CRTD-Vol. 63

Technical Peer Review Report
Report of the Review Panel

Requirements for Disposal of Remote-Handled Transuranic Wastes at the Waste Isolation Pilot Plant

ASME International

Institute for Regulatory Science

DISCLAIMER

This report was prepared through the collaborative efforts of the American Society of Mechanical Engineers (ASME) Center for Research and Technology Development and the Institute for Regulatory Science (referred to thereafter with the collaborators as the Society) for the Office of Science and Technology Development of the U.S. Department of Energy (referred to hereafter as the Sponsor).

Neither the Society nor the Sponsor, or others involved in the preparation or review of this report nor any of their respective employees, members, or persons acting on their behalf, make any warranty, expressed or implied, or assume any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represent that its uses would not infringe privately owned rights.

Information contained in this work has been obtained by the American Society of Mechanical Engineers from sources believed to be reliable. However, neither ASME nor its authors or editors guarantee the accuracy or completeness of any information published in this work. Neither ASME nor its authors and editors shall be responsible for any errors, omissions, or damages arising out of the use of this information. The work is published with the understanding that ASME and its authors and editors are supplying information but are not attempting to render engineering or other professional services. If such engineering or professional services are required, the assistance of an appropriate professional should be sought.

Statement from By-Laws: The Society shall not be responsible for statements or opinions advanced in papers . . . or printed in its publications. (7.1.3)

ISBN No. 0-7918-3585-5

TABLE OF CONTENTS

	PAGE NO.
PREFACE	1
APPENDIX	7
PEER REVIEW PROCESS	13
WIPP FACILITY	19
LEGAL REQUIREMENTS	33
CURRENT PERMITTED METHODOLOGIES FOR CH TRU WASTES	47
CHARACTERIZATION APPROACHES PROPOSED FOR RH-TRU WASTES	75
PEER REVIEW CRITERIA, FINDINGS, AND RECOMMENDATIONS OF THE REVIEW PANEL	99
STAKEHOLDER PARTICIPATION	117
APPENDIX	121
REFERENCES	129
BIOGRAPHICAL SUMMARIES	135
LIST OF ACRONYMS	155

Preface

This report contains the results of a peer review performed jointly by the American Society of Mechanical Engineers (ASME) and the Institute for Regulatory Science (RSI). Based on a request from the Carlsbad Operations Office of the U.S. Department of Energy (DOE), a Review Panel was established to review the "Requirements for the Disposal of Remote-Handled Transuranic Wastes at the Waste Isolation Pilot Plant."

Preliminary negotiations between the DOE and New Mexico Environment Department indicated a desire of the New Mexico Environment Department to cosponsor the peer review. Accordingly, there were extensive negotiations between managers of the peer review program and the New Mexico Environment Department (NMED) on the role and responsibilities of cosponsors of the peer review. After considerable discussion within the NMED, based on legal reasons, a decision was made not to cosponsor the peer review. However, the NMED expressly recognized the need for peer review and the credibility of the current peer review program.

Keeping with the ASME Process, the following Review Panel (RP) was appointed by the Peer Review Committee (PRC) of ASME:

Alan S. Corson
Tom A. Hendrickson
M.C. Kirkland
Peter B. Lederman, Chair
James E. Martin
Wade O. Troxell
Richard Wilson

During the period covered by this report, the ASME PRC overseeing the peer review consisted of the following individuals:

Charles O. Velzy, Member of EP, Chair
Ernest L. Daman, Member of EP
Nathan H. Hurt, Member of EP
A. Alan Moghissi, Member of EP, Principal Investigator of the PR Program
Gary A. Benda
Erich W. Bretthauer
Irwin Feller
Robert A. Fjeld

John T. Greeves
William T. Gregory, III
Peter B. Lederman
Jeffrey A. Marqusee
Lawrence C. Mohr, Jr.
Goetz K. Oertel
Glen W. Suter, II

The supporting staff were the following individuals:

Carolyn Davis: Director of Research at the Center for Research and Technology Development of ASME in Washington DC; Administrative Manager of the ASME PRC

Betty R. Love: Executive Vice President, RSI, Columbia, MD; Administrative Manager of the Peer Review Program. During this peer review, Betty Love was also responsible for management of stakeholder participation.

Sorin R. Straja: Vice President for Science and Technology, RSI; Technical Secretary

Sharon D. Jones: Director of Training Programs, RSI; Manager of Review Panel Operations

The biographical summaries of the members of the RP, the PRC, and the technical staff are located at the end of this report.

Extensive written material was provided by the DOE to the Technical Secretary at the beginning of the process. The Technical Secretary extracted a draft summary for inclusion in this report. This summary was provided to DOE for review and was revised accordingly. Based on the information provided to the Technical Secretary, the Summary included in this report is an accurate representation of the project. The written material provided by DOE was made available to the members of the Review Panel in advance of the meeting in Carlsbad, NM. The agenda of the meeting in Carlsbad appears in the Appendix of this section.

The RP considered materials provided by the DOE and presentations during the Carlsbad meeting. The RP benefitted from a site visit to the Waste Isolation Pilot Plant on the morning of Monday, July 30, 2001 immediately prior to the presentations and from presentations during a workshop convened in conjunction with the peer review meeting. At the end of the meeting, the Review Panel met in an executive session and completed its report. The report of the Review Panel was subsequently copy-edited. Consistent with the procedures established by ASME, this report was provided to DOE for identification of potential errors; misunderstandings; and areas of ambiguity; and was revised accordingly.

The completion of this peer review within the rather short time frame could not have been possible without the support of a number of people. The assistance and cooperation of Bryan Howard, Norbert Rempe, and Phil Gregory are appreciated. The cooperation of Dr. Peter Maggiore, Secretary of the New Mexico Environment Department, and the staff of that Department was most helpful during the peer review.

Charles O. Velzy
A. Alan Moghissi

Appendix

ASME/RSI Peer Review and Workshop
Requirements for Disposal of Remote Handled Transuranic Wastes at the Waste Isolation Pilot Plant
Carlsbad, NM - July 30 - August 3, 2001

AGENDA

Monday, July 30, 2001

Waste Isolation Pilot Plant

8:30 a.m.	Site Visit	
11:30 a.m.	Lunch	

Pecos River Village Conference Center
Carousel House, Carlsbad, NM

Session 1: **Introduction and Regulatory Requirements**
Chair: **Chuck Wiggins**

1:00 p.m.	Welcoming Address	Chuck Wiggins Mayor Pro Tem of Carlsbad
1:10 p.m.	Welcoming Address	Ines Triay Manager, Carlsbad Field Office
1:20 p.m.	Introduction to Panel Workshop	A. Alan Moghissi Institute for Regulatory Science/ASME
2:00 p.m.	NMED Perspective	James Bearzi New Mexico Environment Department
2:30 p.m.	EPA Perspective	Rajani Joglekar U.S. Environmental Protection Agency
3:00 p.m.	Break	

Session 2: **DOE Strategy for RH-TRU Waste Disposal**
Chair: **Betty R. Love**

3:15 p.m.	The DOE RH-TRU Waste Characterization Program	Bryan Howard Los Alamos National Laboratory
4:00 p.m.	Discussion Responding to Audience Questions (Bearzi, Joglekar, Howard)	
5:00 p.m.	Adjournment	

ASME/RSI Peer Review and Workshop
Requirements for Disposal of Remote Handled Transuranic Wastes at the Waste Isolation Pilot Plant
Carlsbad, NM - July 30 - August 3, 2001

AGENDA

Tuesday, July 31, 2001

Pecos River Village Conference Center
Carousel House, Carlsbad, NM

Session 3: **Chair:**	**Review of DOE Submission** **Bryan Howard**	
8:00 a.m.	RH Inventory and Compliance Impacts	Joe Harvill Westinghouse TRU Solutions
8:45 a.m.	Repository Performance	M. Kathryn Knowles Sandia National Laboratory
9:45 a.m.	Break	
Session 4: **Chair:**	**Review of DOE Submission (Cont'd)** **Bryan Howard**	
10:00 a.m.	Application of Acceptable Knowledge for RH-TRU Waste	Bob Kehrman Westinghouse TRU Solutions
11:00 a.m.	Characterization Objectives and NDA/NDE Measurement Systems	Dan Taggart Los Alamos National Laboratory
12:00 p.m.	Lunch	
Session 5: **Chair:**	**Placing RH-TRU Waste in Perspective** **Phil Gregory**	
1:00 p.m.	Summary: RH-TRU: Small Volume-Large Impact	Ines Triay, CBFO
2:00 p.m.	Summary: NAS/NRC: WIPP Report	Werner Lutze Center for Radioactive Waste Management
2:30 p.m.	Discussion Responding to Audience Questions (Triay, Lutze)	
3:00 p.m.	Break	

ASME/RSI Peer Review and Workshop
Requirements for Disposal of Remote Handled Transuranic Wastes at the Waste Isolation Pilot Plant
Carlsbad, NM - July 30 - August 3, 2001

AGENDA

Tuesday continued

Session 6: **Risk Issues**
Chair: **Joe Harvill**

3:15 p.m.	Risk Assessment of Intrusive RH Waste Characterization Methods	Fritz Seiler Sigma Five Associates
4:00 p.m.	Risk/Cost-Impact Analysis for Intrusive RH Waste Characterization Methods	Louis Restrepo OMICRON
4:30 p.m.	Discussion Responding to Audience Questions (Seiler, Restrepo)	
5:00 p.m.	Adjournment	

Wednesday, August 1, 2001

Pecos River Village Conference Center
Carousel House, Carlsbad, NM

Session 7: **Regulatory Experience**
Chair: **M. Kathryn Knowles**

8:00 a.m.	Application of 40 CFR 260, 262, and 264 to RH-TRU Mixed Waste Characterization	Matt Strauss Clay Associates
9:00 a.m.	Application of 40 CFR 191/194 to RH-TRU Waste Characterization	John Bartlett SC&A
9:45 a.m.	Break	

Session 8: **Stakeholders**
Chair: **A. Alan Moghissi**

10:00 a.m.	Discussion Responding to Audience Questions and Statements by Stakeholders Addressing Peer Review Criteria	
12:00 p.m.	Lunch	
1:00 p.m.	Discussion Responding to Audience Questions and Statements by Stakeholders Addressing Peer Review Criteria	
4:00 p.m.	Adjournment	

ASME/RSI Peer Review and Workshop
Requirements for Disposal of Remote Handled Transuranic Wastes at the Waste Isolation Pilot Plant
Carlsbad, NM - July 30 - August 3, 2001

AGENDA

Wednesday continued
Lyndam Hotel, Albuqerque, NM

6:00 p.m. Executive Session

Thursday, August 2, 2001

Lyndam Hotel, Albuqerque, NM

Executive Session

8:00 a.m Writing of the Report *(ASME Review Panel Members only)*

5:00 p.m. Adjournment

Friday, August 3, 2001

Lyndam Hotel, Albuqerque, NM

Executive Session

8:00 a.m Writing of the Report *(ASME Review Panel Members only)*

5:00 p.m. Adjournment

Peer Review Process

INTRODUCTION

There is consensus within the technical community on the definition, process, and key criteria for the acceptability of peer review. Peer review consists of a critical evaluation of a topic by individuals who—by virtue of their education, experience, and acquired knowledge—are qualified to be peers of an investigator engaged in a study. A peer is an individual who is able to perform the project, or the segment of the project that is being reviewed, with little or no additional training or learning.

Recognizing that peer review constitutes the core of acceptability of scientific and engineering information, virtually all professional societies of scientists and engineers have instituted formal procedures for peer review for their activities. The American Society of Mechanical Engineers (ASME), also known as ASME International, has over a century of experience in peer review. Consistent with its mission and tradition, ASME recently established a peer review program devoted to the technologies supported by the Office of Science and Technology of the U.S. Department of Energy (DOE). This program is performed in cooperation with the Institute for Regulatory Science (RSI). The reports of the peer reviews resulting from this program have been published (ASME 1997, 1998, 1999, 2000).

PEER REVIEW PROCESS

The structure of the peer review process established by the ASME/RSI team consists of a tiered system. For each specific area of technology, the entire process is overseen by a Peer Review Committee (PRC). The review of specific topics is performed by Review Panels (RPs).

Peer Review Committee

The PRC is a standing committee formed to oversee peer review for one particular program in an agency. Its members are chosen on the basis of their education, experience, and peer recognition. An attempt is made to ensure that all needed technical competencies and diversity of technical views are represented in the PRC. The members of the PRC must be approved by the Board on Research and Technology Development of the Council on Engineering of the ASME. The PRC includes an Executive Panel (EP) that is responsible for the day-to-day operation of the PRC. Except for the EP, membership in the ASME is not required for appointment to the PRC. As the overseer of the entire peer review process, the PRC enforces all relevant ASME policies, including compliance with professional and ethical requirements. A key function of the PRC is the approval of the appointment of members of RPs for a specific project.

Review Panels

The review of a project, a document, a technology, or a program is performed by a RP consisting of a small group of highly-knowledgeable individuals. Upon the completion of their task, the RPs are disbanded. The selection of reviewers is based on the competencies required for the specific review assignment. The number of individuals in a RP depends upon the complexity of the subject to be reviewed. The selection of a reviewer is based on the totality of that individual's qualifications. However, there are several generally-recognized and fundamental criteria for assessing qualifications of a reviewer. These are as follows:

1. **Education and relevant experience:** A minimum of a B.S. degree and preferably an advanced degree in an engineering or scientific field is required for any peer reviewer. In addition, the reviewer must have significant experience in the area that is being reviewed.

2. **Peer recognition:** Election to an office of a professional society, serving on technical committees of scholarly organizations, and similar activities are considered to be a demonstration of peer recognition.

3. **Contributions to the profession:** Contributions to the profession may be demonstrated by publications in peer-reviewed journals. In addition, patents, presentations at meetings where the papers were peer-reviewed, and similar activities are also considered to be contributions to the profession.

4. **Conflict of Interest:** One of the most complex and contested issues in peer review is a set of subjects collectively called conflict of interest. The ideal reviewer is an individual who is intimately familiar with the subject and yet has no monetary interest in it. Despite this apparent difficulty, the ASME and similar organizations have successfully performed peer review without having a real or an apparent conflict of interest. The guiding principle for conflict of interest is as follows: *An individual who has a personal stake in the outcome of the review may not act as a reviewer or participate in the selection of reviewers.*

Due to the multidisciplinary nature of many projects reviewed by the ASME/RSI team, rapid identification of qualified peer reviewers and their availability to participate in the review process are key ingredients for a successful program. The process used for the identification of reviewers is multifaceted. The Administrative Manager of the Peer Review Program receives recommendations from sources within ASME; previous members of the RP; sister societies; other organizations and individuals; the DOE; DOE contractors; and others. However, the selection of peer reviewers is entirely based on criteria identified by ASME. The details of various aspects of peer review, including conflict of interest, can be found in ASME *Manual for Peer Review* (ASME 2000) and the *Associated Procedures* (RSI 2000).

