Docket NO: OAR-2002-0005-0001

Criteria for the Certification and Recertification of the Waste Isolation Pilot Plant's Compliance with the Disposal Regulations; Alternative Provisions

Background Information Document for Amendments to 40 CFR 194.8 (b)

U.S. Environmental Protection Agency
Office of Radiation and Indoor Air
Washington, DC 20460
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TABLE OF CONTENTS

ACRONYM LIST

A&PCT	Active and Passive Computed Tomography
AK	Acceptable Knowledge
Am	Americium
APNEA	Active and Passive Neutron Examination and Assay
ASME	American Society of Mechanical Engineers
BID	Background Information Document
BIR	Baseline Inventory Report
CA	Compliance Assessment
CAO	U.S. Department of Energy Carlsbad Area Office (now the Carlsbad Field Office)
CAR	Corrective Action Report
CBFO	U.S. Department of Energy Carlsbad Field Office
CCA	Compliance Certification Application
CCD	Charge Collection Device
CCP	Centralized Characterization Project
Cf	Californium
CH-TRU	Contact-Handled Transuranic Waste
Cm	Curium
CPR	cellulosics, plastics, rubber
Cs	Cesium
CT	Computed Tomography
DOE	U.S. Department of Energy
DR	Digital Radiography
DTP	Detailed Technical Procedure
EEG	Environmental Evaluation Group
eV	Electron Volt
FRAM	Fixed Energy Response Function Analysis with Multiple Efficiencies
FY	Fiscal Year
GEA	Gamma Energy Assay
^{2}H	Deuterium
^{3}H	Tritium
HANDSS-55	Handling and Segregating System
He	Helium
HENC	High Efficiency Neutron Counter
HPGe	High Purity Germanium
IDC	Item Description Code
INEEL	Idaho National Engineering and Environmental Laboratory
IPAN	Imaging Passive Active Neutron Counter
KV	Kilovolt
kVp	kilovolts peak
LANL	Los Alamos National Laboratory
LDA	Linear Diode Array
LLNL	Lawrence Livermore National Laboratory
MCS	Mobile Characterization Services
msec	Millisecond

NCR	Nonconformance Reports
NDA	Nondestructive Assay
NDE	Nondestructive Evaluation
NMC	Neutron Multiplicity Counters
NMED	New Mexico Environment Department
Np	Neptunium
NQA	Nuclear Quality Assurance
NRC	U.S. Nuclear Regulatory Commission
NTS	Nevada Test Site
OJT	On-The-Job Training
ORIA	EPA Office of Radiation and Indoor Air
PA	Performance Assessment
PADC	Passive Active Drum Counter
PAN	Passive-Active Neutron
PCB	polychlorinated biphenyls
PDP	Performance Demonstration Program
Pu	Plutonium
QA	Quality Assurance
QAPjP	Quality Assurance Project Plan
QAPP	Quality Assurance Program Plan
QC	Quality Control
RCRA	Resource Conservation and Recovery Act of 1976
RFETS	Rocky Flats Environmental Technology Site
RH-TRU	Remote-Handled Transuranic Waste
RTG	Radioisotopic Thermal Generators
RTR	Real-Time Radiography
SGS	Segmented Gamma Scanner
SGSAS	Segmented Gamma Scanner Assay System
SOP	Standard Operating Procedures
Sr	Strontium
SRIC	Southwest Research and Information Center
SRS	Savannah River Site
SWEPP SGRS	Stored Waste Examination Pilot Plant Gamma Ray Spectrometer
SWEPP PAN	Stored Waste Examination Pilot Plant Passive Active Neutron Counter
TGS	Tomographic Gamma Scanners
TGS CAN	Tomographic Gamma Can Scanners
TMFA	Transuranic and Mixed Waste Focus Area
TRU	Transuranic
TRUCON	Transuranic Package Transporter-II Content Codes
TSDF	Treatment, Storage, Disposal, Recycling Facilities
TWBIR	Transuranic Waste Baseline Inventory Report
U	Uranium
UCL_{90}	Upper 90 Percent Confidence Limit
V	Volt
VE	Visual Examination
VEE	VE Expert

WAC	Waste Acceptance Criteria
WAGS	Waste Assay Gamma Spectrometer
WAP	Waste Analysis Plan
WIPP	Waste Isolation Pilot Plant
WMC	Waste Matrix Code
WMP	Waste Material Parameters
WWIS	WIPP Waste Information System

I. INTRODUCTION

The purpose of this Background Information Document (BID) is to explain the Agency's Waste Isolation Pilot Plant (WIPP) transuranic (TRU) waste generator inspection process in support of alternative provisions for 40 CFR Part 194.8, "Approval Process for Waste Shipment from Waste Generator Sites for Disposal at the WIPP." Specifically, the Agency is proposing to revise section 194.8(b). This document presents:

I. The current regulatory provisions and the basis for inspections, a summary of wastes that require inspection, and an overview of the current inspection approach.

II. A summary discussion of the major technical elements examined during waste characterization inspections at generator sites, including acceptable knowledge (AK), nondestructive assay (NDA), radiography (such as real-time radiography, or RTR), visual examination (VE), and data validation/data transfer (via the WIPP Waste Information System, or WWIS). These discussions present what inspectors examined and how the results impact EPA's assessment of the waste characterization process. Technical descriptions of measurement and examination devices are included, as well as discussion of the impact of different waste matrices on the effectiveness of the measuring or examination device, and the range of waste types that the Agency may be able to approve in the course of an inspection.

III. A summary of results and general conclusions reached by Agency inspectors from May 1998 through the present. This section identifies the number, scope, and results of technical inspections at the generator/storage sites.

IV. Examples of public comments on inspection notices and docketed materials.

V. Conclusions.

I.A Current Provisions and Summary of Pertinent Elements

As specified in §194.24(b)(2) of the Compliance Criteria, the U.S. Department of Energy (DOE) was required to conduct an analysis to identify waste components important to performance assessment (PA). Section 194.24(c) deals with the identification of waste limits associated with these critical components, as well as how the limits are included in performance assessments (§194.32) and compliance assessments (§194.54). In addition, DOE must specify how waste components will be identified, quantified, tracked, and controlled. Important components are summarized in Section I.B of this BID.

Waste characterization, as defined in §194.24(c), is necessary to ensure that waste emplaced in the repository is consistent with the parameters established in the performance assessment (§194.32) and compliance assessment (§194.54), and that limitations (or constraints) on radionuclides and other waste components established by EPA's certification decisions are not exceeded. Waste characterization is also used to ensure that the actual waste inventory is consistent with the waste inventory estimates presented in DOE's Baseline Inventory Report (BIR), which was used in performance and compliance assessment (PA and CA) calculations. Waste characterization activities performed by DOE to demonstrate compliance with §194.24(c) include a "system of controls," involving characterization techniques as well as waste tracking and WIPP inventory identification and management.

In the WIPP certification rulemaking, EPA evaluated waste characterization information provided by DOE in its Compliance Certification Application (CCA) and amended the Compliance Criteria by adding section 194.8. Section 194.8 specifies the waste characterization approval process for DOE waste generator sites. Condition 3 of the certification provides that DOE may not ship waste to the WIPP from any waste stream - other than wastes from specified waste streams - until EPA has approved processes for characterizing such waste streams in accordance with the section 194.8 approval process. Section 194.8(b) requires that, "[f]or each waste stream or group of waste streams at a site proposed for disposal at WIPP," DOE must provide information on how process knowledge will be used for waste characterization of the waste stream(s), and must implement a system of controls at the site, in accordance with §194.24(c)(4). Section 194.8(b) also states that EPA will conduct an ". . . an inspection of a Department audit for the purpose of evaluating the use of process knowledge and the implementation of a system of controls for each waste stream or group of waste streams at a waste generator site." Moreover, DOE must demonstrate that each site has procedures in place to communicate with DOE's WIPP Waste Information System (WWIS). The WWIS is an electronic database that contains information related to the characterization, certification, shipment, and emplacement of TRU waste at the WIPP.

In accordance with section 194.8, EPA must announce scheduled inspections in the *Federal Register*, place relevant DOE documents in the docket, and solicit public comment on those documents for at least 30 days. EPA also must provide written audit or inspection decisions and place these decisions in the public dockets. Section 194.8 also provides that subsequent to any positive determination of compliance under this approval process, EPA intends to conduct inspections, in accordance with §194.21 and §194.24(h), to confirm the continued compliance of the programs approved. The results of such inspections are made available to the public through the Agency's public dockets, as described in §194.67.

I.B Waste Components and Waste Descriptions

As required by § 194.24(b)(2) and § 194.24(c), DOE identified the waste components that were expected to have a significant effect on disposal system performance and the emplacement limits for these components in Chapter 4 (Table 4-10) of the Compliance Certification Application and in Appendices WCA and WCL (Docket A-93-02, Item II-G-1, Volume XIX). DOE must determine the quantities of these components in TRU waste containers. Based on DOE's analysis, EPA regulates the waste components discussed below.

I.B.1 Radiological Waste Components

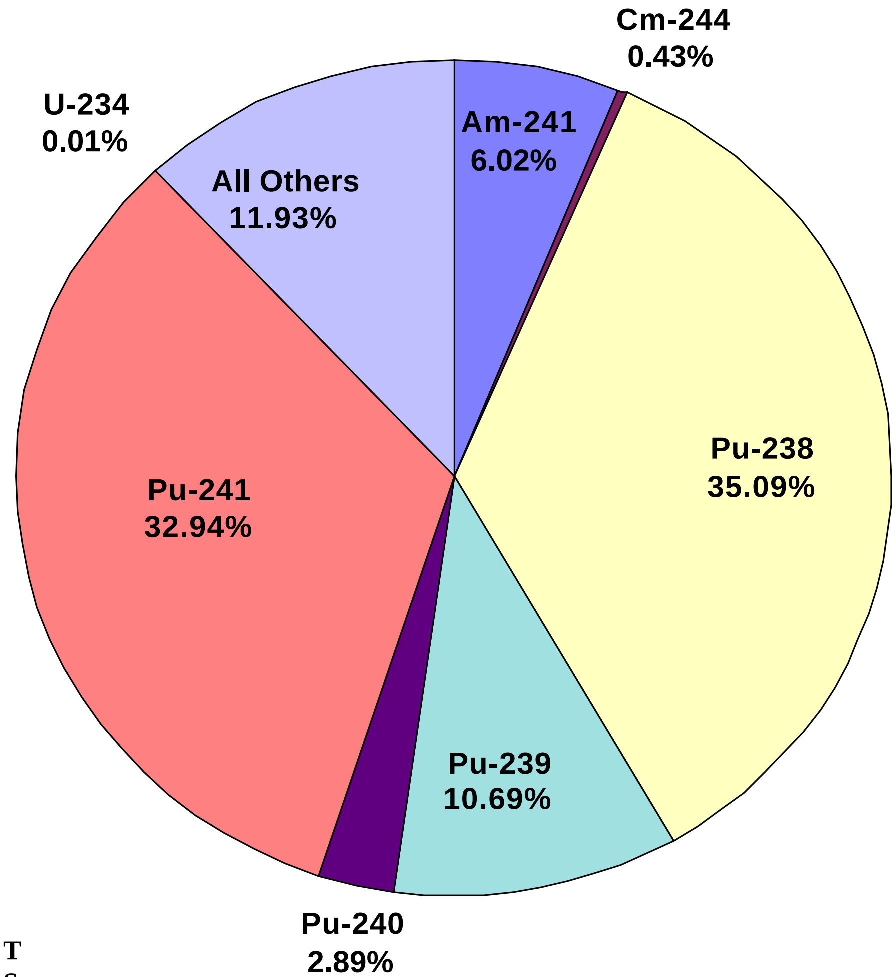
As discussed in Section 24.A.6 of CARD 24 (Docket A-93-02, Item V-B-2), EPA concluded that DOE appropriately identified ten isotopes most significant to the PA, which EPA listed as ^{241}Am, ^{244}Cm, ^{137}Cs, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{90}Sr, ^{233}U, and ^{234}U (the cesium and strontium isotopes and ^{233}U are important to remote-handled TRU waste). These ten isotopes significant to PA comprise about 99 percent of the EPA units anticipated within the WIPP waste inventory. CARD 31, Application of Release Limits, contains an explanation of EPA units for radioisotopes (Docket A-93-02, Item V-B-2). EPA determined that about 90 percent of the total anticipated inventory of 6.55 x 10^6 curies at closure is expected to be contributed by the following seven isotopes: ^{241}Am, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{244}Cm, and ^{234}U (Figure 1). See also EPA's Technical Support Document for Section 194.24: Consolidated Technical Support Document – Compliance Certification Review of Waste Characterization Requirements (Docket A-93-02, Item V-B-15).

DOE identified the following ten radionuclides in Appendix WCL (Docket A-93-02, Item II-G ,Volume XIX) as subject to identification and quantification:

- ^{238}Pu, ^{239}Pu, ^{240}Pu, and ^{242}Pu;
- ^{241}Am;
- ^{233}U, ^{234}U, and ^{238}U;
- ^{90}Sr; and
- ^{137}Cs.

EPA examines tracking of the Appendix WCL list during inspections because the amount of ^{241}Pu and ^{244}Cm may be derived from measurements of isotopes on the WCL list. DOE must track these isotopes against the inventory estimates used in the performance assessment (the inventory estimates are listed in CARD 31, Table 3). As stated in Appendix WCL, "[T]he performance assessment is sensitive to relative changes in inventory curie content as a function of radionuclide decay and ingrowth over time. The magnitude of change in the total curie content depends on the initial ratios of the total activities of the assayed radionuclides at the time of repository closure. Accordingly, the results of the performance assessment analysis are conditional on the ratios assumed. . .." Consequently, the inventory estimates upon which EPA's initial certification is based function as constraints on the amount of the key isotopes that may be disposed in the WIPP. Changes to the inventory estimates would necessitate further analysis by DOE of the effect(s) on the performance assessment, and perhaps, a modification of the certification.

