site, and defers a decision regarding a second repository until 2007.**

Yucca Mountain

Tour group entering North Portal of Yucca Mountain

Sandia National Laboratories

Regulatory Framework Background, continued

1992 **Federal Facility Compliance Act amends the Resource Conservation and Recovery Act to establish that Federal facilities are subject to state environmental laws. As a result, all Federal agencies managing a solid waste facility or hazardous waste disposal site are subject to all applicable Federal, state, and local laws, regulations, and ordinances addressing solid and hazardous waste.**

Regulatory Framework Background, continued

- Congress makes laws that define the responsibilities of Federal agencies regarding radioactive waste management. The responsible agencies (DOE, NRC, EPA) then develop their own rules and regulations to carry out these responsibilities:

  DOE – DOE Order 435.1 and its associated Manual.
  NRC – Code of Federal Regulations (CFR) Title 10, Part 61
  EPA – Resource Conservation and Recovery Act

Sandia National Laboratories

DOE Order 435.1

- DOE Order 435.1 and its associated manual provide detailed "how to" instructions for HLW, TRU and LLW management. Topics covered include:

  Definitions
  Regulatory Requirements
  Responsibilities
  Quality Assurance
  Waste: Characterization, Certification, Treatment, Transfer, Storage, Packaging, Transportation, Monitoring and Disposal

Resource Conservation and Recovery Act (RCRA)

- **As a result of RCRA and the Federal Facility Compliance Act of 1992, a new waste category, mixed waste, was defined as waste that is both radioactive and hazardous according to RCRA.**
- **Wastes that are mixed can be either characteristic or listed mixed wastes, or both.**

Sandia National Laboratories

Characteristic Mixed Waste

- **A characteristic mixed waste has one or more of the following characteristics:**

  - Ignitability (Flash point <60 deg C, ignites at standard temperature and pressure, oxidizer)

  - Corrosivity (Acid or base)

  - Reactivity (Potentially explosive, water-reactive, cyanides, sulfides)

  - Toxicity (Based on the Toxicity Characteristic Leaching Procedure)

TABLE 1—MAXIMUM CONCENTRATION OF CONTAMINANTS FOR THE TOXICITY CHARACTERISTIC

EPA HW No. [1]	Contaminant	CAS No. [2]	Regulatory Level (mg/L)
D004	Arsenic	7440–38–2	5.0
D005	Barium	7440–39–3	100.0
D018	Benzene	71–43–2	0.5
D006	Cadmium	7440–43–9	1.0
D019	Carbon tetrachloride	56–23–5	0.5
D020	Chlordane	57–74–9	0.03
D021	Chlorobenzene	108–90–7	100.0
D022	Chloroform	67–66–3	6.0
D007	Chromium	7440–47–3	5.0
D023	o-Cresol	95–48–7	[4]200.0
D024	m-Cresol	108–39–4	[4]200.0
D025	p-Cresol	106–44–5	[4]200.0
D026	Cresol		[4]200.0
D016	2,4-D	94–75–7	10.0
D027	1,4-Dichlorobenzene	106–46–7	7.5
D028	1,2-Dichloroethane	107–06–2	0.5
D029	1,1-Dichloroethylene	75–35–4	0.7
D030	2,4-Dinitrotoluene	121–14–2	[3]0.13
D012	Endrin	72–20–8	0.02
D031	Heptachlor (and its epoxide).	76–44–8	0.008
D032	Hexachlorobenzene	118–74–1	[3]0.13
D033	Hexachlorobutadiene	87–68–3	0.5
D034	Hexachloroethane	67–72–1	3.0
D008	Lead	7439–92–1	5.0
D013	Lindane	58–89–9	0.4
D009	Mercury	7439–97–6	0.2
D014	Methoxychlor	72–43–5	10.0
D035	Methyl ethyl ketone	78–93–3	200.0
D036	Nitrobenzene	98–95–3	2.0
D037	Pentrachlorophenol	87–86–5	100.0
D038	Pyridine	110–86–1	[3]5.0
D010	Selenium	7782–49–2	1.0
D011	Silver	7440–22–4	5.0
D039	Tetrachloroethylene	127–18–4	0.7
D015	Toxaphene	8001–35–2	0.5
D040	Trichloroethylene	79–01–6	0.5
D041	2,4,5-Trichlorophenol	95–95–4	400.0
D042	2,4,6-Trichlorophenol	88–06–2	2.0
D017	2,4,5-TP (Silvex)	93–72–1	1.0
D043	Vinyl chloride	75–01–4	0.2