COOPERATION WITH OTHER PROFESSIONAL SOCIETIES

The ASME is a large professional engineering society having in excess of 125,000 members. Although the predominant discipline of the members is mechanical engineering, there are members who—by virtue of their education, training, or experience—are competent in other disciplines. The Council on Engineering includes divisions ranging from classical mechanical engineering (design, heat transfer, and power) to solar engineering; environmental engineering; and safety and risk analysis. Despite the diverse competency within the ASME, it is recognized that on occasion it will become necessary to peer review activities which include disciplines that are outside the areas of competency of the ASME and its members. These disciplines may include geology, hydrology, toxicology, and ecology. Consequently, ASME has reached formal and informal agreements with its sister societies to identify qualified reviewers in areas outside of those covered by the membership of ASME.

PERFORMING ORGANIZATIONS

The Center for Research and Technology Development of ASME manages a number of scientific and engineering activities, including peer review for the Office of Science and Technology (OST). Because of ASME's conscious effort to maintain a small in-house staff, it relies upon other organizations to provide detailed project management services in its research, development, and similar activities. Accordingly, ASME and RSI joined forces in a collaborative effort to perform the peer review for OST. While the ASME staff in Washington, DC provides the staff support for the PRC, the detailed management and staff support for the RPs is provided by RSI.

American Society of Mechanical Engineers

As one of the largest professional engineering societies, ASME has a long and distinguished history. Its activities are carried out primarily by members who volunteer their time in support of engineering and scientific advancement. For obvious reasons, ASME also has a paid staff to manage the day-to-day operations of such a large professional society. The ASME has a detailed structure for its operation consisting of councils, boards, divisions, and committees. The Council on Engineering has 38 divisions, including: Environmental Engineering; Solid Waste Processing; Nuclear Engineering; and Safety Engineering and Risk Analysis. The Council on Codes and Standards develops ASME codes and standards that are the backbone of many industries—including power production—worldwide. The Council on Codes and Standards is also responsible for the development of standards for activities such as certification of incinerator operators. The ASME was a founding member of the American Association of Engineering Societies and a founding member of the American National Standards Institute.

Institute for Regulatory Science

RSI is a not-for-profit organization chartered under section 501(c)3 of the Internal Revenue Service. It is dedicated to the idea that societal decisions must be based on the best available scientific and engineering information. According to the RSI mission statement, peer review is the foundation of the best available scientific and engineering information. Consequently, RSI has promoted peer review within government and industry as the single most important measure of reliability of scientific and engineering information. In its activities, RSI seeks the cooperation of scholarly organizations. Historically, a large number of RSI activities have been performed in cooperation with ASME. RSI is located in the Washington, DC, Metropolitan Area.

WIPP Facility

INTRODUCTION

The Waste Isolation Pilot Plant (WIPP) is the principal facility for the disposal of our nation's transuranic (TRU) radioactive waste generated as a result of over 50 years of nuclear weapons research, development, and production. The selection of the WIPP site followed a lengthy search and extensive studies for the identification of a site for disposal of TRU wastes (NRC 1983, 1984). These efforts led to the selection of a 41 km^2 (16 mi^2) site, 26-miles (42-km) east of Carlsbad, NM. Following studies conducted of geological formations stable enough to contain wastes for thousands of years during the 1950s, the National Research Council (NRC 1957) identified deep geologic isolation in salt as a most desirable disposal mode for radioactive waste. Experiments conducted on salt mines revealed that there were no technical difficulties with waste disposal in salt (NRC 1984). The Carlsbad site was selected by the DOE because the deep salt beds located there are expected to provide the necessary stability for waste disposal. The site and the region surrounding it had been studied for many years, and mineral exploration of both potash and hydrocarbon deposits provided additional knowledge regarding the geology of the region. The U.S. Geological Survey and other agencies assisted DOE in identifying the New Mexico location for the repository. The salt deposit at this site, known as the Salado Formation, is a minimum of 2,000 ft (610 m) thick and located at a depth of 1,000-2,000 ft (305-610 m) (Fig. 1).

Salt allows significant deformation without fracturing. The Salado Formation is regionally extensive, and includes continuous beds of salt without complicated structures. The DOE identified the following four advantages of the site:

1. The salt deposit is in a stable geological area with little seismic activity, assuring the stability of a waste repository for thousands of years.
2. Salt deposits indicate the absence of flowing fresh water which could move waste to the surface. Water, if it had been or were present, would have dissolved the salt beds.
3. Salt is relatively easy to mine.
4. Rock salt exhibits a characteristic mechanical behavior, creep, that makes it an excellent host for waste isolation. In response to excavation-induced stress changes, salt slowly flows (or creeps), to close the mined openings. Creep closure starts immediately and continues until the salt has regained its original density and stress distribution. Salt formations tend to slowly and progressively fill mined areas and safely seal radioactive waste from the environment.

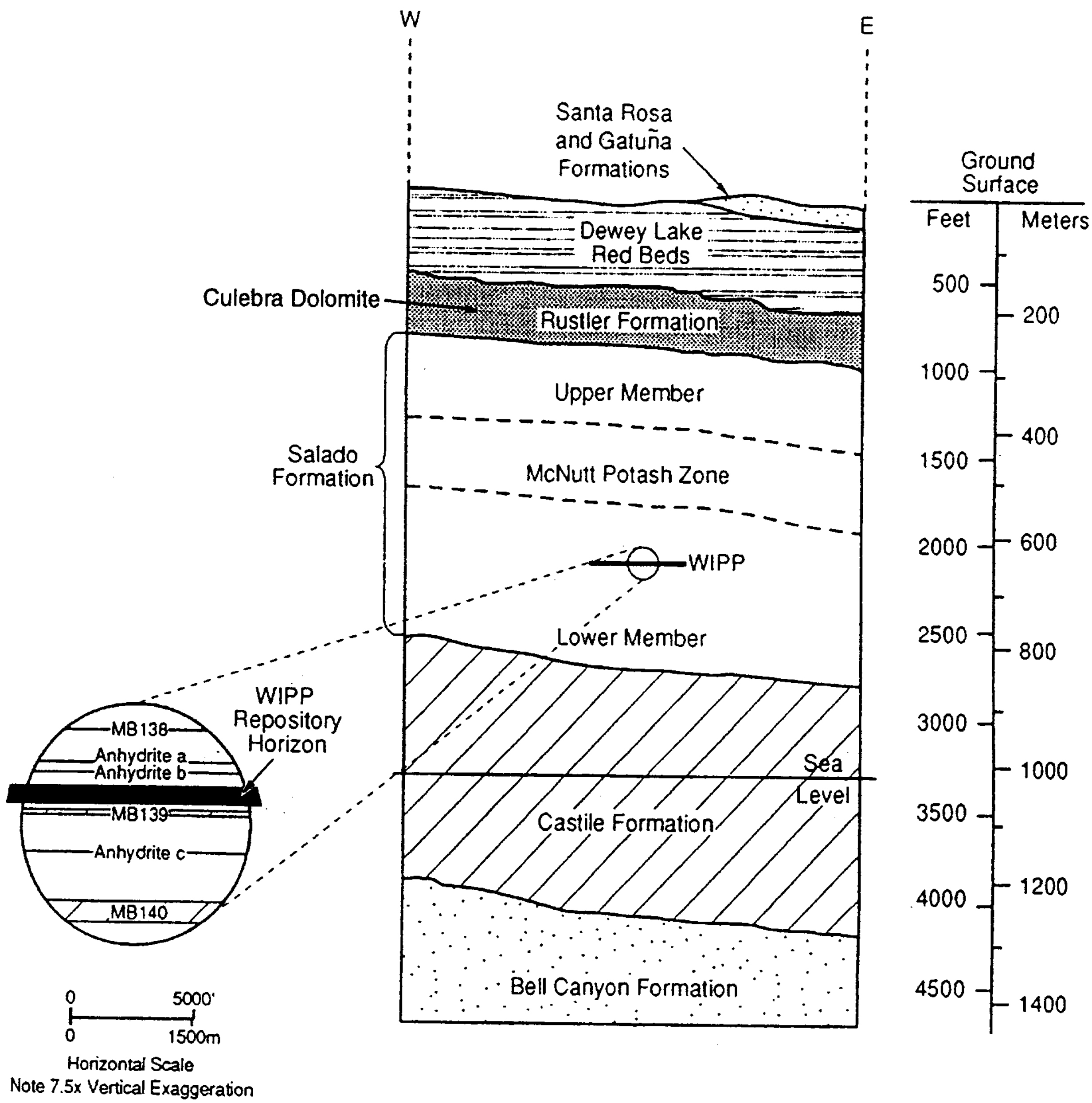

Fig. 1. WIPP Repository and local stratigraphy.

Geological data were collected from the WIPP site and surrounding area to evaluate its suitability as a radioactive waste repository. These data were collected principally by the DOE; the DOE's predecessor agencies; the U.S. Geological Survey; the New Mexico Bureau of Mines and Mineral Resources; and private organizations engaged in natural resource exploration and extraction. The DOE analyzed the data and has stated that the site is suitable for long-term isolation of radioactive waste.

The geology of the WIPP site has specific advantages identified by the DOE against potentially adverse environmental impacts. At the depth of the WIPP repository, the salt will slowly encapsulate the buried waste in the stable rock. Salt rock also shields radioactivity, providing a protection similar to that of concrete. Waste placed in the excavation at the WIPP is expected to be encapsulated and all waste-filled spaces closed over a period of 75-200 years. The waste disposal depth of 2,150 ft (650 m) is close enough to the surface to make access reasonable.

Subsequent to the investigation of the subsurface geology, the DOE selected the Salado Formation as the site of the WIPP repository for the following reasons:

1. The Salado halite units have low permeability to fluid flow, which impedes groundwater flow into and out of the repository;
2. It is regionally widespread;
3. It includes continuous halite beds without complicated structure;
4. It is deep with little potential for dissolution;
5. It is close enough to the surface that access is reasonable; and
6. It is largely free of mobile groundwater, as compared to existing mines and other potential repository sites.

Another of the favorable aspects of subsurface geology at the WIPP site is that the groundwater hydrology in the immediate proximity is characterized by geologic strata with low transmissivity and low hydrologic gradients.

SUBSURFACE GEOLOGY

The WIPP site is located in the northern portion of the Delaware Basin, a structural basin underlying present-day southeastern New Mexico and western Texas, and containing a thick sequence of sandstones, shales, carbonates, and evaporites. At the repository depth of 2,150 ft (650 m), the natural rock is of the Permian age. The sediments accumulated during the Permian period represent the thickest portion of the sequence in the northern Delaware Basin and are divided into four series. From oldest to youngest, these series are: the Wolfcampian, Leonardian, Guadalupian, and Ochoan. As shown in Fig. 2, the Ochoan series is divided into four formations. From oldest to youngest, these formations are: Castile, Salado, Rustler, and Dewey Lake.

Salado formation

This massive bedded salt formation, predominately halite (sodium chloride), is thick and laterally extensive. The Salado formation is approximately 530 to 610 m (1,740 to 2,000 ft) thick in the WIPP site area, and the repository is located in the thickest part. The Salado formation is comprised of three members. From oldest to youngest, these are: Lower Member, McNutt Potash Member, and Upper Member. The WIPP repository is located in the Lower Member. The Salado formation contains many distinctive and laterally continuous layers composed mostly of anhydrite (a potassium-magnesium-calcium sulfate mineral). These layers have been designated by geologists as "marker beds" and numbered to designate vertical position within the Salado Formation.

Castile formation

This formation directly underlies the Salado Formation and comprises the base of the Ochoan Series (Fig. 2). It is found 244 m (800 ft) below the level of the repository. The Castile Formation near the WIPP typically contains three relatively thick anhydrite/carbonate units and two thick halite units. The thickness of the Castile varies regionally as well as locally beneath the WIPP, and there is considerable evidence from borehole data and geophysical surveys that the units of the Castile are deformed. The more brittle anhydrite units of the Castile are probably fractured, and the fracture zones are relatively permeable and act as zones for accumulation of brine originating in the Castile. The Castile is exposed at the surface over a considerable area along the western side of the Delaware Basin. In the eastern part of the basin, it is approximately 430 to 460 m (1,400 to 1,500 ft) thick. At the northern boundary of the WIPP, the Castile's thickness has been measured at 301 m (989 ft).

Bell Canyon formation

The Bell Canyon Formation underlies the Castle Formation and is the uppermost formation of the Guadalupian Series. Near the WIPP, the Bell Canyon is comprised

SYSTEM	SERIES	GROUP	FORMATION	MEMBER	DEPTH AT WIPP WASTE SHAFT meters (feet)
RECENT	RECENT		SURFICIAL DEPOSITS		
QUATER-NARY	PLEISTO-CENE		MESCALERO CALICHE		
			GATUNA		
TRIASSIC		DOCKUM	SANTA ROSA		30 (97)
PERMIAN	OCHOAN		DEWEY LAKE		164 (538)
			RUSTLER	Forty-niner	182 (596)
				Magenta Dolomite	189 (621)
				Tamarisk	215 (707)
				Culebra Dolomite	222 (729)
				lower unnamed	257 (844)
			SALADO	upper	409 (1,343)
				McNutt Potash	526 (1,727)
				lower WIPP	655 (2,150)
					~810 (2,650)
			CASTILE		~1,200 (4,000)
	GUADALUPIAN	DELAWARE MOUNTAIN	BELL CANYON		~1,550 (5,100)
			CHERRY CANYON		~1,900 (6,200)
			BRUSHY CANYON		

Fig. 2. Regional geologic column.

of a layered sequence of sandstones, shales, siltstones, and limestones approximately 300 m (1,000 ft) or more in thickness. It is the uppermost target of hydrocarbon exploration in the local area and is known from outcrops on the west side of the Delaware Basin and from oil and gas exploration boreholes.

Rustler formation

The Rustler Formation directly overlies the Salado Formation and contains five members (Fig. 2). From the base of the Rustler, these member are: Los Medanos Member (formerly referred to as the unnamed lower member), Culebra Member, Tamarisk Member, Magenta Member, and Forty-niner Member. The Culebra and Magenta Members are gypsum-bearing dolomites containing numerous cavities, fractures, and silty zones. The other three members contain various amounts of anhydrite, siltstone, claystone and halite. The Rustler is the youngest (uppermost) formation in the Delaware Basin that primarily contains evaporite deposits. In the WIPP region, the Rustler can be 152 m (500 ft) thick, although it ranges from 91 to 107 m (300 to 350 ft) thick within the WIPP boundary.

Dewey Lake formation

This formation overlies the Rustler Formation at the WIPP. Consisting largely of reddish-brown siltstones and claystones with lesser amounts of sandstone, the Dewey Lake Formation is about 30 to 170 m (100 to 560 ft) thick in the vicinity of the WIPP.