Figure 1. Percentage of Total Inventory Contributed by PA-Significant Isotopes (Curies)



Source: EPA Technical Support Document for Section 194.24 (Air Docket A-93-02, Item V-B-15, Section 4.2.3)

<u>I.B.2 Non-Radiological Waste Components</u>

In addition, DOE identified other waste components that were expected to have a significant effect on disposal system performance and which require limits (Appendix WCL, Table WCL-1). The non-radiological waste components with limiting values are:

- Ferrous metals (iron): minimum of $2x10^7$ kilograms;
- Cellulosics/plastic/rubber: maximum of $2x10^7$ kilograms;
- Free water emplaced with waste: maximum of 1684 cubic meters; and
- Nonferrous metals (metals other than iron): minimum of $2x10^3$ kilograms

I.B.3 General Waste Descriptions

EPA examines general waste descriptions prepared by DOE sites to understand how radiological/non-radiological components are grouped and assessed. Wastes can be assigned waste material parameters that encompass those components with limiting values identified by DOE. The DOE identified (Appendix BIR of the CCA) the following 12 different waste material parameters and 3 different contents packaging materials which are tracked by sites and which allows quantification of non-radionuclide waste components:

Waste Material Parameters

- Iron-base metal/alloys
- Aluminum-base metal/alloys
- Other metal/alloys
- Other inorganic materials
- Vitrified materials
- Cellulosics
- Rubber
- Plastics
- Solidified inorganic materials
- Solidified organic materials
- Cement (solidified)
- Soils

Contents Packaging Materials

- Steel
- Plastic
- Lead (for RH-TRU waste only)

Waste generator sites typically group waste by "waste streams," which are defined as ". . . waste material generated from a single process or from an activity that is similar in material, physical form, and hazardous constituents" (Appendix WAP). Waste streams are not defined by their radionuclide content, but instead are grouped by chemical, physical, and process similarities. The Transuranic Waste Baseline Inventory Report (TWBIR, Appendix BIR) identified 569 different waste streams that will be emplaced in the repository. These wastes are also be categorized into broader Summary Waste Category Groups, defined as S5000 (debris), S4000 (soil/gravel), and S3000 (solidified) waste. Generator sites tend to group waste by Summary Waste Category Group for inspection purposes.

I.C Description of Waste Generators

The wastes to be emplaced in the WIPP originate from generator/storage sites within the DOE Weapons Complex and National Laboratories. Waste must be defense-related TRU waste, and the range of wastes at each generator/storage site is dependent upon the site's past and current missions. The generator/storage sites and the volumes of contact-handled TRU (CH-TRU) and RH-TRU waste expected are identified in Table 1.

Table 1
Anticipated Waste Volumes for Disposal at WIPP

Storage Generator Site	Anticipated CH-TRU Waste (cubic meters)	Anticipated RH-TRU Waste (cubic meters)
Ames Laboratory	0.42	None Reported
Argonne National Laboratory- East	140	None Reported
Argonne National Laboratory - West	750	1,300
Battelle Columbus Laboratories	None Reported	580
Bettis Atomic Power Laboratory	120	6.7
Energy Technology Engineering Center	1.7	0.89
Hanford Site*	46,000	22,000
INEEL*	29,000	220
Lawrence Livermore National Laboratory*	940	None Reported
LANL*	18,000	190
Mound Plant	270	None Reported
Nevada Test Site*	630	None Reported
Oak Ridge National Laboratory*	1600	2,900
Paducah Gaseous Diffusion Plant	1.9	None Reported
Pantex Plant	0.62	None Reported
RFETS*	5,100	None Reported
Sandia National Laboratory	14	None Reported
Savannah River Site*	9,600	None Reported
Teledyne Brown Engineering	0.21	None Reported
U.S. Army Material Command	2.5	None Reported
University of Missouri Research Center	1.0	None Reported
Totals	**110,000**	**27,000**

CH-TRU = contact-handled transuranics; INEEL = Idaho National Engineering and Environmental Laboratory; LANL = Los Alamos National Laboratories; RFETS = Rocky Flats Environmental Technology Site; RH-TRU = remote-handled transuranics
(*) Major Sites

Source: DOE CCA, Chapter 4.

These totals do not include wastes excluded at the time of the Compliance Application (i.e., uncharacterized and classified wastes). There are additional wastes that could be added to the anticipated inventory in the event that the classified waste streams are declassified or the unclassified wastes are identified and characterized. Waste streams from three of the eight major sites (Savannah River, Rocky Flats, and Los Alamos National Laboratories [LANL]), are expected to contribute over 85 percent of the total activity for seven key isotopes.

I.D Current Inspection Process

EPA evaluates the ability of each generator site's waste characterization program to adequately characterize TRU waste through the inspection process as established in §194.8(b). Inspections at generator/storage sites are conducted to verify that characterization activities are performed in accordance with approved site procedures and that the characterization activities are adequate and appropriate to characterize and quantify waste from specific waste streams and waste containers so that the waste will not exceed the approved limits. By approving waste characterization systems and processes, EPA concludes the following: (1) the site personnel are capable of identifying and measuring the radioactive components (such as plutonium) in the TRU waste that must be tracked for compliance[1]; and (2) the characterization program can demonstrate that the waste stream(s) examined meet Condition 3 of the Compliance Certification Criteria.

The approval process described at 40 CFR 194.8(b) requires DOE to provide EPA with two types of information: (1) information on process knowledge[2] for waste streams proposed for disposal at WIPP, and (2) information on the system of controls in place at the generator site. The Agency solicits public comments on DOE site documentation and announces the date of the upcoming inspection.

An EPA inspection/surveillance team visits the site to verify that process knowledge and other elements of the system of controls are technically adequate and being implemented properly. Specifically, the EPA inspection/surveillance team verifies compliance with 40 CFR 194.24(c)(4), which states:

Any compliance application shall: Provide information which demonstrates that

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[1] The potential contents of a waste stream or group of waste streams determine which processes can be used to adequately characterize the waste. For example, if acceptable knowledge information suggests that the waste form is heterogeneous, the site should select a nondestructive assay technique appropriate for such waste in order for adequate measurements to be obtained. Radiography and visual examination help both to confirm and quantify waste components, such as cellulosics, rubbers, plastics, and metals. Once the nature of the waste has been confirmed, the assay techniques then quantify the radioactive isotopes in the waste. In the given example, a TRU waste site may be able to characterize either a wide range of heterogeneous waste streams or only a few. Under the current regulation, the scope of a particular inspection is determined by a site's stated limits on the applicability of proposed waste characterization processes.

[2] Process knowledge refers to knowledge of waste characteristics derived from information on the materials or processes used to generate the waste. This information may include administrative, procurement, and quality control documentation associated with the generating process, or past sampling and analytic data. Usually, the major elements of process knowledge include information about the process used to generate the waste, material inputs to the process, and the time period during which the waste was generated. EPA has used the term "acceptable knowledge" synonymously with "process knowledge." Acceptable knowledge is discussed further in Section II.

a system of controls has been and will continue to be implemented to confirm that the total amount of each waste component that will be emplaced in the disposal system will not exceed the upper limiting value or fall below the lower limiting value described in the introductory text of paragraph (c) of this section.[3] *The system of controls shall include, but shall not be limited to: measurement; sampling; chain of custody records; record keeping systems; waste loading schemes used; and other documentation.*

As waste generator sites establish waste characterization programs for new waste streams (or groups of waste streams), the Agency assesses their compliance with the requirements of Sections 194.24(c)(3) through (5). The Agency conducts inspections at each site to evaluate the use of process knowledge and the establishment of a system of characterization and controls for each waste stream or group of waste streams. The typical elements that are subject to inspection include NDA, VE and/or Radiography, AK, and software controls to include operation and interface with the WWIS. Elements related to the control of characterization systems, such as training records and document control, are also subject to inspection. The scope of a specific inspection is dictated by the systems that are in use for a group of waste streams, how many of these systems have been previously inspected and approved by the Agency, and if the nature of the waste stream changes the performance of any elements of the characterization system. For EPA to confirm that a system of controls has been adequately executed, DOE must demonstrate that measurement techniques and other control methods can be implemented for waste streams that DOE plans to emplace in the WIPP. The number of waste streams or groupings of waste streams that can be approved is dependent upon how well the generator site systems perform for a variety of wastes. While EPA can and has approved relatively broad groupings that mirror the specific authorization being sought by sites, EPA has also restricted its approval to those waste streams it felt could be adequately characterized by the systems examined.

The Agency's compliance decision is conveyed by a letter from EPA to DOE. A copy of the letter, as well as the results of the inspection(s), are placed in EPA's docket.

To summarize, the approval process for site-specific waste characterization controls is as follows (See Figure 2):

a. One or more Federal Register notices for the inspection and placement of related documents in the docket;

b. 30-day public comment period on docketed information from the site to be inspected;

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[3] The introductory text of paragraph 40 CFR 194.24(c) states: "For each waste component identified and assessed pursuant to [40 CFR 194.24(b)], the Department shall specify the limiting value (expressed as an upper or lower limit of mass, volume, curies, concentration, etc.), and the associated uncertainty (i.e., margin of error) for each limiting value, of the total inventory of such waste proposed for disposal in the disposal system."

c. Performance of site inspection based on information provided by DOE:

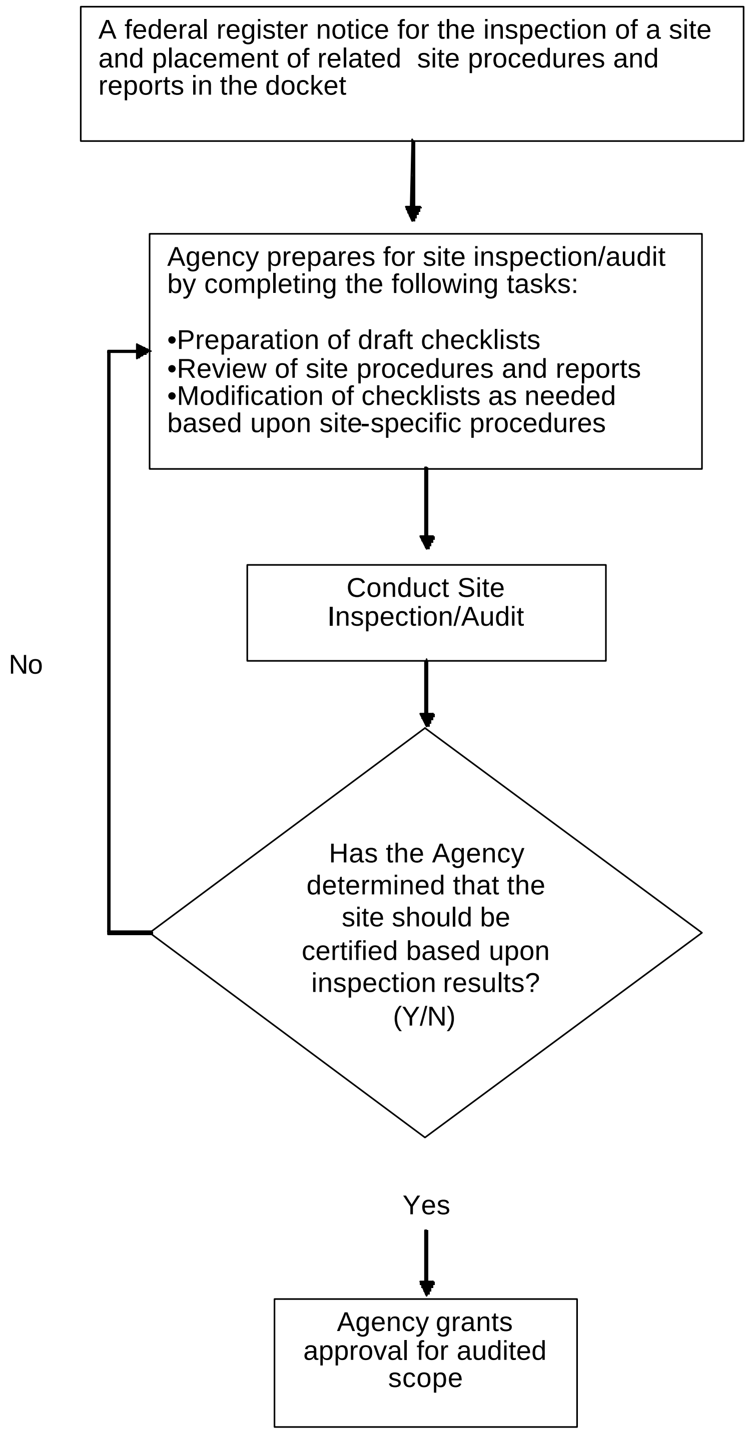
- Review of site procedures and other information, and modification of EPA checklists, if necessary, to incorporate site-specific information;

- On-site verification of the technical adequacy or qualifications of personnel, procedures, and equipment by means of interviews, demonstrations, and completion of checklists; and

d. Preparation of report documenting EPA's inspection(s) and written notice to DOE of EPA's compliance decision.

Under 40 CFR 194.21 and 194.24(h), EPA is authorized to perform follow-up inspections to verify that a TRU waste site is shipping waste that belongs only to those waste streams or groups of waste streams that have been characterized by the approved processes. In the event that the inspection finds that the generator/storage site is not adequately meeting the waste characterization requirements of §§194.24(c)(3) through (5), the agency will not certify the generator/storage site until the inadequacies are resolved and the resolution verified usually through further inspection.

Figure 2
Site Approval Process



II. DESCRIPTION OF TECHNICAL ELEMENTS EXAMINED DURING INSPECTIONS

Specific waste characterization processes, techniques, and elements important to demonstrating 40 CFR 194.24(c) compliance are examined by EPA during inspections, including:

- *Acceptable Knowledge (AK)*. AK is a program whereby historic process data and other data are assembled, assessed, and evaluated to calculate the radionuclide content, in terms of both overall quantity and the presence of specific isotopes. This information is typically compared to assay and other measured data to assess the viability of the AK results, but also often provides direct information used by NDA personnel in the form of a "check" for NDA, as a source of isotopic information, or as a direct replacement for NDA measurements when sites believe their AK information is preferable to that obtained through measurement. At present, sites are required to analyze all TRU waste containers to determine isotopic contents and confirm AK.