Listed Mixed Waste

- **Wastes that contain listed RCRA chemicals, primarily organics, must be treated to Universal Treatment Standards prior to disposal.**

UNIVERSAL TREATMENT STANDARDS
[Note: NA means not applicable]

Regulated constituent common name	CAS[1] number	Wastewater standard	Nonwastewater standard
		Concentration in mg/l[2]	Concentration in mg/kg[3] unless noted as "mg/l TCLP"
Organic Constituents			
Acenaphthylene	208–96–8	0.059	3.4
Acenaphthene	83–32–9	0.059	3.4
Acetone	67–64–1	0.28	160
Acetonitrile	75–05–8	5.6	38
Acetophenone	96–86–2	0.010	9.7
2-Acetylaminofluorene	53–96–3	0.059	140
Acrolein	107–02–8	0.29	NA
Acrylamide	79–06–1	19	23
Acrylonitrile	107–13–1	0.24	84
Aldicarb sulfone[6]	1646–88–4	0.056	0.28
Aldrin	309–00–2	0.021	0.066
4-Aminobiphenyl	92–67–1	0.13	NA
Aniline	62–53–3	0.81	14
Anthracene	120–12–7	0.059	3.4
Aramite	140–57–8	0.36	NA
alpha-BHC	319–84–6	0.00014	0.066
beta-BHC	319–85–7	0.00014	0.066
delta-BHC	319–86–8	0.023	0.066

10 CFR Part 61

- **The NRC is responsible for the licensing and regulation of radioactive waste disposal facilities that accept commercial radioactive waste. 10 CFR Part 61, Licensing Requirements for Land Disposal of Radioactive Waste, covers the following topics:**

  - License Application Requirements
  - Disposal Site Performance Objectives
  - Technical Requirements, including:

    - Facility Design and Monitoring
    - Waste Classification
    - Waste Characteristics (Acceptance Criteria)
    - Labeling

10 CFR 61.55, Waste Classification

- To determine if a waste is Class A, B, or C, long-lived radionuclides:

Table 1

Radionuclide	Concentration curies per cubic meter
C-14	8
C-14 in activated metal	80
Ni-59 in activated metal	220
Nb-94 in activated metal	0.2
Tc-99	3
I-129	0.08
Alpha emitting transuranic nuclides with half-life greater than 5 years	[1]100
Pu-241	[1]3,500
Cm-242	[1]20,000

[1]Units are nanocuries per gram.

- If concentration is <0.1 times the value in Table 1, waste is Class A.
- If 0.1(Table 1 value)<concentration≤Table 1 value, waste is Class C.

10 CFR 61.55, Waste Classification, continued

- If waste contains none of the radionuclides listed in Table 1, waste class is determined using Table 2:

Table 2

Radionuclide	Concentration, curies per cubic meter		
	Col. 1	Col. 2	Col. 3
Total of all nuclides with less than 5 year half-life	700	(1)	(1)
H-3	40	(1)	(1)
Co-60	700	(1)	(1)
Ni-63	3.5	70	700
Ni-63 in activated metal	35	700	7000
Sr-90	0.04	150	7000
Cs-137	1	44	4600

1 There are no limits established for these radionuclides in Class B or C wastes. Practical considerations such as the effects of external radiation and internal heat generation on transportation, handling, and disposal will limit the concentrations for these wastes. These wastes shall be Class B unless the concentrations of other nuclides in Table 2 determine the waste is Class C independent of these nuclides.

- If concentration is <value in Column 1, waste is Class A.
- If Column 1 value<concentration<value in Column 2, waste is Class B.
- If Column 2 value<concentration<value in Column 3, waste is Class C.

10 CFR 61.55, Waste Classification, continued

- If the waste contains none of the radionuclides in Tables 1 and 2, waste is Class A.
- If the waste contains a mix of radionuclides from both Tables 1 and 2, classification is determined as follows:

  - If the concentration of a Table 1 radionuclide <0.1 times the value listed in Table 1, class is determined by the concentration of Table 2 radionuclides.
  - If 0.1(Table 1 value)<concentration≤Table 1 value, waste is Class C if concentration of Table 2 radionuclides <Column 3 values.

10 CFR 61.55, Sum of Fractions Rule

- If a waste contains a mixture of Table 1 or Table 2 radionuclides, the sum of fractions rule is used. To determine the sum of fractions, divide each nuclide's concentration by the appropriate limit and add the resulting values. The appropriate limits must all be taken from the same column of the same table. The sum of fractions for the column must be <1.0 if the waste class is to be determined by that column.