Santa Rosa formation

This formation of Triassic Age, also called the Dockum Group, overlies the Dewey Lake Formation. Characterized by the light reddish-brown sandstones and conglomerates, the Santa Rosa Formation is anywhere between thin to absent within the WIPP site boundaries, but is thicker to the east.

Gatuna formation

This formation overlies the Santa Rosa Formation and is somewhat similar in lithology and color, although the Gatuna is characterized by a wide range of lithologies (coarse conglomerates to gypsum-bearing claystones). The Gatuna is Pleistocene in age, based on the 600,000-year old volcanic ash layer in the Upper Gatuna.

FACILITIES CONSTRUCTED AT THE WIPP

The major construction activities at the WIPP occurred between 1981 and 1990, and the facility accepted its first shipment of Transuranic (TRU) wastes in March 1999. Underground facilities were excavated 655 m (2,150 ft) beneath the surface of the land and include: four shafts; the waste disposal area; an experimental area (now closed); an equipment and maintenance area; and connecting tunnels. The DOE has also excavated the first and second of eight planned panels (designated as Panels 1 and 2) as shown in Fig. 3. Panel 1 has received wastes.

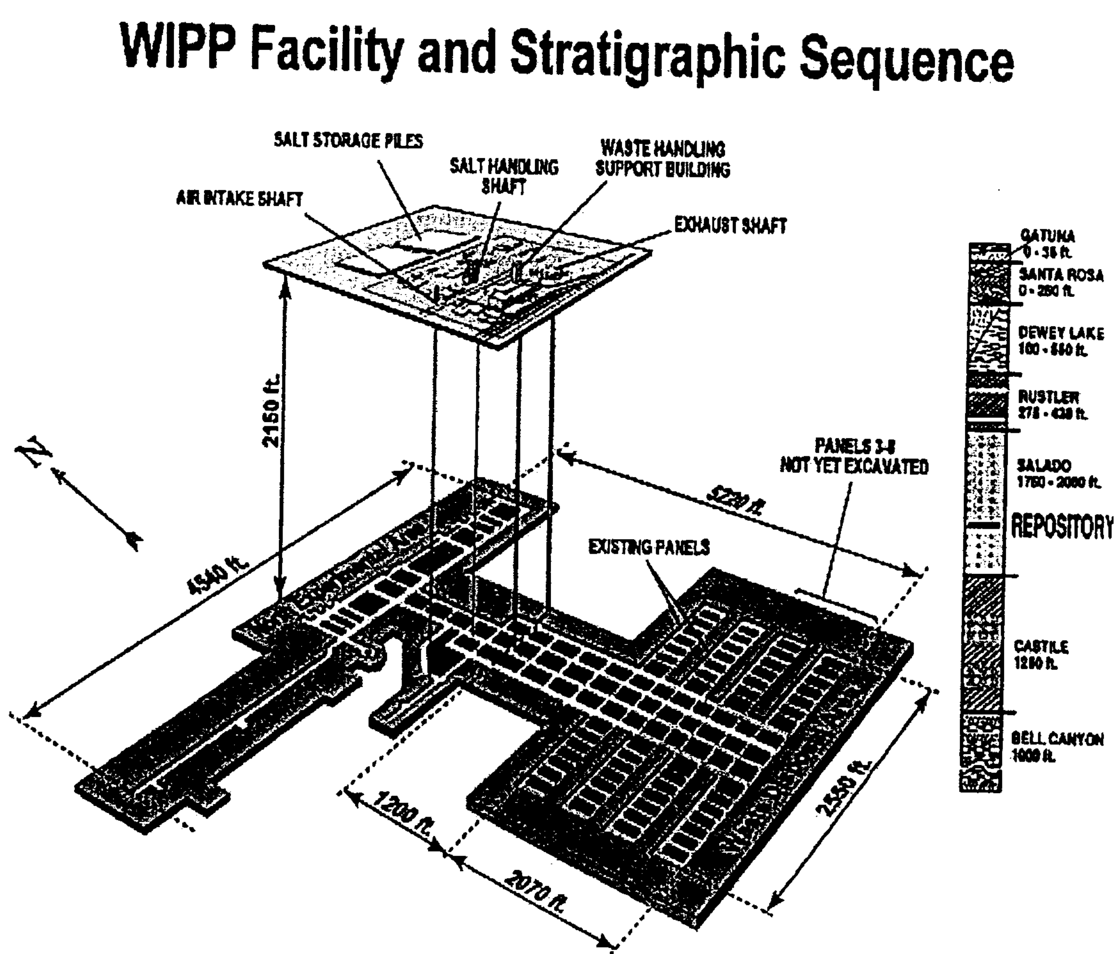

Fig. 3. WIPP facility and stratigraphic sequence.

Each panel is expected to take five years to mine, fill, and close. In addition, panel-equivalents 9 and 10 in Fig. 3 are located in the north-south mine access ways and are calculated to be required to complete the burial of the 1.75 x 10^5 m^3 (6.2 x 10^6 ft^3) of TRU waste permissible under the Land Withdrawal Act (LWA). All panels consist of seven waste disposal rooms, each about 91 m (300 ft) long, 10 m (33 ft) wide, and 4 m (13 ft) high. Pillars between rooms are 30 m (100 ft) wide.

A number of surface facilities have been constructed. The principal surface structure at the WIPP is the Waste Handling Building (WHB) where TRU wastes are unloaded from their transportation containers and transferred to the underground disposal area through the Waste Shaft. The WHB contains four functional areas: 1) the Contact Handled (CH) TRU waste handling area; 2) the Remote Handled (RH) TRU waste handling area; 3) the WHB support area; and 4) the Waste Shaft.

Other WIPP surface facilities include the hoist houses; Support Building; Guard and Security Building; Water Pump House; Transuranic Package Transporter, Model 2 (TRUPACT-II) Maintenance Facility; Training Building; office trailers; Exhaust Filter Building; warehouse and shops; Engineering Building; Core Storage Building; and the Safety and Emergency Services Building.

The underground support facilities include those needed to service and maintain equipment for excavation and disposal operations; monitor for contamination; and allow limited decontamination of personnel and equipment, if necessary. All underground facilities are inspected by the Mine Safety and Health Administration.

Waste Handling Building (WHB)–container storage unit

This building is the surface facility where TRU handling activities will take place. The WHB has a total area of approximately 84,000 ft^2 (7,804 m^2), of which 33,175 ft^2 (3,082 m^2) are designated for the waste handling and container storage of CH TRU mixed waste. The concrete floors are sealed with a coating that makes them impervious to the chemicals and facilitates decontamination if necessary.

The vehicles used to transport TRU mixed waste containers will be received through one of three air-lock entries to the CH Bay of the WHB Unit. The WHB heating, ventilation, and air conditioning system maintains the interior of the WHB at a pressure lower than the ambient atmosphere to ensure that air flows into the WHB, preventing the inadvertent release of radioactive constituents as the result of a contamination event. The doors at each end of the air lock are interlocked to prevent both from opening simultaneously and equalizing CH Bay pressure with outside atmospheric pressure.

The waste containers are visually inspected for physical damage (e.g., severe rusting, apparent structural defects, signs of pressurization) and leakage to ensure that they are in good condition prior to storage. Waste containers are also checked for external surface contamination. If a primary waste container is not in good condition, the DOE will overpack the container.

Parking area container storage unit--parking area unit

The parking area south of the WHB is to be used for storage of waste containers within sealed shipping containers awaiting unloading. The Parking Area Unit provides storage space for 12 loaded containers, corresponding to 1,591 ft^3 (45 m^3) of CH TRU mixed waste. Secondary containment and protection of the waste containers from standing liquid are provided by the transportation containers. Wastes placed in the Parking Area Unit will remain sealed in their TRUPACT-II transportation containers at all times while in this area.

CONTAINER MANAGEMENT PRACTICES

Containers are to be managed in a specified manner that does not result in spills or leaks. Containers are required to be closed at all times, unless waste is being placed in the container or removed. Because containers at the WIPP contain radioactive waste, safety concerns require that containers be continuously vented to obviate the buildup of gases within the container. These gases could result from radiolysis, which is the breakdown of moisture by radiation. The vents are filtered to enable any potential generated gas to escape while particulate matter is retained. Derived waste containers are kept closed at all times unless waste is being added or removed.

Containers with residual liquids

Defense production facilities are prohibited from shipping liquid wastes in the containers sent to the WIPP. In no case is the total residual liquid allowed to equal or exceed 1% (by volume) of the waste container. Consequently, calculations made to determine the secondary containment as required by regulations are based on

10% of 1% of the volume of the containers, or 1% of the largest container, whichever is greater.

Description of containers

Waste containers are to be in good condition prior to shipment from the generator sites, i.e., containers will be of high integrity, intact, and free of surface contamination above established limits. This condition is to be verified upon receipt of the waste at WIPP. Containers are vented through filters, allowing any gases that are generated by radiolytic and microbial processes within a waste container to escape, thereby preventing over-pressurization or development of conditions within the container that would lead to the development of ignitable, corrosive, reactive, or other characteristic wastes.

The volatile organic compounds (VOC) in the headspace of waste containers are limited to maximum allowable VOC room-averaged headspace concentration limits specified in the permit. There are no maximum allowable headspace gas concentration limits for individual containers, as some containers can exceed these values as long as container headspace averages in a disposal room do not.

Containers for CH TRU mixed waste will be either 55-gal (208-L) drums arranged singly in 7-packs; 85-gal (321-L) drums arranged singly in 4-packs; 100-gallon drums, arranged singly or as three-packs; ten-drum overpacks (TDOP) either as overpacks or direct-loaded; or standard waste boxes (SWBs). Following is a summary description for each container type.

Standard 55-gallon drums: These drums meet the requirements for U.S. Department of Transportation (DOT) specification 7A regulations. A standard 55-gal (208-L) drum has a gross internal volume of 7.4 ft^3 (0.208 m^3). One or more filtered vents (as described in Permit Section M1-1d(1)) is to be installed in the drum lid or body to prevent the escape of any radioactive particulate matter and to eliminate any potential for pressurization. Standard 55-gal (208-L) drums are constructed of mild steel and may also contain rigid, molded polyethylene (or other compatible material) liners.

Standard Waste Boxes (SWBs): One or more filtered vents are to be installed in the standard waste box lid or body to prevent the escape of any radioactive particulate matter and to eliminate any potential of pressurization. SWBs have an internal volume of 66.3 ft^3 (1.88 m^3).

One hundred-gallon drums: A 100-gal (379-L) drum has a gross internal volume of 13.4 ft^3 (0.39 m^3). One or more filtered vents are installed in the drum lid or body to prevent the escape of any radioactive particulate matter and to eliminate potential pressurization. These drums are constructed of mild steel and may also contain rigid, molded polyethylene (or other compatible material) liners. These drums may be used as overpacks or may be direct-loaded.

Ten-Drum Overpack: The TDOP is a metal container, similar to a SWB, and is certified to be noncombustible. It is a welded-steel cylinder, approximately 74 in (1.9 m) high and 71 in. (1.8 m) in diameter with a gross internal capacity of 160 ft^3. The maximum loaded weight of a TDOP is limited to 6,700 lbs (3,040 kg). A bolted lid on one end is removable; sealing is accomplished by clamping a neoprene gasket between the lid and the body. Filter ports are located near the top of the TDOP. One or more filtered vents are installed in the ten-drum overpack lid or body to prevent the escape of any radioactive particulate matter and to eliminate any potential for pressurization. A TDOP may contain up to ten standard 55-gal (208-L) drums or one SWB. The TDOPs may be used to overpack drums or SWBs containing CH TRU mixed waste. The TDOP may also be direct-loaded with waste items that are too large to fit into the standard 55-gallon (208-L) drum; the 85-gallon drum; or the SWB.

Eighty-five gallon drums: The 85-gal (321-L) drum overpack is to be used primarily for overpacking contaminated 55-gal (208 L) drums at the WIPP facility. The 85-gal (321-L) drums may be direct-loaded with CH TRU-mixed waste and may be used to collect derived waste. One or more filtered vents are to be installed in the 85-gal (321-L) drum lid or body to prevent the escape of any radioactive particulate matter and to eliminate any potential of pressurization.

Container compatibility: All containers are made of steel, and some will contain rigid, molded polyethylene liners. Requirements to conduct compatibility studies include container materials to assure that containers are compatible with the waste.

WASTE PROCESSING STEPS AT THE WIPP

The handling and disposal of CH TRU wastes at the WIPP involves the following series of steps:

1. A waste shipment arrives at the WIPP by truck. Each truck is capable of carrying up to three TRU Packaging Transport Model IIs (TRUPACT-IIs).
2. After an initial security inspection, a radiological survey, and a shipping documentation review, the truck is parked near the WHB for additional inspection and radiological survey. A forklift is used to transfer each TRUPACT-II from the trailer, through an air lock, and into the WHB, where it is placed in an area called a TRUDOCK, which is used by workers to unload the waste from the TRUPACT IIs.
3. Radiological surveys are conducted to confirm that waste containers have not sustained damage during shipment or waste container removal.
4. At the TRUDOCK, an overhead crane is used to remove the waste containers from the TRUPACT-II and place them on a facility pallet.
5. A forklift moves the loaded facility pallet to the conveyance loading car at the waste handling shaft. The conveyance loading car is used to load the facility pallet onto the waste hoist.
6. The waste hoist descends 2,150 ft (705 m) to the WIPP repository.
7. An underground transporter pulls the loaded facility pallet off the hoist onto the trasporter bed and moves the waste to the appropriate disposal room where a forklift removes the waste containers from the facility pallet and places them in the disposal area. Containers may be stacked three high in the disposal area.
8. Bags of magnesium oxide are placed on top of the stack of containers to serve as backfill. The magnesium oxide will control the solubility of radionuclides and is an added measure of assurance for long-term repository performance.

Legal Requirements

INTRODUCTION

The Waste Isolation Pilot Plant project was authorized in 1979 (PL96-164) as a research and development activity to demonstrate the safe disposal of radioactive waste originating from the U.S. nuclear weapons program. This and several other laws and regulations have resulted in the construction and operation of WIPP as a unique facility for the disposal of transuranic (TRU) waste.

TRU waste is defined as a waste containing alpha-emitting isotopes of transuranic elements which emits more than 100 nCi/g of waste. The half-lives of the isotopes of these elements must be greater than 20 years (LWA 1992; EPA 1993).

Much of the TRU waste contains chemical constituents subject to the regulations of the Resource Conservation and Recovery Act (RCRA) and the New Mexico Hazardous Waste Act. TRU wastes that contain both chemical and radioactive waste are referred to as Mixed TRU. According to RCRA, WIPP is required to have a hazardous waste permit to receive waste containing hazardous waste constituents. The state of New Mexico has adopted the relevant RCRA regulations by reference and thus is authorized to issue hazardous waste permits. WIPP received a permit (NMED 1999) on October 27, 1999 for contact-handled (CH) waste, defined as having a surface radiation dose rate not greater than 200 mrem/h (2 mSv/h). TRU waste with a greater dose rate is defined as Remote Handled (RH) TRU Mixed Waste.