- *Nondestructive Assay (NDA)*. NDA systems are used to detect radionuclide content, including the quantity and isotopic distribution. These systems typically involve: 1) neutron systems (e.g., Passive-Active Neutron (PAN) system) for quantification of a plutonium isotope; and/or 2) Segmented Gamma Scanner (SGS), or a comparable system, typically used to identify specific radioisotopes. Currently, all waste containers are assayed to quantify 10 WIPP-tracked radionuclides. In certain properly justified cases, isotopic information was obtained from AK.

- *Real-time Radiography (RTR)*. RTR records continuous x-ray of drum contents that is used to verify waste material parameters and the correctness of the waste matrix code identified by AK, as well as to quantify cellulosics, plastic, and rubbers.

- *Visual Examination (VE)*. The process of opening a statistically determined number of waste drums and manually examining and recording their contents is called VE. VE is used as a quality control check of RTR.

- *WIPP Waste Information System (WWIS)*. WWIS is a data tracking and validation system that includes data collection and entry at the site, and transmission to and receipt of data at the WIPP site.

These techniques are discussed in more detail in the following subsections. EPA requirements and expectations for these techniques are derived both from 40 CFR 194.24 and DOE's own program requirements, as presented in the CCA and revised over time with EPA's review and approval.

II.A Acceptable Knowledge

AK is generally defined as the use of process information or other waste generator data to determine waste content. AK is a Resource Conservation and Recovery Act of 1976 (RCRA) characterization process that has been adopted by DOE as a TRU waste characterization methodology applicable to the radioactive, as well as the hazardous, portion of the waste. To date, two guidance documents address AK (EPA 1994, EPA 1997), both of which address characterization of the hazardous, not radioactive, portion of the waste using AK. The concept has been extended by DOE to encompass the radioactive portion of TRU waste, with the TRU waste AK characterization requirements presented in attachment WAP of the CCA, as well as in the 1995 WIPP TRU Quality Assurance Project Plan (QAPjP) referenced in the CCA.

In joint EPA/NRC guidance (1997), which is primarily applicable to low-level mixed waste, EPA recognized the use of AK to make RCRA hazardous waste determinations. The guidance does not, however, speak to the use of AK to determine radioactive component content, except to state that the NRC does not describe specific testing requirements for waste to determine if it is radioactive (10 CFR 20.2006 requires that the waste manifest include, as completely as practicable, the radionuclide identity and quantity and the total radioactivity).

The 1994 and 1997 guidances both state that the use of waste knowledge by a generator and/or treatment, storage, disposal, recycling facilities (TSDF) to characterize mixed waste is allowed – and even recommended – to eliminate unnecessary or redundant waste testing. EPA broadly interprets AK to include:

- Process knowledge, which is detailed information on waste obtained from existing published or documented waste analysis data, from a waste generator’s records , or from wastes generated by processes similar to that which generated the waste;

- Available records of radionuclides analysis; or

- Combinations of both, supplemented by confirmatory analysis.

II.A.1 Overview of Technical Elements

AK is used by DOE in the context of radioactive waste characterization to provide the following:

- Waste stream identification
- Radionuclide isotopic content,
- Isotopic ratios,
- Low level vs. TRU designation
- Overall radioactivity based on facility records and process information

- Physical waste type
- Waste material parameter content

As indicated in Section I, DOE is required to identify and quantify specific WIPP-tracked isotopes, additional isotopic information to support waste limits presented in the CCA, as well as inventory estimates presented in Attachment BIR of the CCA. Additionally, waste material parameters require identification. AK is used to obtain available information pertaining to these required parameters, and this information is available to NDA and nondestructive evaluation (NDE) personnel to facilitate their measurement activities. Additionally, information derived via AK is compared to that obtained by NDA measurement to assess the accuracy of AK data.

II.A.2 Technical Description of System or Measurement Device(s)

AK requirements are presented in the WIPP QAPjP (Docket A-93-02, Item II-G-1, Reference 201), as well as Appendix WAP to the CCA. Since submission of the CCA, DOE has removed AK requirements from the QAPjP because it was redundant with the RCRA Waste Analysis Plan (WAP) with respect to AK requirements. As such, EPA uses the most recent version of the WAP as the governing document for AK requirements.

AK is gathered, evaluated, and assessed following a specific process committed to by the DOE in its CCA via associated attachments and references. This process, which is examined by EPA during inspections, includes:

- *Assembling* AK information;
- *Compiling* AK documentation into an auditable record (i.e., the process should include review of AK information to determine the waste material parameters and radionuclides present, as well as source info discrepancy resolution);
- *Assigning* waste streams/waste matrix codes;
- *Identifying* physical forms, waste material parameters, and radionuclides (including, if possible, isotopic ratios);
- *Resolving* data discrepancies;
- *Identifying* management controls for discrepant items/containers/waste streams;
- *Confirming* AK information with other analytical results by comparing AK characterization data with that obtained through NDA, NDE, and/or visual examination, including discrepancy resolution; and
- *Auditing* of AK records.

EPA examines these elements during inspections to ensure that the process is being followed. Specifically, EPA examines whether procedures demonstrate a logical progression from general facility information to more detailed waste stream-specific information.
EPA examines whether the site’s TRU waste management program has procedures to determine:

- Waste categorization schemes (e.g., consistent definitions of waste streams) and terminology,
- Breakdown of the types and quantities of TRU waste generated/stored at the site, and
- How waste is tracked and managed at the generator site, including historical and current operations.

As indicated previously, EPA is particularly concerned about the completeness and accuracy of data collection with respect to those elements critical to continued compliance. Data gathered under the AK process should support identification of radionuclides and parameters important to WIPP performance, as well as information useful when assessing the accuracy of PA inventory assumptions presented in the BIR. EPA examines the AK process to see whether radionuclide origin is documented and that information is collected for:

- ^{241}Am, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{242}Pu, ^{233}U, ^{234}U, ^{238}U, ^{90}Sr, ^{137}Cs, and unexpected radionuclides,
- Ferrous metals (in containers),
- Cellulosics, plastics, rubber, and
- Nonferrous metals (in containers).

In addition to this information, EPA expects AK information to be properly managed and recorded by following procedures requiring that:

- AK information be compiled in an auditable record, including a road map for all applicable information.
- A reference list be provided that identifies documents, databases, QA protocols, and other sources of information that support AK information.
- The overview of the facility and TRU waste management operations in the context of the facility's mission be correlated to specific waste stream information.
- Correlations between waste streams, with regard to time of generation, waste generating processes, and site-specific facilities be clearly described. For newly generated wastes, the rate and quantity of waste to be generated shall be defined.
- Nonconforming waste be segregated.

The AK record must contain the following items:

- A map of the site that identifies the areas and facilities involved in TRU waste generation, treatment, and storage;
- Facility mission description related to TRU waste generation and management;
- Description of the operations that generate TRU waste at the site and process information, including:
  - Area(s) or building(s) from which the waste stream was or is generated,
  - Estimated waste stream volume and time period of generation,
  - Waste generating process description for each building or area,

  - Process flow diagrams, if appropriate,
  - Generalized material inputs or other information that identifies the radionuclide content of the waste stream and the physical waste form; and
- Types and quantities of TRU waste generated, including historical generation through future projections.

Additionally, EPA expects sites to collect additional “supplemental,” or supporting information as available to bolster information included in the AK record, which may include but not be limited to historical safeguard data (for radionuclides), waste package information, shipping records, etc. As a test of AK data viability, NDE and NDA information are compared to AK data to assess AK information accuracy (this is sometimes called “confirmation”). EPA examines whether reevaluation of AK is performed, if NDE/NDA or VE identify waste to be of a different waste matrix category (such as sludges vs. debris) or radionuclide content. The reevaluation should include, as applicable, waste reassignment to a new waste stream and repackaging, if appropriate.

All of the requisite AK data are assembled in an AK Summary that compiles and summarizes information collected, including the basis for all waste stream designations. EPA examines the AK Summary for several elements, including but not limited to whether the AK Summary addresses radionuclide content of waste, how detailed this information is, the nature of supporting documentation, completeness of the AK Summary with respect to inclusion of all pertinent AK data, accuracy of process discussions within the AK Summary, traceability of AK information on a drum/container basis, and AK accuracy calculations (which are generally included in documents outside of the AK Summary).

EPA examines the AK process and the accuracy and viability of the information obtained through this process. As part of this examination, EPA performs a traceability analysis where drums are randomly selected and AK data pertinent to those drums examined. This activity includes not only historic AK information, but NDA and NDE data collected under EPA/WIPP-approved programs, and comparison of these data to AK to demonstrate that the complete characterization process is attainable and approveable. Additionally, EPA examines the interface between NDA, NDE, and AK to see how information is shared and used between the various characterization processes. AK is intended to serve as the “starting point” from which basic waste information is assembled and examined; this information is then used to varying degrees by the NDE and NDA personnel when performing radionuclide assay or x-rays to assess drum waste material and prohibited item contents.

AK information is available to NDA operators to use when performing drum analysis as a source of matrix information and radionuclide content information against which measurements are “checked.” Also, NDA often relies on AK to provide isotopic information, including isotopic ratios. On a case by case basis, EPA has allowed this AK information, if demonstrated to be viable and of exceptional quality, to be used in the radionuclide characterization process. For example, EPA has allowed a site to define the isotopic distribution using AK, but has required verification of one or two isotopes in each drum to confirm the AK-identified isotopes of a number of radionuclides. Specifically, EPA has allowed a site (RFETS) to identify weapons grade plutonium isotopic distributions for plutonium isotopes using AK, but has required measurement of two isotopes in each container to confirm the AK isotopes.

II.A.3 Effect of Waste Matrix Type on Measurement

The viability of the AK process is more directly related to the adequacy of AK information available than to the waste matrix type. Generator facilities are currently assembling AK information on, and characterizing wastes with, the best available AK information. These wastes typically have a significant body of information available through site records, process information, historic assay, etc., and the resulting AK data assembly, assessment, and verification process is generally successful. However, existing wastes to be characterized in the future may have much less historic information available, which means that the AK process aspect of waste characterization could have varying degrees of success with respect to collection of mandatory and supplemental information, acquisition of radionuclide data, etc. Therefore, the AK process is not so much affected by the waste matrix, but instead by the age of the waste, the historic information available for the waste, and the success of data collection efforts by the generator sites.

II.A.4 Scope of EPA Approvals for AK

EPA typically approves site AK on a Summary Waste Category basis, primarily because sites themselves limit the approvals being sought to this categorization. However, EPA's overall approval of any given site may be limited to groups within the Summary Waste Category group, depending upon the technical viability of the various characterization processes. For example, even if AK approval extends to all retrievably stored waste, overall approval could be limited if NDA approval can only be extended to a specific type of waste. EPA also approves the AK process for relatively large groups of wastes that are not necessarily restricted by Summary Waste Category Groupings. For example, wastes generated at Rocky Flats and currently in storage at INEEL tend to have relatively complete data records, regardless of the Summary Waste Category group in question. Even if there is little AK information, EPA can and has extended approval of the process if the site is able to demonstrate a thorough understanding of the AK process. In short, EPA may approve whatever is appropriate given a site's ability to characterize waste using the AK process. AK approval is restricted by the quantity and quality of AK data, not by the waste type.

II.B Nondestructive Assay (NDA)

NDA is used to identify and quantify the radioactive constituents in a container. Waste to be disposed of at WIPP is assayed on a container basis to quantify the activity of the radionuclides, particularly those identified in the transuranic waste baseline inventory report TWBIR as most important to the PA, and to demonstrate that the waste in the container meets the definition of TRU waste.

II.B.1 Overview of Technical Elements

NDA examines the ten isotopes requiring quantification, as well as additional isotopes. The ten isotopes are:

- ^{238}Pu, ^{239}Pu, ^{240}Pu, and ^{242}Pu;
- ^{241}Am;
- ^{233}U, ^{234}U, and ^{238}U;
- ^{90}Sr; and
- ^{137}Cs.

In addition to the isotopes listed as important to PA and requiring quantification, the waste characterization program also is responsible for adequately calculating the emplaced activities of the isotopes contributing to the Waste Unit (in this case, the activity of the TRU alpha emitting isotopes in Table 4-8 of the CCA). Section 4.4.1 of the CCA states,

> Collectively, those elements of the waste characterization program that support long-term regulatory compliance include the determination of the radionuclide inventory (for purposes of normalizing radionuclide releases as required for comparison with 40 CFR Part 191.13(a)), the identification of the physical and chemical waste form inventories (if applicable), and the verification that no wastes are emplaced in the WIPP that exceed the disposal system's safety and/or performance limitations.

The normalization requirement in Table 1 referenced in 40 CFR Part 191.13(a) necessitates knowledge of the EPA Waste Unit, defined as the total curies divided by one million.

EPA has, as part of the inspection program, also required DOE to quantify isotopes other than those identified as important in the CCA or 40 CFR Part 191. These additional isotopes are usually necessary to support the technical adequacy of the assay values for isotopes identified as important to PA. Typically, EPA may require a site to ensure that DOE identify and account for isotopes that may interfere with the assay of isotopes identified as important to PA. One example of additional required isotopes is ^{237}Np at LANL, when LANL was employing the Fixed Energy Response Analysis using Multiple Efficiencies (FRAM) system for gamma spectroscopy. Another example is the presence of ^{244}Cm or ^{252}Cf in waste planned for assay using passive neutron methods. These special cases are documented in the EPA inspection report, and are usually specific to a given system and a given type of waste.

II.B.2 Technical Description of System or Measurement Device(s)

To demonstrate compliance with 40 CFR 194.24(c), DOE described general methods for accomplishing NDA in the CCA. DOE described more detailed requirements for NDA programs in Chapter 9 of the Waste Characterization Quality Assurance Program Plan (QAPP), a document that has since been replaced by the Waste Acceptance Criteria (WAC) document. Each waste generator site describes their specific NDA program, and how the program complies with the upper tier EPA and DOE requirements, in a Quality Assurance Project Plan (QAPjP). Site operating procedures for each instrument or method are then written to implement the QAPjP requirements, along with any other specific instrument or site dependent requirements.

NDA systems typically include data collection and analysis software that performs quality related functions. In accordance with 40 CFR 194.22 any NDA system used to support EPA characterization requirements must adhere to the American Society of Mechanical Engineers (ASME) Nuclear Quality Assurance (NQA) Requirements for Software (ASME, 1990).