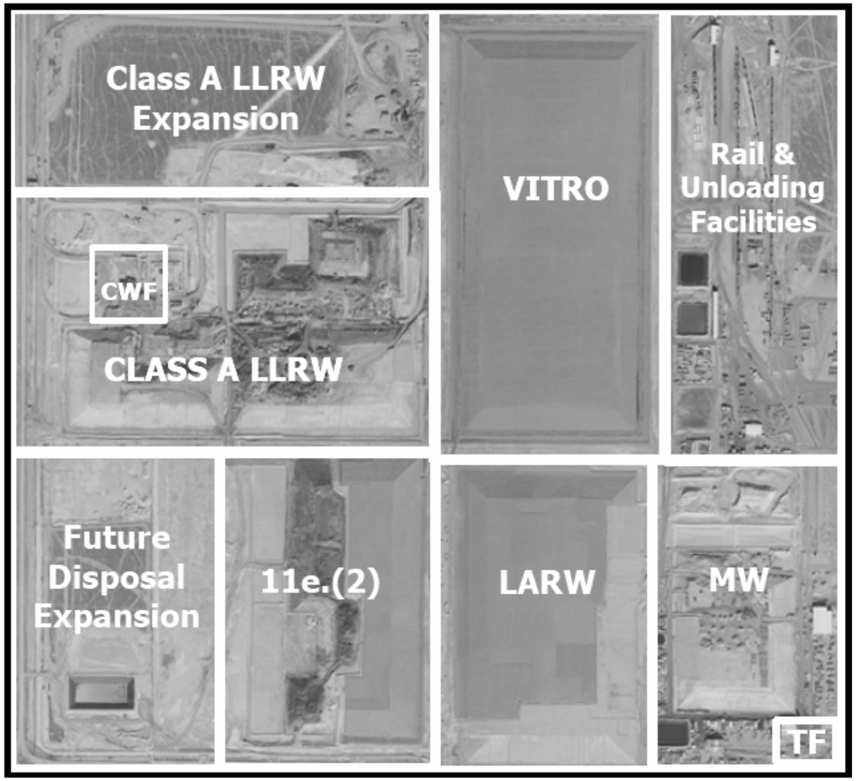
Example: Waste contains 50 Ci/cubic meter Sr-90 and 22 Ci/cubic meter Cs-137. Since both concentrations >Column 1 values in Table 2, they must be compared to Column 2 values. For Sr-90, 50/150 = 0.33; for Cs-137, 22/44 = 0.5; 0.33 + 0.5 = 0.83. Since this is <1.0, waste is Class B.

Disposal Site Waste Acceptance Criteria

- **Disposal site waste acceptance criteria are based on the requirements of 10 CFR 61.56. The following slides summarize the waste acceptance criteria for the DOE Nevada Test Site, Energy Solutions in Clive, Utah, WIPP and Yucca Mountain.**

Energy Solutions Waste Acceptance Criteria

Energy Solutions accepts Class A radioactive and mixed wastes, SNM, NORM/NARM and byproduct material.



Nevada Test Site Waste Acceptance Criteria

- **The Nevada Test Site accepts DOE-titled LLW and MLLW for disposal.**

Bristlecone Pine, Rainier Mesa, and Stockade Wash, Nevada Test Site

Nevada Test Site Waste Disposal

Gate 1 – Mercury, Nevada

Area 3 Radioactive Waste Management Complex, Nevada Test Site

Nevada Test Site Waste Disposal, continued

Waste placement in the Area 5 Radioactive Waste Management Complex, Nevada Test Site

Area 5 Radioactive Waste Management Complex, Nevada Test Site

Waste Profiles

You will receive Waste Profile forms for the Nevada Test Site and Energy Solutions as examples of the requirements that drive waste characterization in the United States.

WIPP Waste Acceptance Criteria

WIPP accepts defense-related transuranic waste.

Yucca Mountain Waste Acceptance Criteria

- **Formal waste acceptance criteria for the Yucca Mountain geologic repository are under development.**

Radioactive Waste Characterization

KHNP Training Program
Module 3: Waste Classification and Characterization

June 13, 2007

Susan D. Carson, Ph.D.
Principal Member of the Technical Staff
Sandia National Laboratories

SAND 2007-

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company,
for the United States Department of Energy's National Nuclear Security Administration
under contract DE-AC04-94AL85000.