The enactment of the Land Withdrawal Act (LWA 1992) resulted in permanent withdrawal and transfer of the administration of federal land for the site from the U.S. Department of Interior to the DOE. This law mandated that the U.S. Environmental Protection Agency (EPA) certify the DOE's compliance with EPA's relevant, generally applicable environmental standards for radioactive materials. Subsequently, the EPA (1996a) issued the criteria to be used in certifying compliance. In response, the DOE provided the EPA with appropriate documents; models; and evaluations of the geology, hydrology, and climate as well as projected performance of the entire disposal system, including the mined repository, shaft seals, panel closures, borehole plugs, and mine backfill. Finally, the EPA (1998) certified that the WIPP met all of the criteria required for the disposal of TRU waste.

The LWA limited the amount and types of TRU wastes that can be emplaced at WIPP. The limits include the following:

1. The WIPP capacity is limited to 1.75×10^5 m^3 (6.2×10^6 ft^3) total TRU waste by volume.
2. No more than 5% (by volume) of RH-TRU waste may have a surface dose rate in excess of 100 rem/h (1 μSv/h).
3. No RH-TRU waste may have a surface dose rate in excess of 1,000 rem/h (10 Sv/h).
4. RH-TRU waste containers shall not exceed 23 Ci/L (851 GBq/L) maximum activity level averaged over the volume of the container.
5. The total radioactivity of RH-TRU waste shall not exceed 5.1 MCi (188.7 PBq).
6. Of the allowed waste disposal volume of 1.75×10^5 m^3 (6.2×10^6 ft^3), the Consultation and Cooperation Agreement with the State of New Mexico limits the volume of RH-TRU waste to 7,080 m^3 (250,000 ft^3).

The 41 km^2 (16 mi^2) area under DOE's jurisdiction at WIPP is deemed sufficient to ensure that at least 1.6 km (1 mi) of intact salt exists laterally between the waste disposal area and the accessible environment, and also to ensure that no permanent residences will be established in close proximity to the facility.

EPA'S CRITERIA FOR WIPP CERTIFICATION

Criteria for certification and recertification of WIPP were published in final form by the EPA (1996a). These criteria were detailed and contained specific requirements. In its regulations, EPA provided requirements not only for quality assurance and characterization but also specific requirements for expert judgement and peer review. The following are excerpts from EPA's regulations:

"§ 194.22 Quality assurance.

(a)(1) As soon as practicable after April 9, 1996, the Department shall adhere to a quality assurance program that implements the requirements of ASME NQA-1-1989 edition, ASME NQA-2a-1990 addenda, part 2.7, to ASME NQA-2-1989 edition, and ASME NQA-3-1989 edition (excluding Section 2.1 (b) and (c), and Section 17.1). (Incorporation by reference as specified in § 194.5.)
(2) Any compliance application shall include information which demonstrates that the quality assurance program required pursuant to paragraph (a)(1) of this section

has been established and executed for:
(i) Waste characterization activities and assumptions;
(ii) Environmental monitoring, monitoring of the performance of the disposal system, and sampling and analysis activities;
(iii) Field measurements of geologic factors, ground water, meteorologic, and topographic characteristics;
(iv) Computations, computer codes, models and methods used to demonstrate compliance with the disposal regulations in accordance with the provisions of this part;
(v) Procedures for implementation of expert judgment elicitation used to support applications for certification or re-certification of compliance;
(vi) Design of the disposal system and actions taken to ensure compliance with design specifications;
(vii) The collection of data and information used to support compliance application(s); and
(viii) Other systems, structures, components, and activities important to the containment of waste in the disposal system.
(b) Any compliance application shall include information which demonstrates that data and information collected prior to the implementation of the quality assurance program required pursuant to paragraph (a)(1) of this section have been qualified in accordance with an alternate methodology, approved by the Administrator or the Administrator's authorized representative, that employs one or more of the following methods: Peer review, conducted in a manner that is compatible with NUREG–1297, "Peer Review for High-Level Nuclear Waste Repositories," published February 1988 (incorporation by reference as specified in § 194.5); corroborating data; confirmatory testing; or a quality assurance program that is equivalent in effect to ASME NQA-1-1989 edition, ASME NQA-2a-1990 addenda, part 2.7, to ASME NQA-2-1989 edition, and ASME NQA-3-1989 edition (excluding Section 2.1 (b) and (c) and Section 17.1). (Incorporation by reference as specified in § 194.5.)
(c) Any compliance application shall provide, to the extent practicable, information which describes how all data used to support the compliance application have been assessed for their quality characteristics, including:
(1) Data accuracy, i.e., the degree to which data agree with an accepted reference or true value;
(2) Date prevision, i.e., a measure of the mutual agreement between comparable data gathered or developed under similar conditions expressed in terms of a standard deviation;

(3) Data representativeness, i.e., the degree to which data accurately and precisely represent a characteristic of a population, a parameter, variations at a sampling point, or environmental conditions;
(4) Data completeness, i.e., a measure of the amount of valid data obtained compared to the amount that was expected; and
(5) Data comparability, i.e., a measure of the confidence with which one data set can be compared to another.
(d) Any compliance application shall provide information which demonstrates how all data are qualified for use in the demonstration of compliance.
(e) The Administrator will verify appropriate execution of quality assurance programs through inspections, record reviews and record keeping requirements, which may include, but may not be limited to, surveillance, audits and management systems reviews."

"§ 194.24 Waste characterization.

(a) Any compliance application shall describe the chemical, radiological and physical composition of all existing waste proposed for disposal in the disposal system. To the extent practicable, any compliance application shall also describe the chemical, radiological and physical composition of to-be-generated waste proposed for disposal in the disposal system. These descriptions shall include a list of waste components and their approximate quantities in the waste. This list may be derived from process knowledge, current non-destructive examination/assay, or other information and methods.
(b) The Department shall submit in the compliance certification application the results of an analysis which substantiates:
(1) That all waste characteristics influencing containment of waste in the disposal system have been identified and assessed for their impact on disposal system performance. The characteristics to be analyzed shall include, but shall not be limited to: Solubility, formation of colloidal suspensions containing radionuclides; production of gas from the waste; shear strength compactability; and other waste-related inputs into the computer models that are used in the performance assessment.
(2) That all waste components influencing the waste characteristics identified in paragraph (b)(1) of this section have been identified and assessed for their impact on disposal system performance. The components to be analyzed shall include, but shall not be limited to: metals, cellulosics; chelating agents; water and other liquids; and activity in curies of each isotope of the radionuclides present.
(3) Any decision to exclude consideration of any waste characteristic or waste component because such characteristic or component is not expected to

significantly influence the containment of the waste in the disposal system.

(c) For each waste component identified and assessed pursuant to paragraph (b) of this section, 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. Any compliance application shall:

(1) Demonstrate that, for the total inventory of waste proposed for disposal in the disposal system, WIPP complies with the numeric requirements of § 194.34 and § 194.55 for the upper or lower limits (including the associated uncertainties), as appropriate, for each waste component identified in paragraph (b)(2) of this section, and for the plausible combinations of upper and lower limits of such waste components that would result in the greatest estimated release.

(2) Identify and describe the method(s) used to quantify the limits of waste components identified in paragraph (b)(2) of this section.

(3) Provide information which demonstrates that the use of process knowledge to quantify components in waste for disposal conforms with the quality assurance requirements found in § 194.22.

(4) Provide information which demonstrates that 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. 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.

(5) Identify and describe such controls delineated in paragraph (c)(4) of this section and confirm that they are applied in accordance with the quality assurance requirements found in § 194.22.

(d) The Department shall include a waste loading scheme in any compliance application, or else performance assessments conducted pursuant to § 194.32 and compliance assessments conducted pursuant to § 194.54 shall assume random placement of waste in the disposal system.

(e) Waste may be emplaced in the disposal system only if the emplaced components of such waste will not cause:

(1) The total quantity of waste in the disposal system to exceed the upper limiting value, including the associated uncertainty, described in the introductory text to paragraph (c) of this section; or

(2) The total quantity of waste that will have been emplaced in the disposal system, prior to closure, to fall below the lower limiting value, including the associated uncertainty, described in the introductory text to paragraph (c) of this section.

(f) Waste emplacement shall conform to the assumed waste loading conditions, if any, used in performance assessments conducted pursuant to § 194.32 and compliance assessments conducted pursuant to § 194.54.
(g) The Department shall demonstrate in any compliance application that the total inventory of waste emplaced in the disposal system complies with the limitations on transuranic waste disposal described in the WIPP LWA.
(h) The Administrator will use inspections and records reviews, such as audits, to verify compliance with this section."

"§ 194.26 Expert judgment.

(a) Expert judgment, by an individual expert or panel of experts, may be used to support any compliance application, provided that expert judgment does not substitute for information that could reasonably be obtained through data collection or experimentation.
(b) Any compliance application shall:
(1) Identify any expert judgments used to support the application and shall identify experts (by name and employer) involved in any expert judgment elicitation processes used to support the application.
(2) Describe the process of eliciting expert judgment, and document the results of expert judgment elicitation processes and the reasoning behind those results. Documentation of interviews used to elicit judgments from experts, the questions or issues presented for elicitation of expert judgment, background information provided to experts, and deliberations and formal interactions among experts shall be provided. The opinions of all experts involved in each elicitation process shall be provided whether the opinions are used to support compliance applications or not.
(3) Provide documentation that the following restrictions and guidelines have been applied to any selection of individuals used to elicit expert judgments:
(i) Individuals who are members of the team of investigators requesting the judgment or the team of investigators who will use the judgment were not selected; and
(ii) Individuals who maintain, at any organizational level, a supervisory role or who are supervised by those who will utilize the judgment were not selected.
(4) Provide information which demonstrates that:
(i) The expertise of any individual involved in expert judgment elicitation comports with the level of knowledge required by the questions or issues presented to that individual; and
(ii) The expertise of any expert panel, as a whole, involved in expert judgment

elicitation comports with the level and variety of knowledge required by the questions or issues presented to that panel.
(5) Explain the relationship among the information and issues presented to experts prior to the elicitation process, the elicited judgment of any expert panel or individual, and the purpose for which the expert judgment is being used in compliance application(s).
(6) Provide documentation that the initial purpose for which expert judgment was intended, as presented to the expert panel, is consistent with the purpose for which this judgment was used in compliance application(s).
(7) Provide documentation that the following restrictions and guidelines have been applied in eliciting expert judgment:
(i) At least five individuals shall be used in any expert elicitation process, unless there is a lack of unavailability of experts and a documented râtionale is provided that explains why fewer than five individuals were selected.
(ii) At least two-thirds of the experts involved in an elicitation shall consist of individuals who are not employed directly by the Department or by the Department's contractors, unless the Department can demonstrate and document that there is a lack or unavailability of qualified independent experts. If so demonstrated, at least one-third of the experts involved in an elicitation shall consist of individuals who are not employed directly by the Department or by the Department's contractors.
(c) The public shall be afforded a reasonable opportunity to present its scientific and technical views to expert panels as input to any expert elicitation process."

"§ 194.27 Peer review.

(a) Any compliance application shall include documentation of peer review that has been conducted, in a manner required by this section, for:
(1) Conceptual models selected and developed by the Department;
(2) Waste characterization analyses as required in § 194.24(b); and
(3) Engineered barrier evaluation as required in § 194.44.
(b) Peer review processes required in paragraph (a) of this section, and conducted subsequent to the promulgation of this part, shall be conducted in a manner that is compatible with NUREG-1297, "Peer Review for High-Level Nuclear Waste Repositories," published February 1988. (Incorporation by reference as specified in § 194.5.)
(c) Any compliance application shall:
(1) Include information that demonstrates that peer review processes required in paragraph (a) of this section, and conducted prior to the implementation of the

promulgation of this part, were conducted in accordance with an alternate process substantially equivalent in effect to NUREG-1297 and approved by the Administrator or the Administrator's authorized representative; and
(2) Document any peer review processes conducted in addition to those required pursuant to paragraph (a) of this section. Such documentation shall include formal requests, from the Department to outside review groups or individuals, to review or comment on any information used to support compliance applications, and the responses from such groups or individuals."

The packaging of waste at the originating sites; transport to the site; transport vehicles; and disposal of heat-generating waste are beyond the scope of this study and are not dealt with in this report.

The health and safety consequences of the postulated repository failure mechanisms appear to be so minimal that simplifications in design may be justified, and cost-effectiveness studies should be carried out to determine whether they would be acceptable. However, the probability and the consequences of potentially rapid flow of brine solutions containing radionuclides, through more permeable formations, have not been completely determined. Once these have been resolved, conventional safety considerations (e.g., number of shafts and packaging of waste for highway transport) might determine the optimum design.

Relaxation of the WIPP waste acceptance criteria (e.g., elimination of the incineration of some of the waste at the Process Experimental Pilot Plant (PREPP) facility and removal of the requirement for the use of steel-case overpack of the wooden boxes) may also have minimal consequences.

EPA'S CERTIFICATION DECISION

Subsequent to the publication of the EPA's regulations on criteria for WIPP certification, DOE undertook a major effort to comply with the EPA's requirements. The result was the decision by the EPA (1998) to certify that WIPP has met the EPA's criteria. However, this certification included certain limitations and requirements. Excerpts of the EPA's certification decision are as follows:

"The EPA finds that DOE has demonstrated that the WIPP will comply with EPA's radioactive waste disposal regulations at Subparts B and C of 40 CFR Part 191.

This decision allows the WIPP to begin accepting transuranic waste for disposal, provided that other applicable environmental regulations have been met and once a 30-day Congressionally-required waiting period has elapsed. EPA's decision is based on a thorough review of information submitted by DOE, independent technical analyses, and public comments. The EPA determined that DOE met all of the applicable requirements of the WIPP compliance criteria at 40 CFR Part 194. However, DOE must meet certain conditions in order to maintain a certification for the WIPP and before shipping waste for disposal at the WIPP."

"The EPA will continue to have a role at the WIPP after this certification becomes effective. As discussed above, DOE must submit periodic reports on any activities or conditions at the WIPP that differ significantly from the information contained in the most recent compliance application. The EPA may also, at any time, request additional information from DOE regarding the WIPP. The Agency will review such information as it is received to determine whether the certification must be modified, suspended, or revoked. Such action might be warranted if, for example, significant information contained in the most recent compliance application were no longer to remain true. The certification could be modified to alter the terms or conditions of certification—for example, to add a new condition, if necessary to address new or changed activities at the WIPP. The certification could be revoked if it becomes evident in the future that the WIPP cannot or will not comply with the disposal regulations. Either modification or revocation must be conducted by rule-making, in accordance with the WIPP compliance criteria (§§ 194.65-66). Suspension may be initiated at the Administrator's discretion, in order to promptly reverse or mitigate a potential threat to public health. For instance, a suspension would take effect if, during emplacement of waste, a release from the WIPP occurred in excess of EPA's containment limits."