Radioactive components in waste to be disposed of at WIPP may be characterized by radiochemistry or NDA. NDA methods are by far the preferred techniques for performing radioassay, as they generally have greater throughput and produce lower human exposures than do radiochemistry techniques.

II.B.2.1 General NDA System Information

The NDA techniques approved for use on WIPP waste containers are classified as active or passive. Passive NDA methods measure spontaneously emitted radiation produced by natural decay of the radioactive isotopes inside the waste container. Active NDA methods measure radiation produced by artificially generated reactions in the waste material. Active NDA systems used for assay of TRU waste generate reactions in the heavy metals within the waste using a low intensity beam of neutrons. Presently, most waste is characterized using passive-active neutron (PAN) counters and gamma ray spectrometry systems. A small fraction of the waste, primarily from the production of radioisotopic thermal generators (RTG), is characterized by calorimetry instruments.

The neutron counting systems being used for NDA of WIPP waste containers are designed to provide quantification of the plutonium isotopes in TRU waste. Neutrons are naturally produced by only a small number of isotopes; the rate at which neutrons of certain energies are produced by the waste container provides a good measure of the quantity of these isotopes. Passive neutron counting systems detect these naturally occurring neutrons and use various computational techniques to relate their quantity to isotopic activities.

Many NDA systems using neutron counting are also capable of active counting. In the active mode, a low intensity beam of neutrons is fired into the waste container. This neutron beam will produce a series of reactions in the fissionable and fissile isotopes within the waste, with the number of particles produced by the reactions being proportional to the amount of fissile and fissionable isotopes present in the waste. The external detectors then count these particles and convert the particle response to source strength. By using active NDA methods and special sensitive neutron detectors, even very small quantities of plutonium in the waste containers can be detected and quantified.

The gamma ray measurement systems being used to characterize WIPP waste containers are based on two basic principals. First, almost all radioactive materials produce gamma rays. Second, the gamma ray pattern produced by any isotope is unique to that isotope; no two isotopes produce the same number of gamma rays having the same energies. Given a detector with good enough resolution to count the various gamma rays individually and a method to determine what the gamma ray energy patterns mean, it is possible to quantitatively determine the isotopes present in a waste sample. Modern radiation detectors coupled to sophisticated computer programs that solve the energy pattern for the presence of certain isotopes are capable of performing this task for a large number of isotopes. The gamma measurement systems approved for use in characterizing WIPP waste are capable of quantifying the presence of many of the isotopes defined by 40 CFR Part 191, even in the presence of potential interfering isotopes and background radiation.

When the gamma and neutron NDA systems are used together, these systems provide information about the radiological content of a waste container. The information that can be produced by the WIPP waste NDA systems includes, but is not limited to, ^{239}Pu equivalent activity, ^{239}Pu fissile gram equivalent, total alpha activity, the decay heat of waste containers, and the activity of the isotopes of interest to the performance assessment and the applicable regulations. The purpose of these data relative to long-term repository compliance with 40 CFR Parts 191 and 194 is to establish the radionuclide content emplaced in the repository.

All assay systems using radiation detection methods must be calibrated using a variety of standards that simulate the various waste compositions, source distributions and interferences common to the waste streams originating from a particular generator site. AK enhances the NDA systems by providing advance information on the radiological characteristics of a waste stream, which allows the NDA systems to be made particularly sensitive to that type of waste by developing realistic calibration standards. Calibration records and expected system performance curves are compared against the actual results of the measurements performed on the waste containers.

II.B.2.2 Neutron Systems

Because they have no charge, and are not purely an electromagnetic packet like gamma rays, neutrons have a unique set of interactions with matter. They do not interact with the electron cloud around a nucleus, but rather with the nucleus itself. Thus, when a material absorbs neutrons, the neutrons are interacting with and changing the nuclei of the atoms in the absorbing material, which can produce a number of secondary reactions. Neutron interactions with nuclei may result in the disappearance of the neutron and its replacement by secondary radiations, or a significant change in the neutron's energy or direction. It may even result in the fragmentation of the nucleus with which it is interacting in a process known as fission. The secondary radiations produced by neutron interactions are usually heavy charged particles; it is these charged particles produced by the conversion of the neutron energy that are seen by neutron detectors, as discussed below. Generally, the type and probability of the various neutron interactions with any given type of nucleus depend strongly on the energy of the neutron.

NDA systems do not require exact measures of neutron energy. For NDA purposes, neutrons can simplistically be divided into two categories based on their energy: high energy or "fast" neutrons, and low energy or "slow" neutrons, using an arbitrary energy division of approximately 0.5 electron volts (eV).

Neutrons are measured indirectly by detecting secondary particles resulting from interactions of neutrons with target nuclei. These possible interactions include:

- (n,p) or (n,α) reactions where a nucleus absorbs a neutron and emits a charged particle, which, along with the recoil product nucleus, causes ionization in the detector;

- Neutron induced fission, or (n,f) reactions, where the detector registers ionization produced by the fission fragments or the prompt or delayed neutrons and photons; and/or

- Neutron scattering, where the recoil nucleus produces ionization in the detector.

The (n,p), (n,α) and (n,f) reactions are of greatest interest for neutron detection because they produce secondary radiations (i.e., charged particles that can be detected directly). The neutron detectors most widely used in NDA systems are gas proportional detectors filled with a light isotope of helium (^3He). These detectors are commonly called helium tubes. A neutron detection system typically contains many helium tubes, maintained under an applied voltage, or electric field. The neutron-helium reaction of interest is shown below:

$$^3He + n \rightarrow {}^3H + p + 0.764 \text{ MeV}$$

The term "cross section" is used to describe the probability of interaction. Helium is used because it has a high cross section for interaction with thermal, or low energy, neutrons, which provides a high detection efficiency and pulse height resolution. The charge liberated by the neutron-helium interaction produces initial ionizations of helium gas. By maintaining the appropriate electric field within the gas, the number of secondary ionizations produced is proportional to those produced initially, while the number of actual ion pairs is multiplied by a factor of many thousands. The detection system collects the ion pairs as charge which, with proper calibration, is correlated with the number of neutron interactions and therefore the sample reaction rate.

Because the probability of neutrons interacting with target materials is a strong inverse function of the neutron's energy, high energy neutrons produced by spontaneous or induced fission ("fast" neutrons) must be slowed before they can be efficiently detected. This occurs through multiple collisions with atoms in the materials within the detection system (i.e., polyethylene, graphite, etc.). Neutron cross sections for a given target nucleus are interaction specific (i.e., there is a different cross section for fission, elastic scattering, inelastic scattering, (n,p) reaction, etc.), and each is strongly dependent on the neutron energy. Cross sections are also material specific. Certain isotopes have large cross sections for various reactions, which may make them a preferred material for neutron detection systems.

The main source of neutrons of interest to NDA result from spontaneous or induced nuclear fission, which is the disintegration of an atomic nucleus into two or more lighter fragments. In general, isotopes of plutonium and uranium have a low rate of spontaneous fission compared to the rate for other decay modes, such as alpha emission. This is particularly so for heavy radionuclides with odd numbers of neutrons and odd mass number, but these isotopes frequently have a high thermal neutron fission cross section, which means these isotopes can be made to undergo induced fission by bombardment with low energy neutrons. Examples of these isotopes are ^{233}U, ^{235}U and ^{239}Pu. Plutonium isotopes with even mass numbers (^{238}Pu, ^{240}Pu, and ^{242}Pu) undergo higher rates of spontaneous fission, and for ^{240}Pu the rates of spontaneous fission and alpha emission are close. This is important as ^{240}Pu is typically present as an impurity in weapons grade plutonium and is a component of TRU wastes.

Assays of TRU wastes by measuring the neutrons emitted by spontaneous fission are called "passive" mode assays. Passive mode measurements count neutrons produced by isotopes with significant likelihood of decay by spontaneous fission, including ^{238}Pu, ^{240}Pu, ^{242}Pu, and ^{244}Cm. Neutrons are also emitted by TRU radionuclides in response to induced fission caused by bombardment with energetic neutrons supplied by the measurement system. Such assays measuring induced neutrons are called "active" mode assays. Active mode assays provide information for ^{239}Pu and ^{241}Pu, as well as other fissile isotopes present in the TRU waste being assayed (e.g., ^{235}U), that fission takes place in response to neutrons supplied by the measurement system.

II.B.2.3 Passive-Active Neutron Counters

PAN counters are used to quantify the amount of a fissile or fissionable nuclide inside a container. More precisely, these systems quantify the amount of a particular radionuclide that would result in the number of counts observed. This is referred to as the effective mass. For active measurements, the ^{239}Pu effective mass is measured, while for passive measurements, the ^{240}Pu effective mass is measured. To convert the effective mass measured into the true mass of each of the radionuclides present, the ratio of each nuclide to that of the primary nuclide being measured must be known. These ratios can be measured using a gamma-ray spectrometry system, described in the following section.

To quantify the effective mass of ^{239}Pu or ^{240}Pu, fast neutrons from induced or spontaneous fissions are detected and counted. Since two or more neutrons usually result from a fission event, neutron counters are operated in coincidence mode. In coincidence mode, an event is only counted when two or more neutrons are individually detected.

Most PAN counters consist of a large number of individual neutron detectors surrounding the container being assayed. The most common type of neutron detector used is a ^{3}He tube, which is a long cylindrical proportional gas counter filled with ^{3}He. Since the probability of detection in a ^{3}He tube is much greater for thermal neutrons than for fast neutrons, ^{3}He tubes are usually surrounded by a moderator. Fast neutrons lose energy through numerous collisions in the moderator until they are reduced in energy, or "thermalized."

As previously described, a PAN counter in passive mode counts neutrons from spontaneously fissioning nuclides, such as ^{240}Pu. In active mode the PAN system counts neutrons generated in the waste container after the container is exposed to fast neutrons from an external source, which induce fissile nuclides in the waste to fission. The most common source of fast neutrons is a D-T neutron generator, although other sources, such as ^{252}Cf sources can also be used. A D-T neutron generator creates 14 MeV neutrons by accelerating deuterium (^{2}H) nuclei into a tritium (^{3}H) target.

Proper use and calibration of a PAN system requires tests using known sources in order to evaluate system efficiency. Additionally, the environmental neutron signal must be measured in order to remove background signals that are not contributed by the waste components. Both the efficiency and the background signal must be periodically checked in order to ensure data quality is not degraded.

II.B.2.4 Photon Emission and NDA

Photons in the general sense are packets of electromagnetic energy, and are the basic constituents of any electromagnetic energy, including visible light. When these photons are generated by de-excitation reactions in an atomic nucleus, they are often referred to as gamma radiation or gamma rays. Gamma photons are essentially the same as x-rays, but have different origins: gamma radiation is emitted during changes in the state of nuclei, while x-rays are emitted during changes in the state of inner or more tightly bound electrons. Gamma radiation is a penetrating radiation best attenuated by dense materials like concrete, lead, etc. Gamma emissions occur at discrete energies that are characteristic of specific radionuclide transitions, enabling their identification by spectroscopic techniques, as discussed below. Gamma photon emissions range in energy from approximately one thousand electron volts (1 KeV) to almost ten million electron volts (10 MeV). For purposes of NDA isotopic measurements of plutonium, the photon emissions of interest occur between the energies of approximately 40 to 640 KeV; for uranium, the photon emissions of interest occur between approximately 100 KeV and 1 MeV in energy.

Their electromagnetic nature causes photons to interact strongly with the charged electrons in the atoms of all matter. The photon gives up energy to an electron, which then is released from its parent atom and collides with other atoms, liberating more electrons. The total charge released is proportional to the photon energy, since the higher the photon energy the more energy is available to release electrons. The charge resulting from this cascade of released electrons is then collected, causing a signal indicating the presence of the gamma photon. The magnitude of the signal tells the energy of the photon since the electrical signal output to the detector is proportional to the energy deposited in the detector. After a large number of these gamma photons have been detected, a graph of the number of gamma photons measured versus the energy of the photons can be displayed. This graph, or spectrum, results in a "fingerprint" of specific radionuclides since the gamma photon energy release pattern is unique for each isotope. With the appropriate calibration, the spectrum allows identification and quantification of photon emitting radionuclides in various media.

There are many types of materials suitable for use in photon detectors. The NDA systems of interest primarily use modern solid state detectors constructed from germanium, in which the charge produced by the photon interactions is collected directly. Germanium is the semiconductor material of choice for modern photon detectors due to its nearly ideal electronic characteristics that allow electrons and "electron holes" to move freely. The ionization charge resulting from the photon interaction within the detector is swept to an electrode by the high electric field in the semiconductor material produced by the voltage applied to the detector with the system's high voltage power supply. The charge is converted to a voltage pulse by a preamplifier; this voltage is then amplified and sent to a multi-channel analyzer, which displays the spectrum of gamma counts detected versus energy. Spectroscopic evaluation, including radionuclide identification by energy peak pattern, background correction, pulse height determination, etc., can then be performed on the spectrum either manually or by computer. By applying calibration and correction factors appropriate to the waste matrix, container, and radionuclides, the spectroscopic data can be transformed into concentrations of specific photon emitting TRU radionuclides.

II.B.2.5 Gamma Ray Spectrometry Systems

Gamma ray spectrometry systems are used to quantify the amount of individual radionuclides, or to measure the ratio of different radionuclides, by detecting gamma-ray emissions. Because radionuclides emit gamma rays of discrete energies, the quantity of individual radionuclides can be related to the number of gamma rays detected at a specific energy. Effective use of gamma ray spectrometry systems requires the user to define the system efficiency and resolution. These parameters must be periodically checked to ensure the system is providing consistent results. The radiological background present at the detector must also be defined in order to calculate accurate results for the radionuclide quantities present in the waste. The background gamma-ray spectrum must be periodically measured in order to ensure that unintended errors are not introduced into the results.

Most gamma-ray spectrometry systems involve one or more high resolution detectors, with high purity germanium (HPGe) being the most common. These detectors, typically about three inches in diameter and three inches in length, are positioned alongside the container. In many systems, commonly referred to as scanners, a collimator is used so that the detector only detects gamma rays emitted from a portion of the container. The detector, or more commonly the container, is then translated until the entire container is measured.