Outline

I. Introduction

II. Process Knowledge

III. Physical Characterization

IV. Radiological Characterization

V. Chemical Characterization

VI. Data Quality Control

VII. Waste Profiles (Nevada Test Site, Energy Solutions)

Waste Characterization Introduction

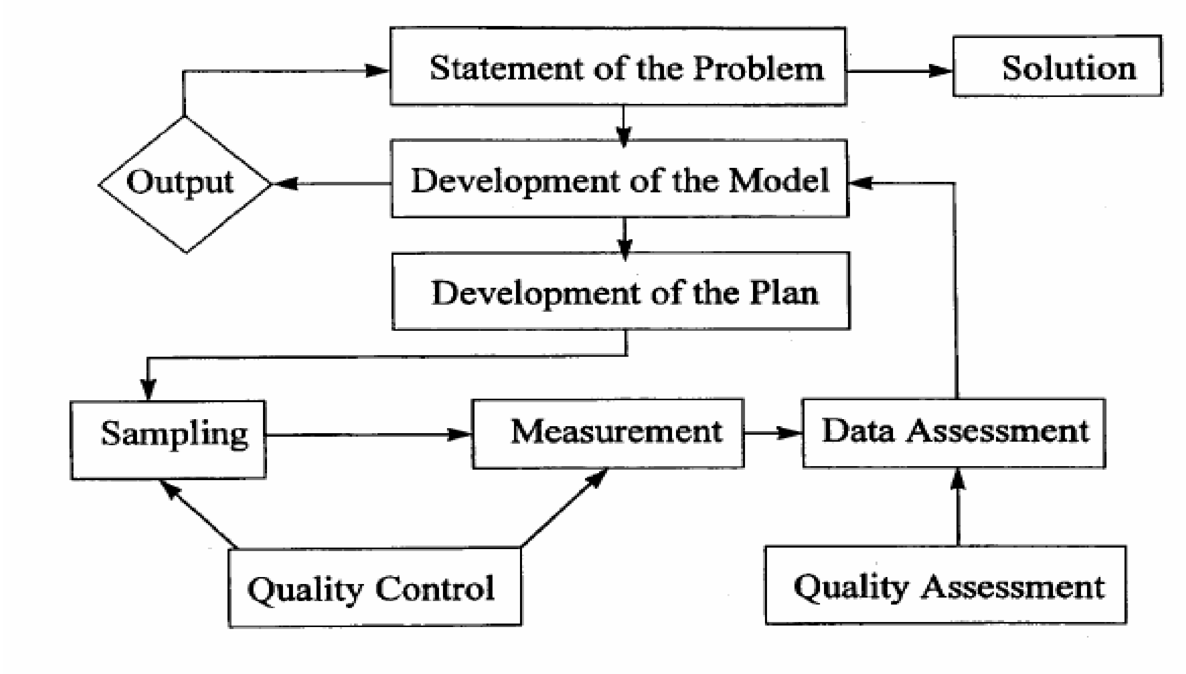
- Waste characterization requires a thorough,accurate assessment of the physical, chemical and radiological characteristics of the waste.

- Waste characterization must demonstrate that the waste meets the performance objectives of the disposal site waste acceptance criteria.

- Waste characterization must be accomplished in a systematic manner using proven methodologies, technologies and techniques with an overriding emphasis on quality assurance and quality control.

Waste Characterization Introduction, continued

- **All waste characterization should be conducted according to a performance-based plan that:**
  - **Protects workers, the public and the environment.**
  - **Provides sufficient information about the waste to ensure correct, safe disposal.**



Waste Characterization Introduction, continued

Types of Waste Requiring Characterization

Traceable Waste Stream:	Simple & Stable	Complex & Stable	Simple & Variable	Complex & Variable
Nuclear Power Plant	✓	✓		
Institutional	✓			
Nuclear Research Lab			✓	
Reprocessing		✓		
Enrichment, Conversion, Fuel Fabrication	✓			
Decommissioning	*	*	*	*
Spent Sealed Source	✓			
Spent Fuel	✓			
Final Waste Form		✓		
Non-Traceable Waste Stream:				
Historical	**	**	**	**

* facility dependent.
** may or may not include this subtype.

Waste Characterization Through Process Knowledge

- The simplest way to characterize radioactive waste is through process knowledge, that is, if you know the process that generated the waste, you can document the types and concentrations of radionuclides and, if applicable, any hazardous materials that may be present.