"In addition to reviewing annual reports from DOE regarding activities at the WIPP, EPA periodically will evaluate the WIPP's continued compliance with the WIPP compliance criteria and disposal regulations. As directed by Congress, this "recertification" will occur every five years. For recertification, DOE must submit to EPA for review the information described in the WIPP compliance criteria (although, to the extent that information submitted in previous certification applications remains valid, it can be summarized and referenced rather than resubmitted) (§ 194.14). In accordance with the WIPP compliance criteria, documentation of continued compliance will be made available in EPA's dockets, and the public will be provided at least a 30-day period in which to submit comments. The EPA's decision on recertification will be announced in the *Federal Register* (§ 194.64)."

"Notices announcing EPA inspections or audits to evaluate implementation of quality assurance ("QA") and waste characterization requirements at generator facilities will be published in the *Federal Register*. The public will have the opportunity to submit written comments on the waste characterization and QA program plans submitted by DOE. As noted above, EPA's decisions on whether to approve waste generator QA program plans and waste characterization systems of controls—and thus, to allow shipment of specific waste streams for disposal at the WIPP—will be conveyed by a letter from EPA to DOE. A copy of the letter, as well as any EPA inspection or audit reports, will be placed in EPA's docket."

"Finally, the WIPP compliance criteria provide EPA the authority to conduct inspections of activities at the WIPP and at all off-site facilities which provide information included in certification applications. (§ 194.21) The Agency expects to conduct periodic inspections, both announced and unannounced, to verify the adequacy of information relevant to certification applications. The Agency may conduct its own laboratory tests, in parallel with those conducted by DOE. The Agency also may inspect any relevant records kept by DOE, including those records required to be generated in accordance with the compliance criteria. For example, EPA intends to conduct ongoing inspections or audits at the WIPP and at waste generator sites to ensure that approved quality assurance programs are being adequately maintained and documented. The EPA plans to place inspection reports in its docket for public examination."

BRIEF WIPP CHRONOLOGY

1957 National Research Council recommended salt as host rock, Identified areas to investigate, and Identified favorable siting criteria

1974 Atomic Energy Commission selected site near Carlsbad for exploratory work

1979 Congress authorized WIPP for research and development for safe disposal of defense-generated radioactive waste

1980 DOE issued Final Environmental Impact Statement (FEIS)

1981 DOE issued Record of Decision

1981 DOE began construction of WIPP Exploratory Shaft

1985 EPA issued 40 CFR 191--radioactive waste disposal standards applicable to WIPP

1986 EPA stated facilities must comply with Resource Conservation and Recovery Act (RCRA) for disposal of mixed (hazardous and radioactive) waste

1990 New Mexico was authorized by EPA to regulate mixed waste

1990 DOE issued first Supplemental Environmental Impact Statement (SEIS)

1991 DOE submitted Parts A and B of the RCRA Permit Application to New Mexico

1992 WIPP Land Withdrawal Act permanently segregates land for WIPP and gave EPA regulatory authority to certify WIPP compliance to 40 CFR 191.

1995 DOE submitted revised RCRA Permit Application to New Mexico Environment Department

1996 EPA issued 40 CFR 194, compliance criteria in February

1996 DOE submitted 84,000 page Compliance Certification Application to EPA

1998 DOE issued SEIS II in January

1998 EPA certified WIPP ready for disposal

1998 New Mexico Environment Department issued draft hazardous waste facility permit (HWFP) for disposal of transuranic mixed waste

1999 First shipment non-mixed waste in March

1999 New Mexico Environment Department issued Hazardous Waste Facility Permit

2000 First shipment of mixed waste in September

Current Permitted Methodologies for CH TRU Wastes

INTRODUCTION

TRU waste for disposal at the WIPP is characterized to meet RCRA driven requirements; EPA characterization requirements stemming from 40 CFR Parts 191 (EPA 1993) and 194, (EPA 1998) transportation requirements; and WIPP operations and safety requirements. Only the RCRA and 40 CFR 194 requirements are subjects of this review; hence, the transportation and WIPP characterization requirements are not discussed in this report.

RCRA CH TRU WASTE CHARACTERIZATION

Waste characterization for disposal at the WIPP is conducted on a waste stream basis (i.e., waste material generated from a single process or activity that is similar in material, physical form, isotropic make-up, and hazardous constituents) and also on a container basis. Defense production facilities assign the waste stream identifier for each container of waste that is shipped. The waste designation is selected from one of three broad categories of solid wastes: Homogenous Solids, Soil/Gravel, and Debris Wastes (NMED 1999). In addition, a number of sub-categories are assigned to the wastes. Characterization and analysis methods vary for each category and sub-category of waste.

The Waste Analysis Plan (WAP), which is part of the Permit (DOE 1997), describes waste characterization activities that a TRU waste generator/storage site must complete before shipping waste to the WIPP for disposal. These activities include test methods; details of planned waste sampling and analysis processes; a description of the waste shipment screening and verification process; and a description of the quality assurance/quality control program. Before the WIPP manages, stores, or disposes of CH TRU mixed waste from a generator/storage site, the site is required to characterize waste in accordance with WAP requirements. For each container of waste destined for disposal, defense production facilities provide the WIPP operators with a written characterization summary known as a Waste Stream Profile Form (WSPF). A four-page sample is shown in Fig. 4 (NMED 1999).

WIPP WASTE STREAM PROFILE FORM

Waste Stream Profile Number: ______________________

Generator Site Name: ________________________ Technical Contact: ________________________

Generator Site EPA ID: __________________ Technical Contact phone number: ________________

Date of audit report approval by NMED: ____

Title, version number, and date of documents used for WAP certification: __________________

____

Did your facility generate this waste? ☐ Yes ☐ No

If no, provide the name and EPA ID of the original generator: ______________________________

____

WIPP ID: ________________________ Summary Category Group: ____________________

Waste Matrix Code Group: ____________________ Waste Stream Name: ________________

Description from the WTWBIR: ____

____

Defense Waste: ☐ Yes ☐ No Check one: ☐ CH ☐ RH

Number of SWBs: __________ Number of Drums: __________ Number of Canisters: __________

Batch Data Report numbers supporting this waste stream characterization: __________________

List applicable EPA Hazardous Waste Codes: ____

Applicable TRUCON Content Codes: ____

Acceptable Knowledge Information

[For the following, enter supporting the documentation used (i.e., references and dates)]

Required Program Information

- Map of site: ____
- Facility mission description: ____

Fig. 4. WIPP waste stream profile form.

- Description of operations that generate waste: ____________________

____

- Waste identification/categorization schemes: ____________________
- Types and quantities of waste generated: ____________________
- Correlation of waste streams generated from the same building and process, as appropriate: ____________________

____

- Waste certification procedures: ____________________

Required Waste Stream Information

- Area(s) and building(s) from which the waste stream was generated: ____________________
- Waste stream volume and time period of generation: ____________________
- Waste generating process description for each building: ____________________
- Process flow diagrams: ____________________

____

- Material inputs or other information identifying chemical/radionuclide content and physical waste form: ____________________

____

- Which Defense Activity generated the waste: (check one)

  ☐ Weapons activities including defense inertial confinement fusion

  ☐ Naval Reactors development

  ☐ Verification and control technology

  ☐ Defense Research and development

  ☐ Defense nuclear waste and material by products management

  ☐ Defense nuclear materials production

  ☐ Defense nuclear waste and materials security and safeguards and security investigations

Supplemental Documentation

Process design documents: ____________________

Fig. 4. (cont'd)

Standard operating procedures: ______________________________

Safety Analysis Reports: ______________________________

Waste packaging logs: ______________________________

Test plans/research project reports: ______________________________

Site data bases: ______________________________

Information from site personnel: ______________________________

Standard industry documents: ______________________________

Previous analytical data: ______________________________

Material safety data sheets: ______________________________

Sampling and analysis data from comparable/surrogate waste: ______________________________

Laboratory notebooks: ______________________________

Sampling and Analysis Information

[For the following, when applicable, enter procedure title(s), number(s), and date(s)]

Radiography: ______________________________

Visual examination: ______________________________

Headspace Gas Analysis

VOCs: ______________________________

Flammable: ______________________________

Other gases (specify): ______________________________

Homogeneous Solids/Soils/Gravel Sample Analysis

Total metals: ______________________________

PCBs: ______________________________

VOCs: ______________________________

Nonhalogenated VOCs: ______________________________

Semi-VOCs: ______________________________

Other (specify): ______________________________

Waste Stream Profile Form Certification

I hereby certify that I have reviewed the information in this Waste Stream Profile Form, and it is complete and accurate to the best of my knowledge, I understand that this information will be made available to regulatory agencies and that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.

Signature of Site Project Manager	Printed Name and Title	Date

NOTE: (1) Use back of sheet or continuation sheets, if required.
(2) If radiography, visual examination, headspace gas analysis, and/or homogeneous solids/soils/gravel sample analysis were used to determine EPA Hazardous Waste Codes, attach signed Characterization Information Summary documenting this determination.

Fig. 4. (cont'd)

Waste characterization based on 40 CFR 194

Waste characterization as described in 40 CFR 194 (EPA 1998) requires that a system be in place to track and control the inventory of waste components to assure that limits associated with the components are not exceeded. The waste components to be tracked and controlled, and the associated limits, are set by a Performance Assessment (PA) conducted by the DOE to show that the WIPP complies with the performance criteria of 40 CFR 191(EPA 1993). The waste components and the limits, all of which are total inventory limits at repository closure, are presented in the WIPP Compliance Certification Application (CCA).

The current CH/TRU waste characterization program characterizes each container of TRU waste for each of the limited components. However, characterizing on a waste stream basis, as is done for RCRA waste characterization, is more than adequate to assure adherence to the large limits allowed at repository closure. The Performance Agreement (PA) and the Compliance Certification Application (CCA) specify no corresponding limit associated with radionuclides; however, the current CH/TRU waste characterization program also quantifies a list of specified radionuclides on a container basis.

ORIGIN OF CH TRU WASTE AND ITS ACCEPTANCE CRITERIA AT WIPP

The TRU mixed wastes that are shipped to the WIPP originate at DOE generator/storage sites and contain both radiological and hazardous waste constituents. The DOE and EPA agreed that, of the hundreds of radionuclides present within these wastes, only ten are important for the WIPP performance assessment: ^{241}Am, ^{244}Cm, ^{137}Cs, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{90}Sr, ^{233}U, and ^{234}U. Of these ten, ^{234}Sr, ^{233}U, and ^{137}Cs are important for RH but not for CH waste streams.

Major types of operations generating waste

Examples of the major types of operations that generate this waste include the following:

Production of nuclear products: This category includes reactor operation; radionuclide separation or finishing; and weapons fabrication and manufacturing. The majority of the TRU mixed wastes were generated by weapons fabrication and radionuclide separation or finishing processes. More specifically, wastes resulting from this category consist of residues from chemical processes; air and liquid filtration; casting; machining; cleaning; product quality sampling; analytical activities; and maintenance and refurbishment of equipment and facilities.

Plutonium recovery: These wastes are residues from the recovery of plutonium-contaminated molds; metals; glass; plastics; rags; salts used in electro-refining; precipitates; firebrick; soot; and filters.

Research and development: This group includes a variety of hot-cell or glovebox activities that often simulate full-scale operations described above, producing similar TRU mixed wastes. Other types of R&D projects include metallurgical research; actinide separations; process demonstrations; and chemical and physical properties determinations.

Decontamination and decommissioning: Facilities and equipment that are no longer needed or usable are decontaminated and decommissioned, resulting in TRU mixed wastes consisting of scrap materials; cleaning agents; tools; piping; filters; plexiglass; gloveboxes; concrete rubble; asphalt; cinder blocks; and other building materials. These materials are expected to be the largest category by volume of TRU mixed waste to be generated in the future.

The TRU mixed wastes that are to be shipped to the WIPP facility for disposal have been placed into waste categories based on their physical and chemical properties (Table 1). The waste generating processes can be described in five general categories:

1. Wastes (such as combustible waste) that result from cleaning and decontamination activities in which items such as towels and rags become contaminated both with hazardous waste constituents and radioactivity. In these cases, the hazardous waste and the radioactive constituent are intimately mixed, both on the rag or towel used for cleaning and as residuals on the surface of the object being cleaned. These waste forms are not homogeneous in nature; however, they are generated in a fashion that ensures that the hazardous and radioactive contaminants coexist throughout the waste matrix.
2. Wastes generated when materials which contain metals and metal ions believed to exhibit the toxicity characteristic (EPA 1996b) become contaminated with radioactivity as the result of plutonium operations (leaded rubber, some glass, and metal waste are typical examples). These materials may also become contaminated with solvents during decontamination or plutonium recovery activities.
3. A class of plutonium processes where non-metallic objects are used and become contaminated with radioactive materials. These objects are subsequently cleaned with solvents to recover plutonium. Surfaces of the objects (such as graphite, filters, and glass) are contaminated with both radioactive and hazardous constituents.
4. Waste generating processes involving foundry operations where impurities are removed from plutonium. These impurities may result in the deposition of toxicity characteristic (EPA 1996b) metals and metal ions
5. In all of the process waste categories in the second half of Table 1, the hazardous and radioactive constituents are physically mixed together as a result of the treatment process. In these wastes, the release of any portion of the waste matrix will involve both the hazardous and the radioactive waste components, because the treatment process generates a relatively homogeneous waste form.

Table 1. Summary of waste generation processes and waste forms.

Waste Category	Hazardous Waste Codes	Description of Processes	Description of Waste Form
Combustibles	F001, F002, F003, D008, D019	Cloth and paper wipes are used to clean parts and wash down gloveboxes. Wood and plastic parts are removed from gloveboxes after they are cleaned. Lead may occur as shielding tape or as minor noncombustible waste in this category.	Materials such as metals may retain traces of organics left on surfaces that were cleaned. Waste may remain on the cloth and paper that was used for cleaning or for wiping up spills.
Graphite		Graphite molds, which may contain impurities of metals, are scraped and cleaned with solvents to remove the recoverable plutonium.	Surfaces may retain residual solvents. Lead may be used as shielding or may be an impurity in the graphite.
Filters	F001, F002	Filters are used to capture radioactive particulate in air streams associated with numerous plutonium operations and to filter particulate from aqueous streams.	Filter media may retain organic solvents that were present in the air or liquid streams.
Benelex® and Plexiglas®	F001, F002, D008	Materials are used in gloveboxes as neutron absorbers. The glovebox assembly often includes leaded glass. All surfaces may be wiped down with solvents to remove residual plutonium.	Surfaces may retain residual solvents from wiping operations. Leaded glass may also be present.
Firebrick and Ceramic Crucibles	F001, F002, F005, D006, D007, D008	Firebrick is used to line plutonium processing furnaces. Ceramic crucibles are used in plutonium analytical laboratories. Both may contain metals as surface contaminants.	Metals deposited during plutonium refining or analytical operations could remain as residuals on surfaces. Surfaces may retain residual solvents.
Leaded Rubber	D008	Leaded rubber includes lead oxide impregnated materials such as gloves and aprons.	The leaded rubber could potentially exhibit the toxicity characteristic.