Some gamma-ray scanners incorporate a transmission source to correct for gamma-ray attenuation in the container. These collimated radioactive sources are positioned directly opposite of the detector. Shutters are often used to shield the source from the detector when it is not being used.

II.B.2.6 Calorimetry Instruments

Calorimetry instruments are used to quantify radionuclides for waste containers that contain significant quantities of ^{238}Pu. The high specific activity of ^{238}Pu, used primarily for radioisotopic thermal generators, results in a measurable heat flux that can be correlated to the activity of the radionuclides in question. Like neutron counters, isotopic ratios must be known in order to relate the heat flux to the activities of individual radionuclides. Calorimetry has only been used in a limited number of instances, and EPA has approved its use only at Rocky Flats.

II.B.3 Effect of Waste Matrix or Waste Type on Measurement

The applicability of PAN counters and gamma-ray spectrometry systems to characterize waste to be disposed of at WIPP depends primarily on the matrix properties of the waste and the types and quantities of radionuclides present. For neutron counters, the matrix parameters of primary interest are the neutron absorption and moderating properties. Large quantities of hydrogen-containing materials will enhance neutron moderation, making active measurements, and to a lesser extent passive measurements, more difficult. The presence of any materials that enhance neutron capture will make any neutron measurements, active or passive, more difficult. Passive and active neutron counters work best with radionuclides having large cross sections for induced fission and high spontaneous fission rates, respectively.

Matrix parameters that affect gamma-ray systems are matrix density and the effective atomic number. Denser materials and materials with high atomic numbers (Z) absorb more gamma rays than less dense, lower Z number materials, resulting in increased gamma-ray attenuation and poorer signal-to-source ratios. Gamma-ray spectrometry systems are best suited to detect radionuclides that emit gamma rays at energies between about 50 keV and 1 MeV with a high probability, or branching ratio. Specific issues related to waste properties are described in the following sections for each of the neutron and gamma detection methods.

II.B.3.1 Neutron Counting Systems

PAN counters typically must account for the following:

- *Radionuclide source (source) heterogeneity*. Most neutron systems are calibrated assuming that sources are uniformly distributed throughout the container volume. When sources are not uniformly distributed, but are instead concentrated in parts of the drum, the system will underestimate or overestimate the ^{239}Pu or ^{240}Pu effective mass.

- *Matrix heterogeneity*. In addition to a uniformly distributed source, most neutron calibrations are done for matrices whose neutron absorption and moderation properties are assumed to be the same throughout the volume of the container. Like non-uniform source distributions, non-uniform matrices can result in an underestimation or overestimation of the ^{239}Pu or ^{240}Pu effective mass.

- *Source self-shielding*. If the fissile material is concentrated in a small volume (i.e., a lump) the inner material is shielded from interrogating neutron flux during an active measurement. This effect, referred to as self-shielding, can result in an underestimation of the ^{239}Pu effective mass. This problem is not significant in passive mode, where the mean free path of the fast neutrons is much larger than the size of the fissile mass.

- *Interfering nuclides*. Any fissile or spontaneously fissioning nuclides, such as ^{244}Cm, not accounted for in the determination of the isotopic ratios will result in an incorrect estimation of the individual radionuclide activities and any derived quantities.

Containers are often rotated during the measurement to reduce the effect of source and matrix heterogeneity on the measurement. Some neutron counters incorporate imaging algorithms to measure the spatial variations in the source distribution and the matrix properties.

II.B.3.2 Photon Measuring Systems

Gamma-ray systems are affected by many of the source and matrix effects that affect neutron counters, including source heterogeneity, matrix heterogeneity, and source self-shielding.

- *Source heterogeneity*. Like neutron counters, most gamma-ray systems are calibrated for uniformly distributed sources, and nonuniform source distributions are likely to result in underestimation or overestimation of radionuclide activities.

- *Matrix heterogeneity*. Gamma-ray system calibrations generally assume that gamma attenuation properties are uniform throughout the volume of the container. Spatial variations in these properties, namely the density and effective atomic number, can cause the radionuclide activities to be incorrectly estimated.

- *Source self-absorption*. Concentrated masses, or lumps, of high Z materials, such as uranium and plutonium, can result in underestimation of the radionuclide activity. Unlike the self-shielding effect in active neutron measurements, the difficulty in gamma spectrometry arises when gamma rays from the interior of the mass are absorbed before escaping the lump.

- *Interfering radionuclides*. Some radionuclides emit gamma rays very close in energy to those being measured. If not properly accounted for, these interfering radionuclides can result in the incorrect determination of radionuclide activities and/or isotopic ratios.

Like neutron counters, effects due to source and matrix heterogeneity can be significantly reduced by rotating the container during the measurement. Additionally, segmented gamma scanners, using transmission sources, can account for spatial variations in the source activity and matrix attenuation properties as a function of height. A number of systems also use computed tomography (CT) to measure the matrix properties and source distribution in three dimensions.

II.B.4 Scope of EPA Approvals for Nondestructive Assay

EPA approves NDA methods for a waste stream or group of waste streams based on the demonstrated capability of the NDA system to quantify the radiological properties of the waste stream (s). This approach has been used because of the 194.8(b) language specifying waste stream examinations, and also because DOE generator sites most often test and qualify their NDA instruments to a given set of waste as defined by waste streams. This approach, however, has led to some problems during waste certification inspections because waste streams are generally defined by physical properties rather than by radiological properties. While there is some correlation between the effectiveness of a given NDA method and the physical properties of the waste material (e.g., a highly absorbing or moderating matrix like organic sludge), in practice this approval system has frequently resulted in limited approvals relative to the total population of waste intended for approval. A few sites, such as INEEL and LANL, currently attempt to define their assay programs as a process applicable to broad ranges of wastes that are defined by their radiological and nuclear properties of interest to the assay method (e.g., moderator/absorber index for neutron systems), rather than strictly by waste stream or Summary Waste Category Group. Other generator sites, such as Savannah River, have programs that are designed around the waste stream intended for shipment.

A radioassay system should be capable of characterizing waste containers, provided the important matrix properties of the containers are within the bounds for which the system is calibrated. For neutron systems, the absorption and moderating properties of the matrix are of primary interest. Density and atomic number of the waste are of primary interest for gamma spectrometry systems. Since NDA systems, particularly neutron systems, often use different parameters to characterize the matrix properties, it is difficult to establish standard limits for matrix characteristics or to compare calibration limits from one instrument to another.

II.C Visual Examination and Radiography

Radiography (e.g., RTR) is a nondestructive, qualitative and quantitative technique that involves x-ray scanning of waste container contents. It is used to identify and quantify waste material parameters important to PA, such as cellulosic, plastic, and rubber content. Radiography also is used to identify items such as liquids, pyrophorics, explosives, compressed gas cylinders, and sealed containers larger than 4 liters, which are prohibited from disposal by DOE. Unlike nondestructive assay, no radiological analysis is done with this technique. Radiography is considered to be both qualitative and quantitative because measurements are made by an operator who views a real-time x-ray scan of the contents of a waste container (e.g., drum or standard waste box) to estimate values for parameters of interest. For example, the operator (based on experience, on-the-job-training, and drum aids) estimates the container fill percentage (i.e., the percentage of the drum filled with waste), the volume of "combustible" materials, metals, etc.

Visual Examination (VE) involves opening of waste containers in glove boxes or other controlled structures and manually cataloging the contents. VE is currently used as either a confirmation of Nondestructive Examination (NDE) - which to date has been RTR - or as a replacement for NDE. Visual verification (which differs from VE in that the visual verification process is used during repackaging and no videotape records are kept) is also used. Sites are required to conduct VE on newly generated waste, on a statistically selected population of waste containers examined through radiography, and on waste containers that the site was unable to characterize using either radiography and/or NDA due to the presence of an interfering material, such as lead shielding. The results of the VE of the statistically selected population of waste containers is used by the site to verify waste container determinations (and measurements) made through radiography. The site is required to calculate miscertification rates on an annual basis and, based on these calculations (and estimates of the number of waste containers to be radiographed in the coming year), determine the required number of waste containers to undergo VE in the following year.

II.C.1 Overview of Technical Elements

EPA typically views actual radiography and VE activities during inspections, as well as supporting documentation and procedures. At a minimum, radiography and VE should provide the following:

- Identification of cellulosics, plastics, and rubber, including quantities;
- Identification of prohibited items, including liquids; and
- Confirmation of Summary Waste Category Group and Waste Matrix Code.

Under the CH-TRU program, every retrievably stored container must be examined to determine the cellulosics, plastics, rubber (CPR), and prohibited item content using RTR. Alternatively, containers can be examined either visually or by a different NDE technology, such as CT or digital radiography (DR), if RTR is not possible. Newly generated wastes do not have to be examined using RTR because the packaging process would exclude the inclusion of prohibited items.

II.C.1.1 RTR Document Review

EPA examines site specific documents and information related to any of the following areas during inspections:

- *Replicate Scans*. The sites must document that the imaging system characteristics of the monitoring system are verified on a routine basis and that independent replicate scans and replicate observations of the audio/video output of the RTR process are performed under uniform conditions and procedures.

- *Independent Observations*. The sites must document that independent observations of RTR scans are performed during each work shift.

- *System Capabilities*. The site must document that its RTR system is appropriate and is capable of characterizing the typical waste configurations and parameters observed at the site.

- *Procedures*. The site must have procedures for ensuring that the RTR system is tested, inspected, and maintained in accordance with manufacturer instructions. In addition, EPA expects the site's procedures to address the following:

    - The RTR system is calibrated through observation of a test pattern at the beginning and end of each work shift (when operating). The RTR system must be able to be adjusted to obtain optimum contrast and resolution using a line-pair gauge or equivalent device.

    - Data management is sufficient to ensure that the RTR results for every waste container are documented, validated, and ultimately verified by VE of a randomly selected statistical population of waste containers.

    - The RTR examination is captured on both audio/video and documents the following types of information necessary for WIPP WAC certification:

        - Item description code (IDC),
        - TRUCON code (Transuranic Package Transporter-II Content Code),
        - Presence or absence of free liquids,
        - Content inventory, and
        - Description of contents packaging materials.

    - The following types of information resulting from the RTR examination must be recorded:

        - Waste container identification number;
        - Date of radiography examination;
        - TRUCON code, IDC, and Waste Matrix Code, as applicable;

-- Any changes made to Waste Matrix Code;
-- Presence or absence of waste container liner;
-- Estimated inventory of waste container contents;
-- Description of contents packaging materials, including the number of layers of packaging;
-- Audio/videotape identification number;
-- Estimate of each applicable waste material parameter weight;
-- Identification of quality control (QC) replicate; and
-- An operator/reviewer signature and date block.

- Explicit guidance is included to account for materials that interfere with the RTR examination (e.g., lead liners, leaded gloves, stabilized wastes or cement, etc.).

- Prohibited items must be identified and procedures followed to ensure that the proper steps are taken to isolate the particular waste container.

- Appropriate measures can be taken when conditions adverse to quality occur.

C *Reporting*. EPA examines the data reports prepared by the site. Each data report batch may not include more than 20 waste containers. The data reports must contain the following types of records:

- RTR data forms,
- RTR reports,
- RTR videotape, and
- Identification of any nonconformance reports (NCRs) and variances pertinent to the data package.

C *Data Quality Characteristics*. The site should have a procedure for correctly calculating and reporting the relative percent difference between the estimated waste material parameter weights (as determined by the RTR operator) and these same parameters as determined visually (i.e., precision). The site must also have a procedure for documenting the accuracy with which the matrix parameter category can be determined through VE of a randomly selected statistical subpopulation of waste containers. The site must prepare and validate RTR data forms and audio/videotape for 100 percent of the waste containers examined (i.e., completeness). The site must also document the comparability of the matrix parameter category determined by RTR with the matrix parameter category determined by VE (i.e., comparability).

II.C.1.2 Additional Verification (RTR)

During the course of the on-site inspection of the radiography system and site operating procedures, the EPA inspection team both observes the radiography operation and interviews radiography operators and other DOE/contractor personnel to assess how well the radiography process is being implemented. As part of the EPA inspection team's observation of the radiography operation, the inspection team both views videotaped recordings of previously radiographed waste containers and observes the actual operation of the radiography equipment. The EPA inspection team notes the presence of required equipment, adherence to procedures, and documentation of all activities.

For example, the EPA inspection team inspects the radiography booth and asks the radiography operators to point out all of the required radiographic equipment, as described originally in the TRU QAPP (Section 10) and Methods Manual (CCA Reference No. 210), and subsequently in the WAP:

- A shielded room that is properly ventilated and lighted,
- An x-ray producing device,
- Controls which allow the operator to vary voltage, typically between 150-400 kV,
- An imaging system that typically includes a fluorescent screen and a low light television camera,
- An enclosure for radiation protection,
- A waste container handling system (including a turntable dolly assembly),
- An audio/video recording system,
- Safety interlocks, and
- An operator control and data acquisition station.

As part of the inspection activities, the radiography operator is required to demonstrate the operation of the radiography equipment, including estimation of waste materials' parameters and volumes, and data entry.

The EPA inspection team also interviews the radiography operators and DOE staff/contractors involved in certifying and tracking operator training to ensure that a formal operator's training program exists and is completely implemented. The EPA inspection team requires the training staff and radiography operators to demonstrate through actual radiography equipment operation and training file documentation that operator training includes the following, at a minimum:

- Formal training

    - Project requirements,
    - State and federal regulations,
    - Basic principles of radiography,
    - Radiographic image quality, and
    - Radiographic scanning techniques.

- Application techniques

- Radiography of waste forms,
- Standards, codes, and procedures for radiography, and
- Site-specific instruction.

C On-the-job training

  - System operation,
  - Identification of packaging configurations,
  - Identification of WMPs,
  - Weight and volume estimation, and
  - Identification of prohibited items.

The EPA inspection team observes the operator's examination of a radiography test drum (either in real time or by reviewing videotape) and expects to see the operator satisfactorily identify its content. The EPA inspection team reviews the contents of the radiography test drum to ensure that the following required elements are present:

C Aerosol can with puncture,
C Horsetail bag,
C Pair of coveralls,
C Empty bottle,
C Irregular shaped pieces of wood,
C Empty one gallon paint can,
C Full container,
C Aerosol can with fluid,
C One gallon bottle with three tablespoons of fluid,
C One gallon bottle with one cup of fluid (upside down),
C Leaded glove or leaded apron, and
C Wrench.