- Process knowledge may include:

  - Description of the process that generates the waste

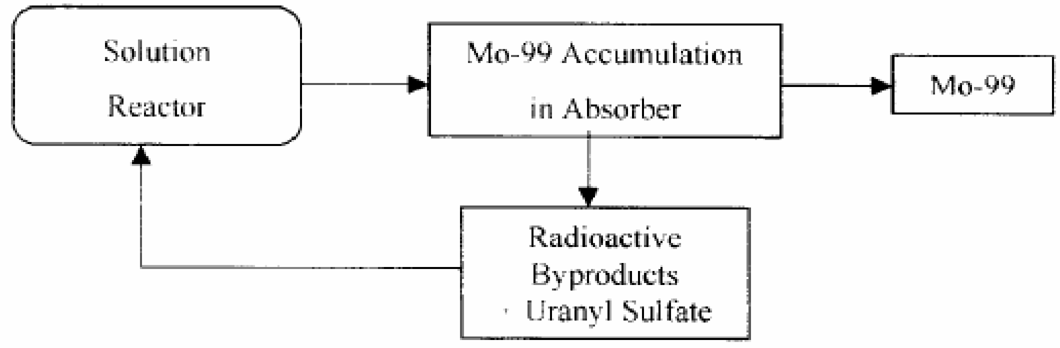
  - Quality assurance data on the waste generation process

  - Historical sampling and analytical data.

Sandia National Laboratories

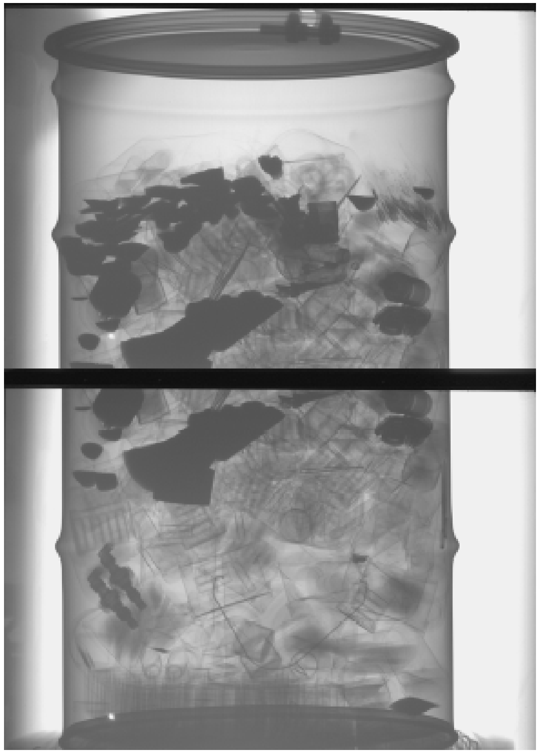
Process Knowledge, continued

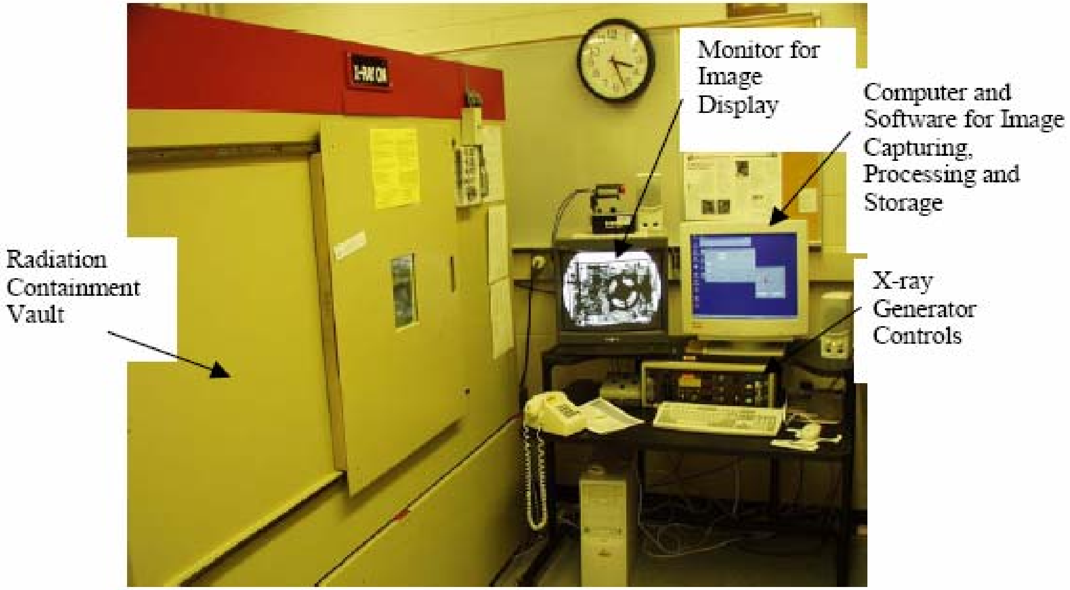
- Example: The process for Mo-99 production for Tc-99 medical isotope generators is well documented. Wastes produced during production would require minimal physical characterization, probably only alpha/beta and gamma spectroscopy to verify expected radionuclide concentrations.