Table 1. (cont'd)

Waste Category	Hazardous Waste Codes	Description of Processes	Description of Waste Form
Metal	F001, F002, D008	Metals range from large pieces removed from equipment and structures to nuts, bolts, wire, and small parts. Many times, metal parts will be cleaned with solvents to remove residual plutonium.	Solvents may exist on the surfaces of metal parts. The metals themselves potentially exhibit the toxicity characteristic.
Glass	F001, F002, D006, D007, D008, D009	Glass includes Raschig rings removed from processing tanks, leaded glass removed from gloveboxes, and miscellaneous laboratory glassware.	Solvents may exist as residuals on glass surfaces and in empty containers. The leaded glass may exhibit the toxicity characteristic.
Inorganic Wastewater Treatment Sludge	F001-F003, D006-D009, P015	Sludge is vacuum filtered and stabilized with cement or other appropriate sorbent prior to packaging.	Traces of solvents and heavy metals may be contained in the treated sludge which is in the form of a solid dry monolith, highly viscous gel-like material, or dry crumbly solid.
Organic Liquid and Sludge	F001, F003	Organic liquids such as oils, solvents, and lathe coolants are immobilized through the use of various solidification agents or sorbent materials.	Solvents and metals may be present within the matrix of the solids created through the immobilization process.
Solidified Liquid	F001, F003, D006, D008	Liquids that are not compatible with the primary treatment processes and have to be batched. Typically these liquids are solidified with portland or magnesium cement.	Solvents and metals may be present within the matrix of the solids created through the immobilization process.
Inorganic Process Solids and Soil	F001, F002, F003, D008	Solids that cannot be reprocessed or process residues from tanks, firebrick fines, ash, grit, salts, metal oxides, and filter sludge. Typically solidified with portland or gypsum-based cements.	Solvents and metals may be present within the matrix of the solids created through the immobilization process.

Table 1. (cont'd)

Waste Category	Hazardous Waste Codes	Description of Processes	Description of Waste Form
Pyrochemical Salts	D007	Molten salt is used to purify plutonium and americium. After the radioactive metals are removed, the salt is discarded.	Residual metals may exist in the salt depending on impurities in the feedstock.
Cation and Anion Exchange Resins	D008	Plutonium is sorbed on resins and is eluted and precipitated.	Feed solutions may contain traces of solvents or metals depending on the preceding process.

Categories of TRU mixed waste

TRU mixed wastes from the above operations are listed by defense production facilities as belonging in one of three broad Summary Category Groups. The characterization is based on the final physical form of the wastes as follows:

Summary category group S3000—homogeneous solids: These wastes include a minimum of 50% (by volume) solid inorganic process residues such as inorganic sludge, salt waste, and pyrochemical salt waste—but exclude soil. Other waste streams are included in this Summary Category Group based on the specific waste stream types and final waste form. This Summary Category Group is expected to contain toxic metals and spent solvents.

Summary Category Group S4000—Soils/Gravel: This Category is assigned to waste streams containing at least 50% (by volume) soil and gravel. This Summary Category Group is expected to contain toxic metals and is also further categorized by the amount of debris included in the matrix.

Summary Category Group S5000—Debris Wastes: These are heterogenous wastes that are at least 50% (by volume) materials that exceed 2.36 inch (60 mm) particle size and that are manufactured objects; plant or animal matter; or natural geologic materials. Smaller particles may be considered debris if they are manufactured objects and if they do not belong to S3000 or S4000. Examples of S5000 waste include gloves; hoses; aprons; floor tile; insulation; plastic; rubber; wood; paper; cloth; and biological materials.

The most common RCRA-regulated hazardous constituents in TRU mixed waste

1. Metals and metal ions: Some of the TRU mixed waste to be emplaced in the WIPP facility contains toxic metals contained in EPA hazardous waste codes D004 through D011 (EPA 2000a). Cadmium, chromium, lead, mercury, selenium, and silver are present in discarded tools and equipment; solidified sludge; cemented laboratory liquids; and waste from decontamination and decommissioning activities. A large percentage of the waste eonsists of lead-lined gloveboxes; leaded rubber gloves and aprons; lead bricks and piping; lead tape; and other lead items. Lead, because of its radiation-shielding applications, is the most prevalent toxicity-characteristic metal present.

2. Halogenated volatile organic compounds: Some of the TRU mixed waste to be emplaced in the WIPP facility contains spent halogenated volatile organic compound (VOC) solvents listed as EPA hazardous waste numbers F001 through F005 (EPA 2000a). Tetrachloroethylene; trichloroethylene; methylene chloride; carbon tetrachloride; 1,1,1-trichloroethane; and 1,1,2-trichloro-1,2,2-trifluoroethane (EPA hazardous waste codes F001 and F002) are the most prevalent halogenated organic compounds identified in TRU mixed waste that may be managed at the WIPP facility during the Disposal Phase. These compounds are commonly used to clean metal surfaces prior to plating, polishing, or fabrication; to dissolve other compounds; or as coolants. Because they are highly volatile, only small amounts typically remain on equipment after cleaning or, in the case of treated wastewater, in the sludge after clarification and flocculation. Radiolysis may also generate halogenated volatile organic compounds.

3. Non-halogenated volatile organic compounds: Xylene, methanol, and n-butanol are the most prevalent nonhalogenated VOCs in TRU mixed waste that may be managed at the WIPP facility. Like the halogenated VOCs, they are used as degreasers and solvents and are similarly volatile. The same analytical methods that are used for halogenated VOCs are used to detect the presence of nonhalogenated VOCs.

Prohibited Items

The TRU mixed waste forms describe both radioactive and hazardous characteristics exhibited by the wastes. The Permit Treatment, Storage, and Disposal Facility Waste Acceptance Criteria (TSDF-WAC) places limits on the waste that can be shipped to the WIPP facility based on the characteristics of the waste form. The following TRU mixed wastes are prohibited at the WIPP facility:

1. Liquid waste. Residual liquid in the container in excess of what is reasonably achievable by pouring, pumping, and/or aspirating; liquid in the internal container in excess of 1 inch (2.5 cm) of liquid in the bottom of the container; or total residual liquid in any payload container (e.g., 55 gallon drum or standard waste box) in excess of 1% (by volume) of that container.
2. Pyrophoric materials, such as elemental potassium.
3. Hazardous wastes not occurring as co-contaminants with TRU wastes.
4. Wastes incompatible with backfill; seal and panel closures materials; container and packaging materials; shipping container materials; or other wastes.
5. Wastes containing explosives or compressed gases.
6. Wastes with polychlorinated biphenyl (PCB) concentration of 50ppm (50 mg/kg) or more.
7. Wastes exhibiting the characteristic of ignitability, corrosivity, or reactivity (EPA Hazardous Waste Numbers D001, D002, or D003).
8. Any waste container that does not have VOC concentration values reported for the headspace.
9. Any waste container which has not undergone either radiographic or visual examination.
10. Any waste container from a waste stream which has not been preceded by an appropriate, certified Waste Stream Profile Form.

Before accepting a container holding TRU mixed waste, WIPP operators audit the radiography or visual examination (VE) data records of the generator/storage sites to verify that the container holds no unvented compressed gas, and that residual liquid does not exceed 1% (volume) in any payload container. Radiography tapes are to be selected randomly for at least 1% of containers received at the WIPP, at which time they are reviewed and compared to radiographic data forms. If waste does not include at least 50% of any given category by volume, characterization shall be performed using the waste characterization process required for the category constituting the greatest volume of waste for that waste stream. To ensure the integrity of the WIPP facility, waste streams identified as containing incompatible materials or materials incompatible with waste containers are not to be shipped to the WIPP unless they are treated to remove the incompatibility.

Waste generated as a result of waste container handling and processing activities at the WIPP facility are known as "derived" wastes. Because derived wastes can contain only those RCRA-regulated materials present in the waste from which they were derived, no additional characterization of the derived waste is required for disposal purposes. In other words, generator/storage site characterization data as well as knowledge of the processes at the WIPP facility will be used to identify and characterize hazardous waste and hazardous constituents in derived waste.

TRU waste, by definition, must contain 100 nCi or more of transuranic elements per gram of waste, which means that the radioactive component of the waste will always be present within the waste in significant concentrations. The TSDF-WAC limitations and restrictions are provided to ensure that any waste form received at the WIPP facility is stable and can be managed safely. One benefit of waste form restrictions— such as no liquids—is that they limit the kinds of releases that could occur to those that would be readily detectable through visual inspection (i.e., large objects that fall out of ruptured containers) or through the use of radiation monitoring—either locally or within the adjacent area—to detect materials that have escaped from containers.

Releases and spills

Some waste forms only contain radioactive contamination on the surface, because they are not the result of a treatment process or are not porous in form. These include glass, leaded rubber, metals, graphite, ceramics, firebricks, and plastics. In theory, a hazardous waste release could occur if the interiors of these materials became exposed and were involved in a release or spill. Such an occurrence is not likely during operations, because no activities are planned or anticipated that would result in the breaking of these materials to expose fresh surfaces. The WIPP facility will handle only sealed containers of waste and derived waste. The practice of handling sealed containers minimizes the opportunity for releases or spills. For the purposes of safety analysis, it was assumed that releases and spills during operations occur by either of two mechanisms: 1) surface contamination, and 2) accidents.

Regardless of how the release occurs, the nature of the waste and the processes that generated it is such that the radioactive and hazardous components are intimately mixed. A release of one without the other is not likely, except for releases of VOCs from containers. Surface contamination is the only credible source of contamination external to the containers during normal operations. Surface contamination is assumed to be caused by waste management activities at the generator site that result in the contamination of the outside of a waste container. Contamination would most likely consist of particulate matter (dirt or dust) that would be deposited during generator-site handling/loading activities. This contamination may not be detected by visible inspections. Surface contamination is monitored upon arrival at the WIPP facility through the use of swipes and radiation monitoring equipment, as specified in the WIPP Permit (NM Hazardous Waste Regulations, Title 20; NMED 1999). Detection using radioactivity is very sensitive and allows for the detection of contamination that may not be visible on the surface of the container. This exceeds the capability required by the RCRA, which is generally limited to inspections that detect only visible evidence of spills or leaks. Releases can occur from accidents, and those that occur within the waste handling process are assumed to result in the release of radioactive contaminants and VOCs. Radioactive releases are detectable using surface-sampling (swipe) techniques. The most common RCRA-regulated hazardous constituents in TRU mixed waste to be managed at the WIPP facility consist of: metals; halogenated volatile organic compounds; and nonhalogenated volatile organic compounds.

WASTE STREAM IDENTIFICATION

Waste characterization activities at generator/storage sites include the following, although not all of these techniques will be used on each container:

1. Radiography, which is an x-ray technique, to determine physical contents of containers.
2. Visual examination (VE) of opened containers as an alternative way to determine their physical contents or to verify radiography results.
3. Headspace-gas sampling to determine VOC content of gases in the void volume of the containers.
4. Sampling and analysis of waste forms that are homogeneous and can be representatively sampled to determine concentrations of hazardous waste constituents and toxicity-characteristic contaminants of waste in containers.

5. Compilation of acceptable knowledge (AK) documentation into an auditable record, including process knowledge and prior sampling and analysis data.
6. Non-destructive assay, typically segmented gamma scans (SGS) and passive/active neutron interrogation (PAN), to quantify radionuclides for 40 CFR 194 waste characterization compliance.

Auditable records allow DOE operators to conduct a systematic assessment, analysis, and evaluation of generator/storage site compliance with the WAP and the Permit. Waste analysis parameters to be characterized include confirmation of physical form; presence of toxicity characteristic contaminants; and exclusion of prohibited items. The characterization techniques used by generator/storage sites include AK, which incorporates confirmation by headspace-gas sampling and analysis; radiography; and homogeneous waste sampling and analysis. All confirmation and characterization activities are to be performed in accordance with the WAP. The analytical requirements are specified by the analytical method being used (e.g., Fourier Transform Infrared Spectroscopy (FTIRS), Gas Chromatography/Mass Spectrometry (GC/MS)).

Waste analysis parameters characterized for the 40 CFR 194 (EPA 1998) characterization program are quantity of metals; quantities of cellulosics; plastics; and rubber; quantity of free water; and a list of ten radionuclides. The characterization techniques used by generator/storage sites for these parameters also include AK and radiography as well as non-destructive assay (NDA).

Radiography

Radiography techniques have been developed by the DOE to aid in the examination and identification of containerized waste. There are specific requirements that relate to radiography methods used at respective facilities. A radiography system typically consists of: 1) an X-ray-producing device; 2) an imaging system; 3) an enclosure for radiation protection; 4) a waste container handling system; 5) an audio/video recording system; and 6) an operator control and data acquisition station.

Although these six components are required, it is expected that there will be some variation within a given system between sites. The radiography of a waste container is recorded by an audio/videotape or equivalently non-alterable media and is maintained as a non-permanent record. The estimated waste material parameter and weights should be determined by compiling an inventory of waste items, residual materials, and packaging materials. Containers whose contents prevent full examination to the extent expected for the radiography technique and waste form, are subject to visual examination.

Visual examination

As an additional quality control (QC) check on radiography, or in lieu of radiography, the waste container contents are verified directly by visual examination. The visual examination consists of a semi-quantitative and/or qualitative evaluation of the waste container contents, and is recorded on audio/videotape. Visual examination is performed on a statistically determined portion of waste containers to verify the results of radiography. This verification includes use of the Waste Matrix Code; waste material parameter weights; and the ensurance of the absence of prohibited items.

Visual examination includes describing the contents of a waste container, and estimating or measuring the weight of the contents. The description identifies the discernible waste items, residual materials, packaging materials, and waste material parameters. Estimated weights are established through the use of historically derived waste weight tables and an estimation of the waste volumes.

Headspace-gas sampling and analysis

Headspace-gas sampling is performed on waste containers that are in compliance with the container temperature equilibrium requirements (i.e., 72 h at 18°C or higher). Waste containers designated as summary category S5000 (Debris waste) are sampled for headspace gas a minimum of 142 d after packaging. Waste containers designated as Summary Categories S3000 (Homogenous solids) and

S4000 (Soil/gravel) are sampled a minimum of 225 d after packaging. This drumage criteria ensures that the drum contents have reached 90 % of steady state concentration within each layer of confinement to allow a representative sample to be taken (NMED 1999.) Two types of headspace-gas sampling protocols may be employed: 1) the manifold headspace-gas sampling protocol, and 2) the direct canister headspace-gas sampling protocol.

Once the headspace gas sample has been collected in accordance with the HWFP requirements, the sample is taken to a laboratory for analysis. The laboratory analyzes the sample using the allowable methods in the HWFP and reports the concentration of all analytes on the target analyte list. In addition, the presence of any tentatively identified compounds (TICs) observed during the analysis is reported.