Training drums must contain all of the required test elements. The EPA inspection team requests the radiography operator to discuss how the site has determined that the test drum contained test elements that were typical of what might be encountered at the site (both content and packaging density).

EPA expects there to be a process for ensuring that the RTR operators receive standardized training and certification, recertification, retraining, and on-the-job training with oversight from appropriately qualified RTR operators. RTR operators must have sufficient experience to operate the RTR system. EPA expects RTR operators to be instructed in the specific waste generating practices and typical packaging configurations expected for each matrix parameter category or IDC.

EPA inspectors examine the procedures for ensuring that this training occurs, as well as operator training/experience records to ensure that the personnel operating the RTR system are qualified and appropriately trained. Inspectors also interview the RTR operators and observes their operation of the RTR system.

EPA expects the generator sites to provide procedures regarding the operation of the RTR system, and RTR/VE records (see below) that document that the required technical elements are adequately addressed by these procedures. EPA may require the generator site to provide RTR data packages and RTR/VE comparison sheets, including calculations of miscertification rates and other information pertinent to making the determination that the generator site has a system of controls in place that adequately meets the requirements of §194.24(c)(4).

II.C.1.3 VE Document Review

EPA examines VE documents and information related to any of the following areas during inspections:

- *Documentation*. The VE procedure ensures that the inventory of unopened contents includes a description and documented weight of all waste items, residual materials, poly liners, contents packaging materials, and waste material parameters.

- *Reference Tables*. The site's VE procedure has reference tables, updated as necessary, to facilitate the development of weight estimates and assignment of wastes to waste material parameters, also updated as necessary during the process. The site must establish standard nomenclature and volumetric conversion factors.

- *VE Data*. VE staff record a description of the location, container, and estimated volume of any detected liquid. All empty containers must be weighed and recorded, with the gross weight of each container recorded on the VE data form. The site must also record the total number of bags or packages found in each waste container. Replicate weight measurements must also be made.

- *Miscertification Rate*. The site must have a procedure to select a random statistical sample of waste containers for VE and correctly calculate and report an annual mis-certification rate. The site may use INEEL's historical miscertification rate of 2 percent to calculate the number of waste containers that must be visually examined during the first year of program activities. However, the site must also have a procedure for establishing a site-specific miscertification rate that is based on the last 12 (or more) months of certification activities.

- *Radiography Check*. EPA expects that site procedures require the use of data from VE to check the matrix parameter category and waste material parameter weight estimates as determined by radiography.

C *Replacement Containers*. The facility must have a procedure for selecting replacement waste containers. The site's replacement strategy should be restricted to a waste stream or waste stream lot that, through the random selection process, happened to have container(s) identified for VE. The procedure must ensure that VE is performed on the replacement container. Once containers have been visually examined, the upper 90 percent confidence limit (UCL_{90}) for the proportion miscertified must be correctly calculated. EPA expects the site to use the hypergeometric distribution for the UCL_{90} calculation.

C *Data Management*. The site must have a procedure for data management that is sufficient to ensure that the VE results for every waste container examined are documented and validated.

C *Documentation*. VE examination must be captured on both audio and video to document IDC, TRUCON code, the presence or absence of free liquids and other prohibited items, content inventory, and a description of contents packaging materials.

C *Data Reports*. The site must ensure that data reports are prepared on a per-batch basis, which includes no more than 20 waste containers, and the data reports must contain VE data forms, VE reports, VE videotape(s), and identification of any NCRs and variances pertinent to the data package. The site's data reporting procedures should ensure that the following types of information resulting from the VE are recorded:

- Waste container identification number,
- Date of VE,
- TRUCON code, IDC, and Waste Matrix Code, as applicable,
- Any changes made to the Waste Matrix Code,
- Presence or absence of waste container liner,
- Estimated inventory of waste container contents,
- Description of contents packaging materials, including the number of layers of packaging,
- Audio/videotape identification number,
- Estimate of each applicable waste material parameter weight,
- Identification of QC replicate, and
- Operator/reviewer signature and date blocks.

C *Interfering Items*. The site's VE procedure should provide explicit guidance on how to handle materials that interfere with the examination, such as metal containers, discolored plastic bags, stabilized wastes or cement, etc. Also, the site's VE procedure must require that prohibited items be identified and that the proper steps be taken to isolate a waste container with prohibited items.

C *Discrepancy Resolution*. EPA expects the site to have a procedure for resolving discrepancies between VE QC checks and between RTR and VE observations, and to ensure that appropriate measures can be taken when conditions adverse to quality occur.

II.C.1.4 Additional Verification-VE

During the course of the on-site inspection of VE activities and site operating procedures, the inspection team observes VE activities and interviews VE experts and other personnel to assess how well the VE process is being implemented. As part of the inspection team's observation of the VE, the inspection team views videotaped recordings of previously examined waste containers and observes the actual VE of waste containers (when possible). Inspectors note the presence of required equipment, adherence to procedures, and documentation of all activities.

For example, the EPA inspection team inspects the VE glove box (or room) and ask the VE experts to point out all of the required equipment, as described in DOE's Method Manual (CCA Reference No.210), as listed in the following bullets:

- Check weights (certified to National Institute of Standards and Technologies standards),
- Scales,
- Torque wrenches,
- Airflow meters,
- Platform scale,
- Empty 55-gallon drums,
- Remote drum handler,
- Knifes, scissors, platform ladder, dolly/drum mover, leather gloves, plastic bags, tape, towels, decontamination solution, secondary containment bags, permanent markers, rubber and/or surgical gloves,
- Video camera,
- Audio recording system, and
- Glove box or negative pressure containment area.

The EPA inspection team also interviews the VE experts and other personnel involved in certifying and tracking operator training to ensure that a formal operator's training program exists and is complete. There must be a standardized training program for visual inspection examiners that includes both formal classroom and on-the-job training (OJT). The program must be specific to the generator site and includes the various waste configurations generated/stored at the site. The EPA inspection team interviews the VE experts to determine whether (and the extent to which) they have received training on the specific waste generating processes, typical packaging configurations, and waste material parameters expected to be found in each matrix parameter category at the site. EPA expects the VE training program to include:

- Formal training
    - Project requirements,

- State and federal regulations,
- Application techniques, and
- Site-specific instruction.

• On-the-job training

  - Identification of packaging configurations,
  - Identification of waste material parameters,
  - Weight and volume estimation, and
  - Identification of prohibited items.

EPA expects sites to provide procedures regarding the performance of VE. EPA also expects generator sites to provide VE data packages and RTR/VE comparison sheets, including calculations of miscertification rates and other information pertinent to making the determination that the generator site has a system of controls in place that adequately meets the requirements of 194.24(c)(4).

II.C.2 Technical Description of System or Measurement Device(s)

II.C.2.1 Radiography

Radiographic systems include not only real-time systems, but new systems that are currently being brought on-line at DOE sites. These new systems may offer advantages over RTR with respect to system resolution, etc.

Real-Time Radiography

Sites are currently conducting NDE examination of all waste containers using standard radiography techniques (i.e., an x-ray tube, an image intensifier, and a charge coupled device camera). As part of the RTR process, the RTR operator (or drum handler) loads up to three waste containers onto a rolling sled that is then moved into the RTR vault. The drum(s) is placed on a turntable that the operator uses to rotate the drum and the x-ray system components automatically move up and down to smoothly transition through the entire height of the drum (with every revolution the height of the x-ray system components change to allow for an automated, complete scan of the entire container from top to bottom). Some sites do not employ a turn table that automatically moves up and down, but rely instead, on the operator to manually adjust the height of the drum manually to obtain a scan of 100 percent of the drum's height.

The x-ray-producing device has controls that allow the operator to vary the voltage, thereby controlling image quality. It is typically possible to vary the voltage, between 150 to 430 kilovolts (KV), to provide an optimum degree of penetration through the waste. For example, high-density material should be examined with the x-ray device set on the maximum voltage to ensure maximum penetration through the waste container. Low-density material should be examined at lower voltage settings to improve contrast and image definition.

The imaging system typically uses a fluorescent screen and a low-light television camera. To perform radiography, the waste container is scanned while the operator views the television screen.

The RTR operator controls the entire process from a remote operator's booth and the entire exam is recorded on audio/video tape (some sites use optical disks). The operator then records the data using data sheets; however, several sites use automated data entry systems. For example, INEEL RTR operators use an automated data entry system, which has a series of screens designed to capture the required information. The RTR examination results are used by the site to verify that the physical waste form matches the waste stream description, to document the waste matrix code group, to estimate waste material parameters and drum utilization, to confirm AK, and to identify prohibited items. Sites also compare the radiography RTR examination results with those obtained through VE to calculate miscertification rates on an annual basis and, based on these calculations (and the expected number of waste drums to be processed next year) determine the required number of waste containers to undergo VE in the following year.

II.C.2.2 Visual Examination

Sites are currently conducting VE on a statistically selected subpopulation of waste containers examined through radiography, and any waste container that the site was unable to characterize through radiography due to the presence of an interfering material, such as lead shielding. As part of the VE process, the VE team typically opens each waste container in a specially designed glove box that is approximately 15 feet long and operated under a negative-pressure environment. At some sites, core sampling is also conducted in this glove box. Although the VE process is relatively straightforward, it is a physically demanding and intensive operation and typically consists of the VE technicians performing the following steps:

- Load the waste drum at the back end of the glove box,
- Remove the drum lid and empty the drum's contents in the middle portion of the glove box,
- Open every individual waste package or bag, and
- Manually sort and categorize waste materials for subsequent weighing and repackaging at the front end of the glove box.

The entire process is conducted under the supervision of the VE expert (VEE) and is recorded on both audio/video tape and waste container inventory sheets. The VE results are used by the site to verify waste form, confirm and/or identify prohibited items, and verify drum utilization and waste material parameter estimates made through radiography. The VEE also assesses the need to open individual bags or packages of waste. If individual bags/packages are not opened, estimated weights are recorded. Estimated weights are established through the use of historically derived waste weight tables and an estimation of the waste volumes. It may not be possible to see through inner bags because of discoloration, dust, or because inner containers are sealed. In these instances, documented AK can be used to identify the matrix parameter category and estimated waste material parameter weights. If AK is insufficient for individual bags/packages, actual weights of waste items, residual materials, contents packaging materials, or waste material parameters are recorded. The sites also compare the VE data to that obtained through radiography to calculate miscertification rates on an annual basis and, based on these calculations (and the expected number of waste drums to be processed next year), determine the required number of waste containers to undergo VE in the following year.

II.C.3 Effect of Waste Matrix or Waste Type on Measurement

As discussed previously, the RTR operator can vary the voltage to provide an optimum degree of penetration through the waste. For example, high-density material needs to be examined with the x-ray device set on the maximum voltage to ensure maximum penetration through the waste container. In comparison, low-density materials need to be examined at lower voltage settings to improve contrast and image definition. For example, containers with lead liners or containers filled with sludges or stabilized (or cemented) wastes cannot be readily penetrated by the x-ray energy. Thus, containers with lead liners, or other containers whose contents prevent full examination, are either repackaged or examined using VE.

Radiography systems also can have difficulty detecting cellulosics in lead-lined drums because a higher energy x-ray must be used to scan through the lead lining. The higher energy x-ray scans past the cellulosics as well. Similarly, sites may be unable to differentiate between cellulosics and plastics, as low density materials can appear very similar. Densely packed drums with highly heterogeneous waste materials can be difficult to characterize, as can bottles and cans that are completely filled with liquid (there is no observable meniscus during container motion).

VE is a physically demanding task and densely packed drums can take a long time to be completely examined; however, as long as sufficient time and working space are available there should be no reduction in data quality. Likewise, waste containers packed with fine particles (e.g., soda ash, graphite, or incinerator residue) can present a housekeeping problem, but also can be examined as long as sufficient time and working space are available.

Inner containers that are opaque or are packed with sharp metal objects are challenging and must be handled with care. Opaque containers are generally opened, unless the VEE is able to determine what the contents of the container are based on AK. The handling of waste packages containing sharp metallic objects is minimized and often times set aside for repackaging so as not to present undue risks to the VE personnel.

II.C.4 Scope of EPA Approvals for Radiography and Visual Examination

All types of CH TRU wastes may be examined using RTR, except for those that are packed in lead-lined containers or have been stabilized. Also, all types of CH TRU wastes may be examined using VE, except for those that have been stabilized.

EPA's approvals with respect to RTR and VE have been limited to date by the scope of the approval sought by the sites. Reinspection would be required with the introduction of new systems (e.g., DR/CT, VE technique), or specific wastes (e.g. RH TRU waste, lead-lined drums).

II.D WIPP Waste Information System and Data Validation

To ensure that the sites ship only waste that conforms with the waste component requirements established by DOE, a system of controls must be implemented that includes tracking of information about waste destined for the WIPP. For this purpose, DOE uses a computerized waste tracking system, the WIPP Waste Information System (WWIS). The WWIS is a data transfer system whereby waste characterization and other information is input electronically at generator sites and is transferred to WIPP prior to waste shipment. Additionally, EPA examines the data validation and verification processes for checking data ultimately input into the WWIS.

II.D.1 Overview of Technical Elements

When EPA conducts inspections to verify compliance with §194.24(c)(4), EPA reviews the WWIS for the following items:

- The total quantity of waste (volumetrically);
- The quantity of the important non-radionuclide waste components for which DOE has identified limits;
- Radionuclide activity for the ten WIPP radionuclides;
- Radionuclide activity uncertainty;
- Radionuclide mass;
- Radionuclide mass uncertainty;
- TRU alpha activity;
- TRU alpha activity uncertainty;
- Verification data;
- Verification method;

C Visual examination of container;

C WAC certification data;

C Waste Matrix Code (WMC); and

C General location of the waste in WIPP.

II.D.1.1 Data Validation/Verification and WWIS Inspection Components

EPA inspects the following components of the systems of control for tracking WIPP waste parameters:

- *Documentation*. The inspection team first reviews site documentation including, but not limited to, Standard Operating Procedures (SOPs), Detailed Technical Procedures (DTPs), and QAPjPs. These are reviewed to ensure that technical elements are adequately addressed, that the applicable WAC and WAP technical elements and requirements are adequately addressed in site procedures or other documents, and that the technical results of procedure implementation are adequate.