Physical Characterization, Real-Time Radiography

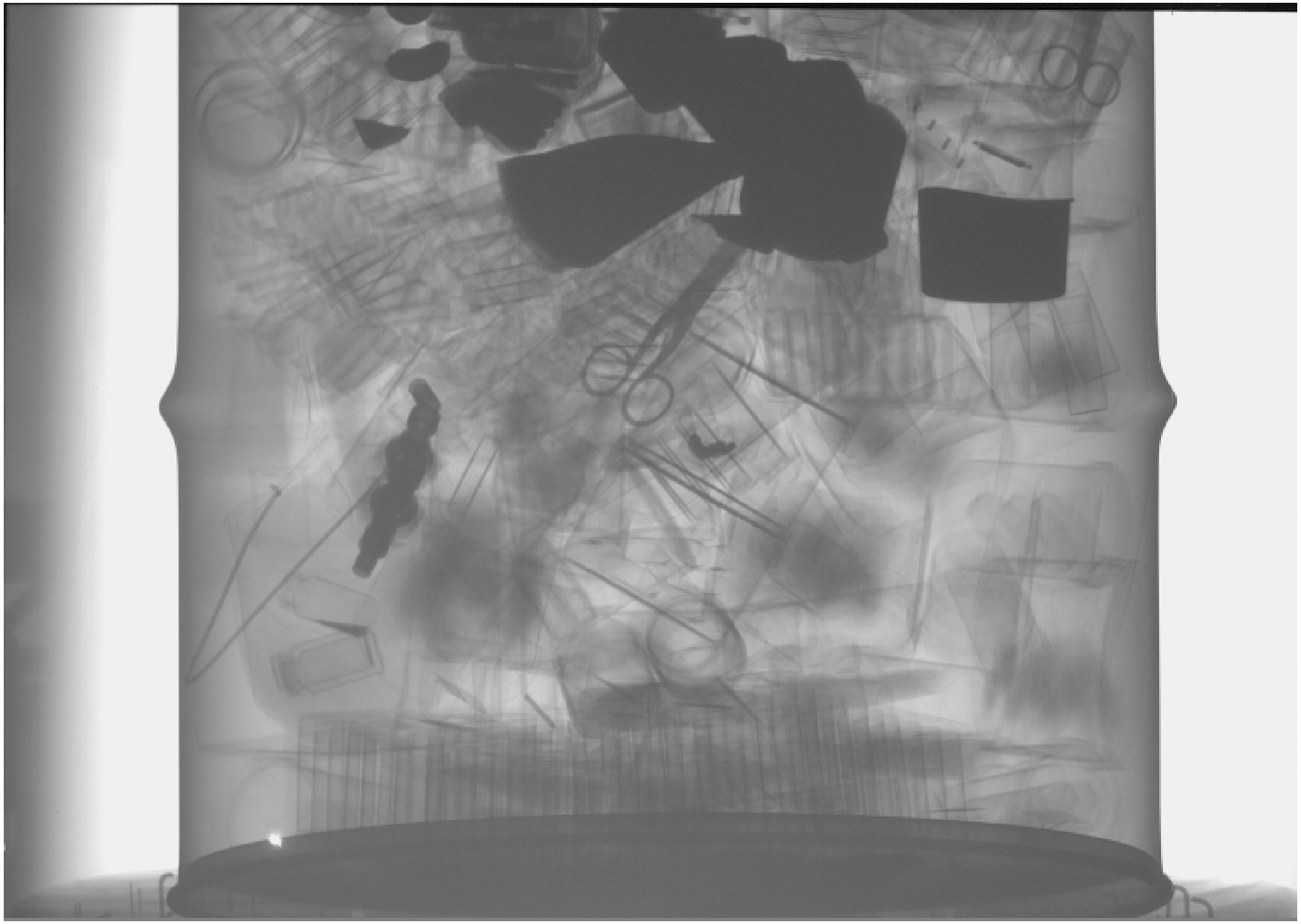
Real-time radiography enables you to determine what is inside an unknown waste package without opening it. For example, you may need to know if the package contains free liquid, so it can be stabilized for disposal.