Sampling and analysis of homogenous solids and soil/gravel

The methods used to collect samples of TRU mixed waste classified as homogenous solids and soil/gravel from waste containers, are designed to ensure that the samples are representative of the waste from which they are taken. A sufficient number of samples are collected to adequately represent the waste being sampled. For those waste streams defined as Summary Category Groups S3000 or S4000, debris that may also be present within these wastes need not be sampled. Samples of retrievably stored waste containers are collected using appropriate coring equipment or other EPA-approved methods to collect a representative sample. Newly-generated wastes that are sampled from a process as they are generated may be sampled using EPA-approved methods—including scoops and ladles—that are capable of collecting a representative sample.

The QC requirements for sampling homogenous solids and soil/gravel include: collecting co-located samples from cores or other sample types to determine precision; equipment blanks to verify cleanliness of the sampling and coring tools and sampling equipment; and analysis of reagent blanks to ensure that reagents, such as deionized or high pressure liquid chromatography (HPLC) water, are of sufficient quality.

Once the homogeneous solid or soil/gravel sample has been collected in accordance with the HWFP requirements, the sample is taken to a laboratory for analysis. The laboratory analyzes the sample using the allowable methods in the HWFP and reports the concentration of all analytes on the target analyte list. In addition, the presence of any tentatively-identified compounds (TICs) observed during the analysis is reported.

Acceptable knowledge

This characterization technique incorporates confirmation by headspace-gas sampling and analysis; radiography; and homogeneous waste sampling and analysis. Both RCRA regulations and the New Mexico Hazardous Waste Management Regulations (NMED 1997) authorize the use of AK in appropriate circumstances by waste generators—or treatment, storage, or disposal facilities—to characterize hazardous waste. Acceptable knowledge is described by the EPA (EPA 1994) as an alternative to sampling and analysis; it can be used to meet all or part of the waste characterization requirements under the RCRA. AK includes a number of techniques used to characterize TRU mixed waste, such as process knowledge; records of analysis acquired prior to RCRA; and other supplemental sampling and analysis data (EPA 1994). AK is used in TRU mixed waste characterization activities in three ways:

1. To delineate TRU mixed waste streams
2. To assess if TRU mixed heterogeneous debris wastes exhibit a toxicity characteristic (NMED 1997)
3. To assess if TRU mixed wastes are listed (NMED 1997)

TRU mixed waste streams are evaluated by applicable provisions of the AK process prior to management, storage, or disposal by the Permittees at the WIPP. TRU mixed waste management AK information defines waste categorization schemes and terminology; provides a breakdown of the types and quantities of TRU mixed wastes that are generated and stored at the site; and describes how wastes are tracked and managed at the site—including historical and current operations. Information related to TRU mixed waste certification procedures and the types of documentation (e.g., waste profile forms) used to summarize AK are also provided. The amount and type of supplemental AK information required from generator/storage sites is site-specific and cannot be mandated, but sites collect information as appropriate to support required AK information.

The AK written record includes a summary that identifies all sources of waste characterization information used to delineate the waste stream. For each TRU mixed waste stream, the generating sites compile all process information and data supporting the AK used to characterize that waste stream. The type and quantity of supporting documentation will vary by waste stream, depending on the process generating the waste and site-specific requirements imposed by the DOE.

Non-destructive assay (NDA)

Radioassay is a term used to define measurement methods for determining the radionuclide content of waste. The isotopic composition of RH-TRU waste is usually determined from documented AK and, in some cases, from measurements taken on the product material during processing at each site. NDA techniques allow an item to be assayed without altering its physical or chemical form. NDA techniques can be classified as active or passive. Passive NDA is based on the observation of spontaneously-emitted radiations created through radioactive decay of the isotopes of interest or their radioactive daughters. Most active NDA is based on the observation of gamma or neutron radiation that is emitted from a target isotope when that isotope undergoes a transformation resulting from an interaction with stimulating radiation provided by an appropriate external source.

STATISTICAL METHODS USED IN SAMPLING AND ANALYSIS

Generator/storage sites use statistical methods to: 1) select waste containers for visual inspection; 2) select retrievably-stored waste containers for totals analysis; 3) set the upper confidence limit; and 4) apply control charting for newly-generated waste stream sampling. Statistical sampling techniques are not currently employed in waste characterization activities employed for 40 CFR 194 (EPA 1999) compliance.

Selecting waste containers for visual examination

As a QC check on the radiographic examination of waste containers, a statistically-selected portion of the certified waste containers is opened and visually examined. The data from visual examination is used to verify the matrix parameter category, waste material parameter weights, and absence of prohibited items, as determined by radiography. The data obtained from the visual examination can also be used to determine— with acceptable confidence—the percentage of miscertified waste containers from the radiographic examination. Miscertified containers are those that radiography indicates meet the WIPP Waste Acceptance Criteria and Transuranic Package Transporter-II Authorized Methods for Payload Control, but visual examination indicates do not meet these criteria. Participating sites initially use an 11% miscertification rate to calculate the number of waste containers that are visually examined until a site-specific miscertification rate has been established.

The site-specific miscertification rate is applied initially to each Summary Category Group to determine the number of containers in that Summary Category Group requiring visual examination. However, a Summary Category Group-specific miscertification rate is determined when either six months have passed since radiographic characterization commenced on a given Summary Category Group or at least 50% of a given Summary Category Group has undergone radiographic characterization, whichever occurs first. The Summary Category Group is then subject to the visual examination requirements of this reevaluated Summary Category Group-specific miscertification rate to ensure that the entire Summary Category Group is appropriately characterized. The site-specific miscertification rate is reassessed annually.

Statistical sampling and analysis of homogeneous solids and soil/gravels for totals

The statistical approach for characterizing retrievably-stored homogeneous solids and soil/gravel waste using sampling and analysis relies on using acceptable knowledge to segregate waste containers into relatively homogeneous waste streams. Once segregated by waste stream, random selection and sampling of the waste containers followed by analysis of the waste samples are performed to ensure that the resulting mean contaminant concentration provides an unbiased representation of the true mean contaminant concentration for each waste stream.

Preliminary estimates of the mean concentration and variance of each RCRA-regulated contaminant in the waste are used to determine the number of waste containers to select for sampling and analysis. The preliminary estimates are made by obtaining a preliminary number of samples from the waste stream or from previous sampling from the waste stream. Preliminary estimates are based on samples from a minimum of five waste containers. Samples collected to establish preliminary estimates that are selected, sampled, and analyzed in accordance with applicable provisions of the WAP are used as part of the required number of samples to be collected.

The calculated total number of required waste containers can then be randomly sampled and analyzed. Waste container samples from the preliminary mean and variance estimates may be counted as part of the total number of calculated required samples if and only if:

1. There is documented evidence that the waste containers for the preliminary estimate samples were selected in the same random manner as is chosen for the required samples.
2. There is documented evidence that the method of sample collection in the preliminary estimate samples were identical to the methodology to be employed for the required samples.
3. There is documented evidence that the method of sample analysis in the preliminary estimate samples was identical to the analytical methodology employed for the required samples.
4. There is documented evidence that the validation of the sample analyses in the preliminary estimate samples was comparable to the validation employed for the required samples. In addition, the validated samples results should indicate that all sample results were valid according to the analytical methodology.

Upon collection and analysis of the preliminary samples, or at any time after the preliminary samples have been analyzed, the generator/storage site may assign hazardous waste codes to a waste stream. For waste streams with calculated upper confidence limits below the regulatory threshold, the site must collect the required number of samples if the site intends to establish that the constituent is below the regulatory threshold.

Statistical headspace gas sampling and analysis

If a waste stream meets the conditions for representative headspace gas sampling, then headspace-gas sampling of that waste stream may be done on a randomly-selected portion of containers in the waste stream. The minimum number of containers that are sampled is determined by taking an initial VOC sample from 10 randomly-selected containers. These samples are analyzed for all the target analytes.

Waste container samples from the preliminary mean and variance estimates may be counted as part of the total number of calculated required samples if and only if:

1. There is documented evidence that the waste containers for the preliminary estimate samples were selected in the same random manner as is chosen for the required samples.
2. There is documented evidence that the method of sample collection in the preliminary estimate samples were identical to the methodology to be employed for the required samples.
3. There is documented evidence that the method of sample analysis in the preliminary estimate samples were identical to the analytical methodology employed for the required samples.
4. There is documented evidence that the validation of the sample analyses in the preliminary estimate samples were comparable to the validation employed for the required samples. In addition, the validated samples results should indicate that all sample results were valid according to the analytical methodology.

The mean and standard deviation calculated after sampling *n* containers is then used to calculate a UCL_{90} for each of the headspace gas VOCs.

Control charting for newly-generated waste stream sampling

Significant process changes and process fluctuations associated with newly-generated waste are determined using statistical process control (SPC) charting techniques; these techniques require historical data for determining limits for indicator species, and subsequent periodic sampling to assess process behavior relative to historical limits. SPC is performed on waste prior to solidification or packaging for ease of sampling. If the limits are exceeded for any toxicity characteristic parameter, the waste stream can be recharacterized, and the characterization can be performed according to procedures required in the WAP.

A Shewhart control chart (Gilbert 1987) is a control chart for statistical means that is used for checking whether current data are consistent with past data and whether shifts or trends in means have occurred. If a current sample mean from the process lies within the limits, the process is said to be "in control," or consistent with historical data. If the current mean exceeds the limits, the process has likely changed from historical periods. Logical sets of historical data to be used for the construction of limits in this application are the data from the initial characterization of the waste stream, if available; from characterization of a different lot of the waste stream, or from a retrievably-stored waste stream of the same type from the same process. At a minimum, the logical set includes ten representative sample values collected and analyzed from the newly-generated waste stream. The data used for construction of the limits is justified. The underlying assumptions for control charts are that the data are independent and normally-distributed with constant mean μ and constant variance σ^2. The statistical tests for normality can be conducted and data transformation to normality performed, if necessary. Transformations should take place prior to any calculations that use the data.

Each limit is constructed such that there is a 90 % confidence that the true mean does not exceed a limit. One-sided control limits are used because once a waste stream has been determined to be RCRA-hazardous and the limit exceedance of interest is on the lower side—that is when the process may become nonhazardous. Likewise, once a waste stream has been determined not to be RCRA-hazardous and the limit exceedance of interest is on the upper side—that is when the process may become RCRA-hazardous. Whether or not exceeding the limit would result in a change in the RCRA-hazardous nature of the waste stream depends on how close the observed control limits are to RCRA limits.

Current process data are collected and averaged for comparison to the control limit for the mean. The collection period and number of samples included in the average are dependent on the waste stream characteristics. A small number of samples will reflect more of the process variability and there will be more limit exceedances. If two or three samples are collected for the mean in the required annual (or batch) sampling of a relatively homogeneous waste stream, limit exceedances may not occur. If the waste stream is less homogeneous, it will be necessary to collect more samples to meet the required confidence limit. Periodically, it will be necessary to update the control limit for a process. An update that includes all historical data is performed if there is no evidence of a trend in the process or a shift in the mean for the process. If there has been a shift in the mean, only more recent data that reflect the shift are used. Control limits shall be based on at least ten data points that are representative of the process and do not exhibit outliers or a trend with time.

Characterization Approaches Proposed for RH-TRU Wastes

INTRODUCTION

The characterization program proposed by the DOE for RH-TRU wastes is a modified version of what is already approved for CH TRU wastes. The proposed characterization program is a Performance-Based Measurement System (PBMS) approach that focuses on ensuring that sufficient data is collected to meet characterization objectives. The approach allows flexibility in applying the allowable methods to collect the necessary information. This is in contrast to the CH waste characterization approach which requires, for most characterization activities, that a specific method be used to collect data from 100% of the waste.

In order to minimize potentially-large RH-TRU waste characterization costs and also to minimize worker radiation exposure to highly-radioactive RH-TRU waste containers canisters, changes to the characterization approach are necessary. Procedures that rely on AK, which in turn relies largely on process knowledge, are proposed for quantifying and tracking the important RH-TRU waste components. Proposed tracking of the waste components is based on waste stream information. When AK does not provide the necessary waste component information, sampling programs or direct measurement characterization methods (radiography, radioassay, and/or VE) will be used as appropriate. The DOE's approach allows sites to tailor their programs to lower worker exposure, while ensuring that necessary information is collected to meet characterization objectives for safely managing and disposing of the waste.

RH-TRU wastes may contain both radioactive and non-radioactive chemical components. To comply with RCRA requirements, chemical components must be identified. Three chemical constituents have a potential impact on the long-term performance of the repository. These are: 1) the amount of free water; 2) the amount of corrodible metals; and 3) the amount of cellulosics, plastics, and rubber.

The challenges for safely characterizing RH-TRU mixed wastes are substantially greater than for CH TRU wastes. The RH-TRU mixed wastes have the same physical characteristics as the CH TRU wastes (i.e., debris, homogeneous solids, and soils/gravel). However, the distinguishing difference between the two wastes is the radioactivity of relatively short-lived beta and gamma emitters (including the fission and activation products, that can have a surface dose rate of up to 5,000 times more than the largest allowable CH rate) are characteristic of RH-TRU mixed wastes. The higher external dose rates of the RH wastes necessitate additional precautions be taken in waste management procedures. Whereas CH wastes are stored in unshielded buildings, moved using operators and forklifts, and inspected by physically viewing its condition, RH-TRU mixed wastes are typically stored in heavily shielded vaults or hot cells and managed by indirect management of the waste containers. The proposed RH-TRU mixed waste operations incorporate specially-designed equipment and shielded containers and storage areas to unload, move and store the wastes. The process is intended to minimize operator/technician exposure to the penetrating radiation associated with RH-TRU mixed wastes. The indirect interaction includes inspecting the waste using remote cameras and using specially-designed equipment and shielded containers to move the waste.

Since the volume of RH wastes to be disposed at the WIPP is less than 5% of the total CH wastes, the decision was made to place the RH waste containers in horizontal holes pre-drilled in the walls of the underground rooms where the CH wastes containers are to be stacked. Thus the RH wastes must be placed prior to stacking the CH wastes on the repository floor.

RH CHARACTERIZATION

The proposed RH characterization program (WAP) incorporates a characterization approach that relies on both AK and testing of the waste. The waste characterization proposal is based on EPA guidance published by the EPA's Office of Solid Waste and Emergency Response for a Performance-Based Measurement System (PBMS). The implementing plan (EPA 1994) outlines guiding principles for such a system and states:

"PBMS conveys what needs to be accomplished, but not prescriptively how to do it. Under a performance-based approach, EPA would specify questions to be answered by monitoring, the decisions to be supported by the data, the level of uncertainty acceptable for making the decisions, and the documentation to be generated to support the PBMS approach in the monitoring program."