- *Data Collection and Entry*. EPA examines the overall data collection and date entry process for consistent implementation to ensure data integrity and accuracy. Procedures are also examined to ensure that they are acceptable and allow for submitting data to WIPP via the WWIS system.

- *Data Validation*. EPA ensures that procedures exist and are technically adequate for reviewing/validating waste characterization data prior to submittal to WIPP via WWIS.

- *Data Requirements*. The Agency also determines whether data are collected and formatted consistently with requirements of WWIS, including:

    - Container number
    - Site identifier
    - Waste stream profile number
    - Matrix code
    - TRUCON code
    - Decay heat
    - Decay heat uncertainty
    - Packaging number
    - Assembly identifier
    - Handling code
    - Waste type code
    - Radionuclide name
    - TRU alpha activity
    - TRU alpha activity uncertainty
    - TRU alpha activity concentration
    - TRU alpha activity concentration uncertainty
    - ^{239}Pu equivalent activity
    - ^{239}Pu fissile gram equivalent
    - ^{239}Pu fissile gram equivalent uncertainty
    - Packaging layers

- Radionuclide activity
- Radionuclide activity uncertainty
- Radionuclide mass
- Radionuclide mass uncertainty
- Waste material parameter weight
- Radioassay method
- Assay date
- Characterization method
- Characterization method date
- Alpha surface contamination
- Dose rate
- Sample identifier
- Sample type
- Sample date
- Analyte
- Analyte concentration
- Analyte detection method
- Shipment number

• *Data Security*. Procedures should be in place to ensure that data in the system are secure.

• *WWIS Verification*. Procedures should be in place to verify data submitted to the WIPP via the WWIS system.

The sites must provide any container-specific tracking reports (e.g., WWIS Waste Container Data Reports), data validation forms, and other information as needed to determine that the site has a system of controls in place that adequately meets the requirements of §194.24(c)(4).

II.D.1.2 Demonstration of WWIS Implementation

EPA inspection team observes a demonstration of data entry and submittal to the WIPP site via the WWIS system and interviews system operators and data tracking/validation officials to assess the extent to which the specified processes are being implemented. The inspection team observes adherence to procedures, proper documentation of required data (e.g., validation at the project level, verification of data received from the WWIP site after submittal of characterization data), and results of system operation.

No specific analytical equipment is required for this process other than the WWIS itself and any other site-specific data entry systems used to convey site information to the WWIS, including any computerized systems for implementing data validation procedures. EPA expects the sites to provide a demonstration of their data systems, the ability to transmit and receive data from the WWIS system, and the ability to verify that accurate data have been input into the WWIS system. EPA inspectors examine the data system used to collect waste characterization data to ensure that all appropriate data fields required for entry into the WWIS are accounted for and that the data are transferrable to WWIS either manually or electronically. Further, EPA evaluates the quality of the input data, by reviewing data packages at the point of project level data validation (the point at which data are input into the WWIS for submittal to WIPP). EPA expects a demonstration of the site's ability to ensure connectivity with the WWIS and that data can be transmitted via the WWIS to WIPP and received from WIPP as entered into the site's individual data system.

II.D.1.3 Personnel Qualifications

EPA checks that personnel conducting validation/review and verification and entry of waste characterization data into the WWIS data system are qualified to enter data and verify accuracy of waste characterization data for wastes destined for disposal at WIPP. Specifically, EPA examines procedures for ensuring that training occurs and operator training/experience records for:

- Initial WWIS orientation

- Using the *WIPP Waste Information System User's Manual for Use by Shippers/Generators* (DOE/CAO-97-2273)

- Site-specific procedures for manual or electronic data entry into WWIS.

II.D.2 Technical Description of Measurement Device

As previously described, the WWIS is an electronic database that contains information related to the characterization, certification, shipment, and emplacement of TRU waste at the WIPP. The data are required to ensure that waste destined for WIPP meets applicable regulatory conditions, including radionuclide data on CH and RH TRU waste, cumulative activity of RH waste, and amount of important waste material parameters (e.g., cellulosics). Individual generator sites are responsible for inputting waste data into the WWIS system externally. Generator sites have developed their own unique systems for collecting the information needed to be transmitted to WWIS, including worksheets, electronic spreadsheets, and fully integrated electronic data systems. Regardless of the mechanism for collecting data, each generator site is responsible for verifying and validating all required data prior to submittal to WIPP via the WWIS system.

In the CCA, DOE stated that the WWIS tracks waste components and associated uncertainties against their upper and lower limits and provides notification before the waste component limits are exceeded, in accordance with 40 CFR Part 194.24(e)(1) and (2). Each site has determined its own approach for submitting TRU waste characterization data to WIPP for shipments for disposal. In some cases, sites have developed separate databases to track data generation, validation, and/or data submittal to WIPP. At other sites, the data input system is manual, which may result in a higher degree of uncertainty in data quality. However, issues with respect to data quality may also arise at sites using electronic data collection, verification, and transmittal. For example, EPA observed during an inspection at INEEL that personnel had the ability to change data without receiving proper approval for such changes.

II.D.3 Effect of Waste Matrix or Waste Type on Measurement

The WWIS and data validation programs at sites are not impacted by waste type, with the exception of RH-TRU waste. EPA determined in its initial certification that DOE did not provide any waste characterization methods for RH-TRU waste, nor was there discussion specific to how DOE will quantify the RH-TRU waste. All of the waste characterization discussions in Chapter 4 of the CCA concern CH-TRU waste, except for Chapter 4, Table 4-13 (p. 4-49), which is entitled "Applicable CH- and RH-TRU Waste Component Characterization Methods." Furthermore, DOE provided no discussion regarding the applicability of CH-TRU waste characterization methods to RH-TRU waste. Therefore, the effectiveness of existing WWIS procedures and methods has yet to be demonstrated for RH-TRU waste streams.

II.D.4 Scope of EPA Approvals for Data Validation/Verification and the WWIS

The range of waste types that EPA may approve at any given time is not affected by the WWIS or the data validation processes, with the exception of RH-TRU waste as described in section D.3. To date, approvals have not specifically been limited by waste type, although they may be limited due to other factors (e.g.NDA).

III. SUMMARY OF RESULTS AND LESSONS LEARNED

III.A Summary of Results

Implementation of the inspection process described in Sections I and II has resulted in a program whereby EPA is compelled to provide authorizations that either mirror that sought by the site (i.e., for given waste streams or Summary Waste Category Groups), or is less than that sought by a site due to system limitations. Consequently, EPA is required to revisit sites multiple times as new systems, wastes, or other elements arise. Table 2 presents inspections performed by EPA to date under the authority of § 194.8(b) and the scope of the resulting approvals. As shown in this Table, EPA has inspected 7 sites, ranging from one to 9 times each. The broadest approval given by EPA has been for specific Summary Waste Category Groups of Retrievably Stored Waste (i.e., debris waste at RFETS), while the most limited approval was for a single waste stream at the SRS, although this limited approval was all that SRS sought at the time of the inspection. DOE sites that have been authorized by EPA to ship waste to the WIPP have adequate waste characterization programs overall. In some instances, EPA was unable to complete an inspection because of the site's limited implementation of activities within the scope of the inspection.

Table 2
§ 194.8(b) Inspections Performed by EPA as of January, 2002

Generator Site	Date of Inspection	Type of Inspection	Inspection Scope	Elements Examined	Scope of EPA Approval
Rocky Flats (RFETS) EPA- RFETS-6.98-8	June 22-25, 1998	194.8	Contact-handled debris waste	NDA, AK, RTR, VE, WWIS/DV	Characterization program was approved, with NDA approval limited to the use of IQ-3 SGS and WM3100 PNC
RFETS EPA- RFETS-4.99-8	April 27-28, 1999	194.8	Leco crucibles and pyrochemical salt	NDA, AK, VE	Characterization program was approved and broadened to include Leco Crucibles and pyrochemical salt, with NDA approval expanded to include the use of calorimetry (CAL/GAMMA)
RFETS EPA RFETS-11.99-8	November 16-18, 1999	194.8	Wet residue, dry residue, pyrochemical salts, incinerator ash (including Leco crucibles and magnesium oxide inserts)	NDA/gravimetric techniques, AK, WWIS/DV	Characterization program was approved and broadened to include wet/dry residue, pyrochemical salts, and incinerator ash, with NDA approval expanded to include SGS Can Counters, SGS Drum Counters, and the TGS
RFETS EPA-RFETS-9.00-8	September 18-21, 2000	194.8	Residues	NDA	Characterization program was approved, with NDA approval expanded to include NMC, two new TGS CAN Scanners, and a skid-mounted Tomographic Gamma Can/Drum Scanner
RFETS EPA-RFETS-1.01-8	January 29-February 2, 2001	194.8	Contact Handled Retrievably Stored Debris/Solids	NDA	Inspection postponed by DOE
RFETS EPA-RFETS-5.01-8	May 14-17, 2001	194.8	Debris waste	NDA, WWIS/DV, VE, RTR	Limited approval of SuperHENC, Building 569 PADC, Building 569 Tomographic Gamma Scanner.

Generator Site	Date of Inspection	Type of Inspection	Inspection Scope	Elements Examined	Scope of EPA Approval
INEEL EPA-INEEL-7.98-8	July 28-30, 1998	194.8	Contact-handled retrievably stored debris waste generated at Rocky Flats	AK, NDA, VE, RTR, WWIS/DV	Limited characterization program was approved for only inorganic solids and graphite debris waste, with NDA limited to Canberra IQ2 and SWEPP PAN
INEEL EPA-INEEL-5.99-8	May 17-21, 1999	Originally planned to be 194.8, revised to 194.24	Scheduled to examine solids, debris, soils, gravels.	AK, NDA, RTR, WWIS/DV	Elements of system examined were inconclusive with regard to wastes examined; EPA instead verified that previously approved system was being adequately maintained
INEEL EPA-INEEL-4.00-8	April 24-28, 2000	194.8	Contact-handled retrievably stored debris waste generated at Rocky Flats	NDA, WWIS/DV, VE, RTR	Characterization program was approved and broadened to include all CH retrievably stored debris waste generated at Rocky Flats. NDA approval broadened to include SWEPP SGRS and PAN systems
INEEL EPA-INEEL-12.00-8	December 5-7, 2000 and one day follow-up on January 8, 2001	194.8	Contact-handled retrievably stored homogenous solids (S3000) waste generated at Rocky Flats	AK, NDA	Characterization program was approved and broadened to include homogenous solids; NDA approval expanded to include SWEPP SGRS and PAN systems re-examined for subject waste
INEEL EPA-INEEL-7.01-8	July 25-26, 2001	194.8	Contact-handled retrievably stored homogenous solids and debris waste generated at Rocky Flats	NDA	Characterization program was approved; NDA system approval broadened to include WAGS
INEEL EPA-INEEL-10.01-8	October 29-31, 2001	194.8	Organic sludge	NDA, AK	Inspection postponed by DOE
SRS EPA-SRS-11.00-8	November 6-17, 2000	194.8	Waste stream SR-T001-221F-HET (a contact-handled debris waste)	AK, NDA, VE, RTR, WWIS/DV	Characterization program approved for one waste stream; NDA approved use of PAN and SGS systems

Generator Site	Date of Inspection	Type of Inspection	Inspection Scope	Elements Examined	Scope of EPA Approval
SRS EPA-SRS-9.01-8	September 24-26, 2001	194.8	Retrievably stored, contact-handled debris waste generated at SRS and limited to waste streams SRW027-221F HET A-HET-E	AK, NDA, VE, RTR, WWIS/DV	Inspection postponed by DOE
SRS EPA-CCP-10.01-8	October 15-19, 2001	194.8	Retrievably stored, contact-handled debris waste generated at SRS and limited to waste streams SRW027-221F HET A-HET-E	AK, NDA, VE, RTR, WWIS/DV	All elements approved for CCP systems at SRS only (i.e., CCP VE, IPAN/GEA, RTR, WWIS).
SRS EPA-SRS-12.01-8	December 12-16, 2001	194.8	Retrievably stored, contact-handled debris waste generated at SRS and limited to waste streams SRW027-221F HET A-HET-E	AK, NDA	Report pending.
LANL EPA-LANL-6.99-8	June 14-18, 1999	194.8	Contact-handled, retrievably stored debris and solidified homogenous solid wastes (S5000 and S3000)	AK, NDA, VE, RTR, WWIS/DV	All elements approved, NDA systems approved were the TGS and HENC
NTS EPA-NTS-6.99-8	June 7-11, 1999	194.8	Contact-handled debris waste	AK, NDA, VE, RTR, WWIS/DV	Waste characterization program did not adequately characterize the proposed waste; approval denied.
Hanford EPA-HAN-1.00-8	January 24-28, 2000	194.8	Contact-handled debris waste	AK, NDA, VE, RTR, WWIS/DV	Characterization program was approved for contact-handled debris waste; NDA systems approved were two GEA systems and one IPAN system

Generator Site	Date of Inspection	Type of Inspection	Inspection Scope	Elements Examined	Scope of EPA Approval
Hanford EPA-HAN-12.01-8	December 17-21, 2001	194.8	Contact-handled debris and solid waste	NDA, VE	Approved to characterize CH-debris waste using the SGSAS NDA system and CH-solids using VE process during repackaging.
AK = Acceptable Knowledge; CAL/GAMMA = Calorimetry; CBFO = DOE Carlsbad Field Office; CCP = Centralized Characterization Project; DOE = U.S. Department of Energy; DR/CT = Digital Radiography/Computed Tomography; DV = Data Validation; GEA = Gamma Energy Assay; EPA = U.S. Environmental Protection Agency; HENC = High Efficiency Neutron Counter; HGPe = High Purity Germanium; INEEL = Idaho National Engineering and Environmental Laboratory; IPAN = Imaging Passive Active Counter ; LANL = Los Alamos National Laboratories; LLNL = Lawrence Livermore National Laboratory; NDA = Nondestructive Assay; NMC = Neutron Multiplicity Counter; NTS = Nevada Test Site; PADC = Passive Active Drum Counter; RFETS = Rocky Flats Environmental Technology Site; RTR = Real-Time Radiography; SGS = Segmented Gamma Scanner; SGSAS =Segmented Gamma Scan Assay System ; SRS = Savannah River Site; SWEPP SGRS = Stored Waste Examination Pilot Plant Gamma Ray Spectrometer ; SWEPP PAN = Stored Waste Examination Pilot Plant Passive Active Neutron Counter ; TGS CAN = Tomographic Gamma Scanner; TRU = Transuranic; VE = Visual Examination; WAGS = Waste Assay Gamma Spectrometer; WIPP = Waste Isolation Pilot Plan; WWIS = WIPP Waste Information System					

III.B Lessons Learned

As a result of our site inspection experience we have identified a number of general observations, or "lessons learned," related to waste characterization activities.