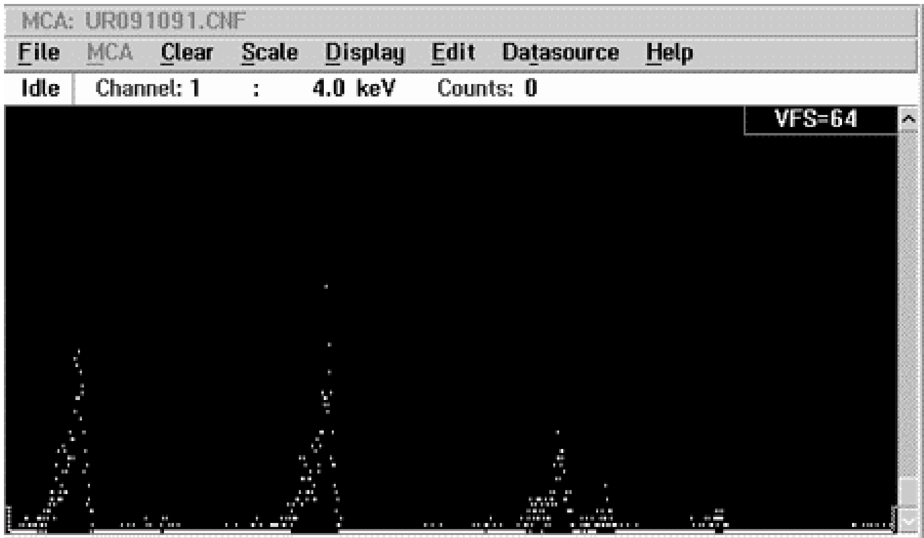


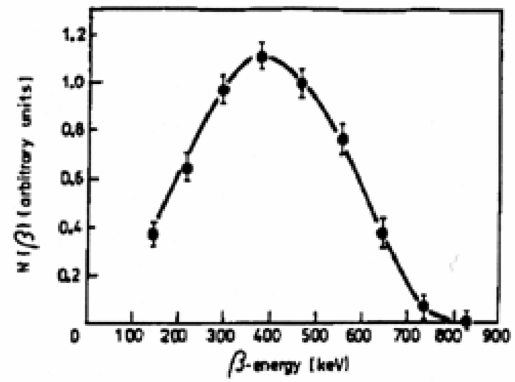
Sandia National Laboratories

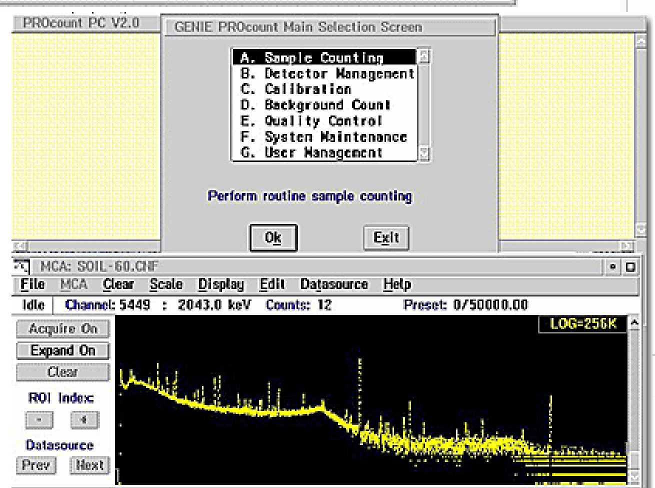
Real-Time Radiography, continued

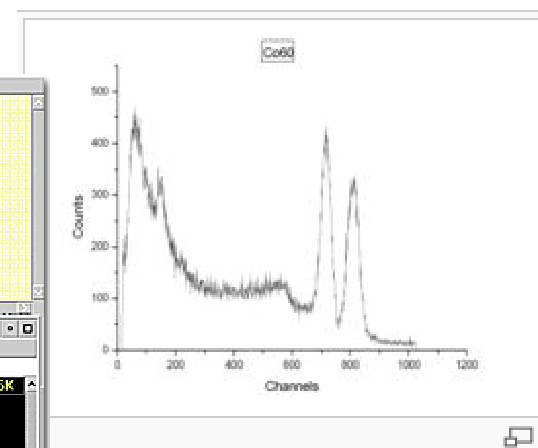


Radiological Characterization
Alpha, Beta, Gamma Spectroscopy









Sandia National Laboratories

Alpha, Beta, Gamma Spectroscopy, continued

- **Spectroscopic data is used to:**

  - Identify radionuclides and their concentration
  - Classify waste
  - Set safety standards for waste handling
  - Determine waste disposal requirements

Chemical Characterization of Mixed Waste

- Since mixed waste is a reality in the United States, a determination must be made for all radioactive waste as to whether or not it is mixed. This is accomplished through process knowledge and/or sampling and analysis.
- If a waste is only a characteristic mixed waste (corrosive, reactive, ignitable or toxic as per RCRA), once it is treated to remove the characteristic, it can be disposed of as LLW.
- If the waste contains a listed material, it must be treated and disposed of as mixed waste.
- Sampling and analyses must be carried out according to strict protocols, and formal sample chain of custody records must be maintained at all times.

Waste Characterization Data Quality Control, Sampling and Analysis Issues

Factor	Issue(s)
Sample Knowledge	Mixture of processes; uncertain process history
Sample Homogeneity	Heterogeneous; variable physical, chemical and radiological properties
Sampling	Sampling access may be limited; no mixing capability
Analytical Sample Preparation	May require lengthy digestion
Measurement	Extensive quality control, data assessment and reporting
Data Use	Supporting decisions for safe storage and disposal

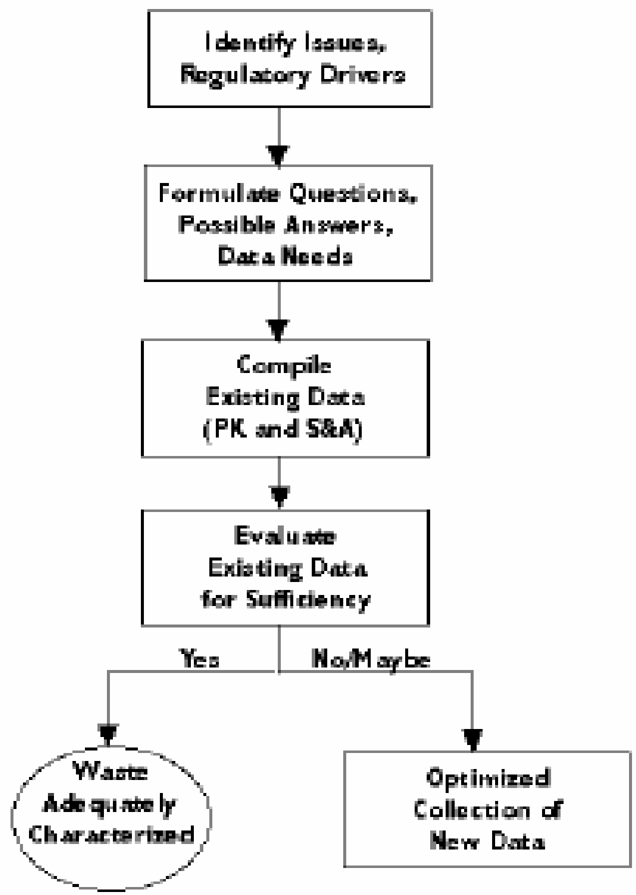
Data Quality Objectives and Quality Assurance Objectives

- Data quality objectives define what information is needed to characterize waste. They are qualitative and quantitative statements that clarify the program's objectives, define the types of data required, and specify acceptable decision error rates that will be used as the basis for establishing the quality and quantity of data needed to support decisions.

- Quality assurance objectives establish minimum requirements for data measurement and representation and are designed to provide information that will satisfy the data quality objectives. They include data: Accuracy
  Precision
  Representativeness
  Completeness
  Comparability

Data Quality Objectives, continued

APPLYING DQO PROCESS PLANNING
TO WASTE CHARACTERIZATION



Sample Data Quality Objective Table

Data Quality Objective	Characterization Method	Implementation Methods
1. Account for TRU activity.	1. PK 2. Direct Assay 3. Characterization at the time of packaging	1. PK must include TRU information. 2. Waste stream value established by sampling & analysis. 3. TRU activity measured for each container.
2. Ensure that waste is of defense origin.	PK	Use PK to determine if waste was generated in a defense-related activity.
3. Limit canister activity to <23 Ci/L.	1. PK 2. Direct Assay 3. Characterization at the time of packaging	1. Use PK to show that this limit not possible for this waste stream. 2. Obtain total activity for a few representative containers to establish waste stream activity. 3. Measure total activity of each container.

Summary

Accurate waste characterization is the key to successful management of radioactive waste streams. Strict quality assurance and quality control during waste sampling and analysis is necessary to ensure that the waste is properly disposed.