- Implementation of waste characterization is not consistent across sites. Because one generator site is capable of implementing an adequate program does not mean that other sites that use the same equipment are also implementing an adequate program. For example, while EPA has approved the use of Mobile Characterization System (MCS) NDA at RFETS (Inspection EPA-RFETS-6.98-8; Air Docket A-98-49, Item II-A4-4), EPA has not allowed the use of the same equipment at Nevada Test Site due to concerns regarding quality control, measurement performance, and documentation (Inspection EPA-6.99-8; Air Docket A-98-49, Item II-A4-9).

- Sites have not been able to characterize all of their wastes at the time of inspection, and approvals have been sought and given based on sites' own limitations. For example, Savannah River Site originally sought and was granted EPA approval for characterization of a single waste stream, and wrote procedures specific to that waste stream (Inspection EPA-SRS-11.00-8; Air Docket A-98-49, Item II-A4-16). EPA may extend approvals for all waste types in some areas, but in other instances the limitation is warranted. For example, use of the WWIS for data transmittal is not conditioned on waste type, but the method of nondestructive analysis may be. INEEL initially developed procedures and characterization activities focusing only on inorganic solids and graphite debris waste (Inspection EPA-INEEL-7.98-8, Air Docket A-98-49, Item II-A4-2). Consequently, a single, one-size-fits-all approval typically is not possible for all waste types and processes at a site.

- AK and NDA personnel sometimes do not communicate adequately, resulting in the use of AK data by NDA personnel that the AK personnel did not know existed. For example, Hanford Site NDA personnel used AK radioassay information to help determine isotopic distribution, but this information was not provided to the AK personnel, included in the AK record, or integrated into AK Summary documentation. The AK-NDA linkage is crucial when AK is used directly by NDA personnel, and EPA inspectors examine AK-NDA interface issues as part of the evaluation of the overall characterization program. Problems with the interface reflect a loss of control over use of important data by a site.

- EPA has performed some inspections for which only limited examples of procedural implementation were provided by the site. Only a few waste containers were fully characterized, and it was difficult to determine how the system would function once the process was fully operational.   For example, initial approval of the INEEL waste characterization system for solids/solidified waste was sought based on full characterization of only a single drum of waste (Inspection EPA-INEEL-12.00-8; Air Docket A-98-49, Item II-A4-15). In such instances, it is essential that rigorous application of controls be maintained after approval is given and production level characterization begins. In the case of INEEL, EPA found that this site inadvertently shipped waste characterized using an NDA system that was not yet approved by EPA, necessitating more inspections by EPA. (Inspection EPA-INEEL-7.01-8; Air Docket A-98-49, Item II-A4-17).

Once EPA has given the initial approval to a site's overall program, it is useful to perform "system check" inspections on a regular basis. The frequency of inspections may lessen as the site demonstrates institutional control over the characterization process. EPA should have flexibility in scheduling inspections, and this flexibility should be independent of DOE's own inspection process.

- Often EPA inspectors arrive at a site to find that the lower-tier procedures that they reviewed in advance have been revised by the site, in response to earlier CBFO inspections and surveillances or for other reasons. EPA has experienced this problem at every site. This situation interferes with the smooth progress of the inspection plan, because inspectors must take the time to compare the procedures and understand the changes before proceeding with the substance of the inspection.

- Consistent with 40 CFR 194.8(b), EPA's approach to site approvals has been to authorize characterization only for certain waste streams or groupings of waste streams (i.e., Summary Waste Category Groups). Consistent with its QA procedures, DOE's approach has been to certify sites' characterization programs overall and then authorize shipment only of waste streams presented by the site. This difference in approach to site approvals/certification has been confusing for DOE sites, particularly during EPA's early inspections in 1998 and 1999.

IV. SUMMARY OF PUBLIC COMMENTS ON EPA INSPECTIONS

This section presents several examples of the public comments that EPA has received on their inspection results. As of January 2002, we have published a total of twenty-one Federal Register notices related to those inspections. In response to the twenty-one notices, we have received nine sets of comments. Of the comments received, four were from the Environmental Evaluation Group (or EEG, New Mexico's independent scientific oversight organization for the WIPP) and focused specifically on documents in the docket [see Docket A-98-49, Category II-A3, Items 11, 21, 22, and 31]. EEG observers usually attend EPA inspections, and so have the opportunity to discuss their comments directly with DOE personnel during the inspection.

Other than comments from EEG, we received five sets of comments. Four of these sets were requests to extend the public comment period, which we did in one instance [see Docket A-98-49, Category II-A3, Items 3, 8, 27, and 30], and the remaining set contained specific comments on documents in the docket [see Docket A-98-49, Category II-A3, Item 29]. We respond to comments sent to the docket in our inspection reports, which are filed in Docket A-98-49, Category II-A4. Representative examples of comments are presented below.

EPA-INEEL-7.01-8 (July 25-26, 2001); Air Docket A-98-49, Item II-A4-17

EPA received two sets of comments in EPA Air Docket A-98-49 in response to our *Federal Register* notice of July 13, 2001. The comments are filed as (1) Item II-A3-27 and (2) II-A3-29. Examples of significant comments follows.

Issue A: Information provided in Docket A-98-49 was not sufficient to enable the public or EPA to reach conclusions about the compliance of the WAGS system. Therefore, EPA should extend the public comment period.

1. Based on the documents in the docket, it is impossible for EPA or the public to know how many drums were certified using the WAGS system because none of the documents in the docket describe what characterization and quality assurance (QA) procedures were used on the 1,917 drums with waste in the 69 shipments that INEEL made to WIPP between December 7, 2000 and June 27, 2001 (INEEL shipments KN001201 and 1202, IN010031 to 010097 -- WIPP Waste Information System data). [1]

2. The docket provides no basis for EPA, or the public, to conclude that the WAGS System actually operated in a manner equivalent to the SGRS system for any or all of the period that it was being used as part of the waste characterization process. [1]

3. Neither EPA, nor the public, can conclude that the drums shipped to WIPP were adequately characterized, so the question of what should now be done with those drums at WIPP cannot be answered based on documents currently available to the public. We believe that

EPA cannot make any decision about the status of those drums without adequate documentation being made available to the public. [1]

4. Based on the documents in the docket, we cannot conclude that the WAGS system meets the quality assurance requirements of 40 CFR 194.8(a). [1]

5. Based on the documents in the docket, we also cannot conclude that the WAGS system meets the waste characterization requirements of 40 CFR 194.8(b). [1]

6. The docket provides no documentation regarding how INEEL or EPA determined which drums were characterized using the WAGS system, how the WAGS system was used and how its use changed during the time period in question, as to the nature of the process knowledge documentation for those drums, or other relevant information. Thus, based on what is available in the docket, the public cannot adequately comment on the status of those drums, nor does EPA have adequate information to make its determinations. [1]

7. As specified in its Federal Register notice of July 13, 2001 (66 Fed. Reg. 36723), EPA is providing its normal 30-day public comment period on "waste characterization program documents." However, the current situation is not normal, it is the most complex yet faced by EPA involving a site's waste characterization program. In such an abnormal situation, a longer public comment period is necessary, and it is clearly allowed by 40 CFR 194.8. In addition, the fact that important documents are not yet available necessitates an extension of the public comment period to allow public comment on the appropriate documentation. [1]

Response to Issue A:

We decided not to extend the comment period. We believe that 30 days was sufficient time to allow the public to raise questions or concerns about the WAGS system, and that the information that we docketed was appropriate, for the reasons explained below.

When we open a comment period under 40 CFR 194.8, the primary purpose of the public comment period is to allow the public to provide potentially relevant information to EPA or to raise compliance concerns or questions, so that EPA is aware of those concerns and questions and can seek resolution to them prior to making a final compliance decision. Any specific processes or waste streams about which we are seeking public input are defined in the inspection notice that we provide in the *Federal Register*. As we explained in our May 1998 Certification Decision (see, for example, EPA Air Docket A-93-02, Item V-C-1, pp. 2-8 to 2-11 and 6-26), EPA's compliance decision under 194.8 must be based on our independent inspections of waste characterization processes. Inspections involve review of many different documents, interviews with staff, and on-site demonstrations, which are then summarized and made public in our inspection reports. It is neither possible nor appropriate to attempt to place all information that may be relevant to the scope of our inspection in our docket before we conduct an inspection.

We docketed key documents that we determined were pertinent to the proposed WAGS system. In light of the WAGS-related nonconformance that we identified in June 2001 (see Issue B below), and in anticipation of public concern, we included additional DOE documents that directly pertained to the nonconformance. It was not our expectation that the public would be able to reach conclusions about either the WAGS system's technical adequacy or the WAGS-related nonconformance based solely on the docketed materials. EPA makes the determination of compliance following a site inspection.

With regard to comment A.1, we obtained objective evidence during our July 2-3 inspection at INEEL that established the status of all drums characterized by the WAGS system and shipped to the WIPP site. This information is contained in our report for inspection no. EPA-INEEL-7.01-24 (Docket A-98-49, Item II-A1-28).

EPA-RFETS-4.99-8 (April 27-28, 1999); Air Docket A-98-49, Item II-A4-6

EPA received one set of comments from the EEG in response to the items announced in the *Federal Register* on March 25, 1999 (64 *FR* 14418). The letter from EEG, dated April 23, 1999, may be found in EPA Air Docket A-98-49, Item II-A3-11. Below are some examples of significant issues raised in EEG's letter and EPA's response to those issues. EPA inspectors discussed some of the issues with DOE Carlsbad Field Office (CAO) personnel (Sam Vega, Van Bynum, and Mark Doherty) and RFETS personnel (Gerald O'Leary and Mark Castagneri) during the inspection, in the presence of Ben Walker of EEG.

EEG Issue D: Sites such as RFETS must meet requirements for certain waste material parameters that have not been shown to affect the WIPP's performance. RFETS should consider the relative importance of waste material parameters.

1. The RFETS QAPjP follows the CAO's Transuranic Waste Characterization Quality Assurance Program Plan (TRU Waste QAPP, CAO-94-1010, Revision 0) in continuing to consider all of the TWBIR waste material parameters equally. . . [The RFETS QAPjP], and the overall RFETS TRU waste program, should develop training and awareness of the relative importance of obtaining defensible measurements for the two types of waste material parameters [i.e., cellulosics/plastics/rubbers and ferrous metals] that have been shown to be important to containment of waste in the repository.

EPA's Response to Issue D:

This comment suggests that, by treating "all of the TWBIR waste material parameters equally," RFETS (and DOE generally) may be compromising in some fashion the analysis of waste parameters that are central to compliance with EPA's disposal regulations. EPA did not find evidence during the inspection to support the claim that RFETS is not properly accounting for the important waste parameters. As for other parameters, EPA does not have a basis to require programmatic changes in the WIPP project unless they are shown to be necessary for compliance with our regulations.

EEG Issue N: The docketed items were well done but may be insufficient for assessing RFETS compliance.

1. [EEG's] comments. . . should be considered as describing deviations in what, for the most part, appears to be a very well-planned program adequate to meet the EPA's waste characterization planning requirements specified in 40 CFR 194.8. . . The EEG does, however, point out that documentation the EPA may need for thorough analysis of RFETS compliance with 40 CFR 194 may not be covered by the documents provided to the WIPP docket for public review.

EPA's Response to Issue N:

EPA agrees that the RFETS TRU Waste Management Manual and Quality Assurance Project Plan are well-prepared documents. EPA cannot rely solely on such documents, however, to evaluate transuranic waste sites' quality assurance and waste characterization programs. As we have noted elsewhere, inspections and inspections are appropriate mechanisms for verifying compliance with Conditions 2 and 3 of our certification of the WIPP (see, for example, 63 FR 27359). Prior to, during, and after inspections EPA may review a wide variety of procedures, records, and data in order to reach a determination that the programs under review are adequately established and executed. EPA requires DOE to submit a site's top governing documents prior to an inspection to afford the public an opportunity to comment on the site's programs and to raise issues that the Agency should consider in deciding whether or not to approve those programs.

V. CONCLUSIONS

EPA's inspection process examines the technical elements important to demonstrating compliance with 40 CFR 194.24 waste characterization systems of control. EPA inspectors examine Acceptable Knowledge (i.e., the historical documentation that provides radionuclide, waste material parameter, and other information), Nondestructive Assay (for radionuclide quantifications), Visual Examination/Radiography (to assess physical waste contents), and data transfer and data validation. Evaluation of these technical elements is sufficiently comprehensive to assess the technical adequacy of the system of controls for waste characterization.

Inspections conducted to date have demonstrated that the application of technical elements listed above varies considerably from site to site. The regulatory language governing site inspections has led EPA to respond to issues involving one or more technical elements by restricting the scope of site approval. As a result, EPA inspectors must return to an approved site if the site seeks to ship additional waste streams, use equipment not previously inspected, or make significant changes to procedures or methods for waste characterization.

REFERENCES

EPA 1994. U.S. Environmental Protection Agency. *Waste Analysis at Facilities that Generate, Treat, Store, and Dispose of Hazardous Waste*. EPA Office of Solid Waste. Directive Number 9938.4-03. April 26, 1994.

EPA/NRC 1997. U.S. Environmental Protection Agecy & U.S. Nuclear Regulatory Commission. *Joint NRC/EPA Guidance on Testing Requirements for Mixed Radioactive and Hazardous Waste*. 62 FR 62079-62094. November 20, 1997.