The EPA further clarified the PBMS approach by stating:

"Regulatory methods are written so that they may be used as quantitative trace analytical methods to demonstrate that a waste does not contain constituents that require it to be managed as a hazardous waste. If particular RCRA applications do not require this rigor, looser analytical criteria may be applied, provided that they satisfy the data quality requirements for the particular application. Since data quality needs are project-specific in the RCRA Program, in order to successfully perform analyses it is necessary to address data quality issues prior to initiating any analyses. Good science indicates that, at a minimum, the following questions should be asked before beginning any analyses:

1. What is the purpose of this analysis? (Why are we doing this analysis?)
2. How (for what action) is the data generated from this analysis to be used?
3. What are the data quality needs for this project, i.e. how good does the data have to be to be useful for its intended purpose (including regulatory drivers, target analytes, matrices, concentration levels, statistical confidence levels, etc.)?

CHARACTERIZATION METHODS

The characterization methods in the proposed RH WAP are AK, radiography, and VE; site specific methods are selected to ensure quality control. The RH WAP requires that AK be used in making hazardous waste determinations. Under the proposed approach, AK may also be used to determine the physical form of the waste and the absence of prohibited items. Hazardous waste determinations made using AK may be supplemented with applicable information obtained through radiography and/or VE if the AK information alone is insufficient for applying hazardous waste numbers. Testing is required to confirm the characterization that is done using AK as the sole characterization technique; this confirmation utilizes radiography and/or VE. The assignment of hazardous waste numbers by using AK does not have to be confirmed. Due to differences in site-specific AK information and the intense radiation associated with RH-TRU wastes, the process used for confirming the AK must also be site-specific. Each site is to provide confirmation on a representative sample of the waste stream.

The characterization methods in the proposed program for compliance with 40 CFR 194 requirements are AK, radioassay, radiography, and radiological survey. In this program AK is used to identify the physical form of the waste (summary category group), to quantify the important waste components (metals, cellulosics, plastics, rubber, free water)—and where feasible—to quantify the total radioactivity of waste streams. AK may be supplemented with applicable information obtained through radioassay or radiography if the AK information alone is insufficient to meet characterization objectives.

AK refers to applying knowledge of the wastes based on the materials or processes used to generate the wastes. AK includes documented attributes of waste streams, such as chemical, physical, and radiological properties. This may include process knowledge, which relies on the generators' knowledge of the material properties associated with the waste-generating processes; the fate of those materials during and subsequent to the processes; and associated administrative controls. Process knowledge commonly includes detailed information on the waste obtained from existing waste analysis data; review of waste-generating processes; or detailed information relative to the properties of the wastes that are known due to site-specific and/or process-specific factors (e.g., material accountability and tracking systems or waste management databases may supply information on wasted isotopic composition and/or quantity of radionuclides, among other waste attributes).

Waste characterization using AK involves the compilation and evaluation of information concerning waste-generating processes or activities at a site. AK information may include previous testing data; waste generating procedures; chemical inputs to the processes; time period that the processes took place; the facilities involved; types of waste generated; and past sampling, analytical data, and hazardous waste determinations made to satisfy host state requirements. AK information may contain reference materials; process flow diagrams; personnel interviews; analytical results; hazardous waste determinations under RCRA; and packaging logs and videotapes. AK information may also include administrative controls as a basis for the absence of prohibited items in the waste.

AK is used in program activities to characterize RH-TRU wastes to the extent practicable as determined on a site-by-site basis depending upon the types of wastes being characterized and the types of data required. Hence, AK balances requirements for providing definitive characterization data of waste streams where sampling and analysis are not feasible or necessary (e.g., waste streams for which it is difficult to obtain a representative sample because of physical form and/or heterogeneous composition—including metals, glass, combustibles).

Radiography may be used for determining physical form; the absence of prohibited items; and quantifying non-radioactive waste components. Additionally, radiography may be used on a limited basis to supplement AK in assuring that appropriate EPA hazardous waste numbers are assigned. Radiography is a nondestructive qualitative and semi-quantitative technique that involves X-ray scanning of waste containers to identify and verify container contents. When radiography data is required, representative selections of containers will be used for these measurements. However, due to the intense radiation and lead shielding associated with RH-TRU wastes, it may not be possible to image all of the waste containers using a site's radiography equipment. Therefore, those sub-populations selected according to the operational constraints associated with the radiography operations (including image quality and operator safety) may be used. To reduce waste characterization worker exposure, the RH WAP does not propose a replicate scan, as is required for radiography of CH TRU wastes. A replicate scan requires removing the container from the radiography system and then replacing it at a later time, resulting in additional exposure. Using VE as a quality control check on radiography also is not proposed in order to reduce waste characterization worker exposure.

The VE is a characterization technique of the proposed RH WAP that may be used for determining physical form and absence of prohibited items, and may be used on a limited basis to supplement AK to ensure that appropriate EPA hazardous waste numbers are assigned. The proposed RH WAP does not make any distinction between newly-generated and retrievably-stored waste for characterization (unlike the CH WAP); therefore, the RH WAP proposes to use VE as a characterization technique for any container. The proposed RH WAP requires that either a videotape (or equivalent) be made of all VE characterizations, or that dual operator signatures be documented in lieu of a tape. Use of existing videotape records (or equivalent) is permitted as it eliminates additional exposure of the waste characterization worker, while ensuring quality control.

Similar to the requirements for radiography in the proposed RH WAP, VE is not required on every container. VE on every container would result in additional exposure to the waste characterization worker and may not be needed to meet quality control supported by VE. Due to the intense radiation associated with RH-TRU waste, it may not be possible to open all of the RH-TRU waste containers for VE due to operational constraints (e.g., hot cell limitations on maximum dose rate). Therefore, subpopulations based on the VE operational constraints may be used. If VE data are being used to meet quality control, containers examined must be representatively selected. Detailed information regarding selection of a representative container must be included in the site-specific implementation procedures. Because VE operations can produce data that are similar in type and quality to radiography, the procedures parallel those for radiography in the proposed RH WAP.

In addition to the characterization techniques required by the RH WAP, the characterization program for RH waste includes AK and radioassay techniques for determining the radionuclide content of the waste. Radioassay is a term used to define measurement methods for determining the radionuclide content of wastes, and includes both nondestructive assays (NDA) and destructive assays (i.e., radiochemistry). The isotopic composition of RH-TRU wastes is usually determined from documented AK and, in some cases, from measurements taken on the product material during processing at each site. The isotopic composition of the waste need not be determined by direct analysis or measurement of the waste unless AK is not available.

The NDA techniques allow an item to be assayed without altering its physical or chemical form. NDA techniques can be classified as active or passive. Passive NDA is based on the observation of spontaneously-emitted radiations created through radioactive decay of the isotopes of interest or their radioactive daughters. Most active NDA is based on the observation of gamma or neutron radiation that is emitted from a target isotope when that isotope undergoes a transformation resulting from an interaction with stimulating radiation provided by an appropriate, external source.

In the destructive assay technique, a representative sample is collected from the waste and physically and/or chemically processed for subsequent analysis by standard radioactivity counting methods. Radiochemical analyses are to demonstrate that sampling methods and analytical equipment used can produce results with sufficient precision and accuracy to meet disposal requirements.

Dose rate measurements can provide estimates of the radionuclides present in the waste. Measurements are taken of the containerized waste and correlated to a known isotopic inventory to provide estimated curie contents of the container. This process requires knowledge of the isotopic ratios for the waste stream. The isotopic ratios can be determined by AK or by measurement of a sample of the waste. The sample can be a smear taken on the waste or an aliquot of the waste subjected to radiochemistry.

Radiochemistry is a destructive assay technique in which a representative sample is collected from the waste and physically and/or chemically processed for subsequent analysis by standard radioactivity counting methods. Radiochemistry is most commonly used to analyze the radionuclide content of homogeneous waste forms resulting from liquids such as process sludge or other sludge waste forms. (DOE 2001 b)

COMPARISON OF THE RH WAP AND CH WAP

The RH-TRU wastes are currently prohibited at the WIPP because it has not yet been demonstrated that RH-TRU waste could be characterized in the same manner as CH TRU waste. The DOE submits that RH-TRU waste should not be characterized using the same criteria as those used for CH TRU waste; thus, there are differences between the RH WAP and CH WAP. The major differences, which reflect the Performance-based measurement system (PBMS) approach in the RH WAP, are summarized in Tables 2 through 5. In general, the proposed RH WAP requires AK, radiography, and/or VE as characterization methods for RH-TRU waste. The CH WAP requirements for each of the proposed methods has been maintained except where the specific requirement conflicts with the PBMS approach, or could lead to unnecessary additional waste characterization worker exposure. The CH WAP requires sampling and analysis to confirm AK and the application of some characterization techniques on every container. The proposed RH WAP does not require confirmatory testing, sampling, or analysis and allows for representative selection of containers for radiography and VE; thus workers are not unnecessarily exposed to the additional penetrating radiation associated withconducting confirmatory activities.

Any RH-TRU waste container that has not been characterized by AK—supplemented as necessary by radiography and/or VE—is prohibited at the WIPP facility.

Data Quality Objectives

RH WAP Requirement	Difference from CH WAP	Justification
Determine the physical form of the waste at the Summary Category Group level • S3000: Homogeneous Solids • S4000: Soil Gravel • S5000: Debris	Only the Summary Category Group is necessary for RH-TRU waste	Evaluation of the repository modeling indicates that the amount of waste in the individual material parameter categories does not affect repository integrity. (See Appendix 1)
Determine the absence of prohibited items • Liquids (Permit Module II, Section II.C.3.a • Pyrophoric materials (Permit Module II, Section II.C.3.b) • Incompatible waste (Module II, Section II.C.3.d) • Explosives and compressed gases (Permit Module II, Section II.C.3.e) • PCBs with concentrations greater-than-or-equal-to 50 ppm (Module II, Section II.C.3.f)	None	N/A
Determine the listed and characteristic hazardous constituents in the waste • Determine if a waste is listed as specified in 20.4.1.200 NMAC (incorporating 40 CFR §261.31 and 33); assign the appropriate US EPA hazardous waste number(s); and ensure that the US EPA hazardous waste number(s) are listed in Permit Attachment O. • Determine if a waste exhibits the toxicity characteristic as specified in 20.4.1.200 NMAC (incorporating 40 CFR §261.24); assign the appropriate US EPA hazardous waste number(s); and ensure that the US EPA hazardous waste number(s) are listed in Permit Attachment 0.	None	N/A

Table 2. (cont'd)

	Data Quality Objectives	
RH WAP Requirement	**Difference from CH WAP**	**Justification**
Identification of Appendix VIII constituents	Not required for RH-TRU waste	Identifying the presence of additional Appendix VIII constituents that do not overlap with the hazardous constituents identified for a characteristic or listing does not affect the integrity of the repository and is not necessary to store or dispose of the waste at WIPP.

Table 3. Differences between Proposed RH-TRU Mixed Waste Characterization Acceptable Knowledge Method and the CH TRU Mixed Waste Characterization Acceptable Knowledge Method.

Acceptable Knowledge		
RH Requirement	**Difference from CH**	**Justification**
<u>Administrative controls for prohibited items</u> Sites may rely on administrative controls to ensure absence of prohibited items. Sites must implement a procedure(s) which addresses the following elements associated with administrative controls: • Organization(s) responsible for compliance with administrative controls. • A description of the administrative controls used by the site to ensure that prohibited items are documented and managed in accordance with site-specific certification plans. • The oversight actions, and frequency of actions, to verify compliance with administrative controls. • On-the-job training specific to administrative control procedures. • A statement that personnel may stop work if noncompliance with administrative controls is identified. • The nonconformance and corrective action process	None	N/A
<u>List of information necessary</u> The Permittees shall obtain from each Department of Energy (DOE) RH-TRU waste generator/storage site (site), AK information for meeting the required DQOs in Section R-1c.	The RH WAP requires that only information necessary to meet the applicable DQO(s) be collected and maintained, rather than requiring a prescriptive list of information for all AK.	Based on the PBMS approach, only the data related to the intended purpose need be collected.

Table 3. (cont'd)

Acceptable Knowledge		
RH Requirement	**Difference from CH**	**Justification**
AK auditing The AK process and waste stream documentation must be evaluated through assessments by quality assurance organizations. Audit checklists for AK shall be used to review applicable elements based on the DQOs that are being met using AK data.	Only the information required by the site procedure, which specifies the information necessary to meet the intended DQO(s), will be subject to audit.	Based on the PBMS approach, only the data related to the intended purpose need be collected or evaluated. Each site will establish the requirements that are necessary to meet the intended DQO(s) in their procedure.
AK required for determining listed constituents AK is required to identify toxicity characteristic and listed U.S. EPA hazardous waste numbers pursuant to 20.4.1.200 NMAC (incorporating 40 CFR §§ 261.24,261.31 and 261.33). As allowed by 20.4.1.500 NMAC (incorporating 40 CFR 264.13(a)(2)), the assignment of U.S. EPA hazardous waste numbers in compliance with the generator host-state requirements is considered AK for this RH WAP.	None	N/A
Hazardous waste numbers must be applied conservatively If different sources of information indicate different hazardous wastes are present, then sites shall include all sources of information in its records and conservatively assign all appropriate U.S. EPA hazardous waste numbers.	None	N/A
Use of hazardous waste determinations made in accordance with host-state requirements as AK As allowed by 20.4.1.500 NMAC (incorporating 40 CFR 264.13(a)(2)), the assignment of U.S. EPA hazardous waste numbers in compliance with the generator host-state requirements is considered AK for this RH WAP.	This information is used as AK for CH TRU waste, but was not specifically called out in the CH WAP.	Hazardous waste determinations must be conducted in accordance with the minimum requirements of RCRA, regardless of the state in which they are made. 40 CFR 264.13(a)2 allows for the use of data developed under 40CFR Part 261, which is the process that is used to establish the hazardous waste determination in the host state.

Table 3. (cont'd)

Acceptable Knowledge		
RH Requirement	**Difference from CH**	**Justification**
Use of AK information from similar waste streams • If sites can demonstrate correlations and similarities between the CH and RH-TRU waste operations, characterization information for the CH TRU waste stream may be used to determine the physical form, U.S. EPA hazardous waste number(s), and absence of prohibited items for the RH-TRU waste stream. • If sites can demonstrate correlations and similarities between the RH- TRU waste operations at other sites, characterization information for that RH-TRU waste may be used to determine the physical form, U.S. EPA hazardous waste number(s), and absence of prohibited items for their RH-TRU waste stream.	None	N/A
Training Site personnel responsible for compiling AK, assessing AK, and resolving discrepancies associated with AK shall be qualified and trained in the following areas at a minimum: • RH WAP and the RH TSDF-WAC • State and Federal RCRA regulations associated with solid and hazardous waste characterization • The nonconformance and corrective action process • Site-specific procedures associated with waste characterization using AK	None	N/A

Table 3. (cont'd)

RH Requirement	Acceptable Knowledge	
	Difference from CH	Justification
QAO: Precision The qualitative determinations, such as compiling and assessing AK documentation, do not lend themselves to statistical evaluations of precision. Therefore, precision requirements are not established for AK. However, the acceptable knowledge information is subject to audits as specified in Permit Attachment R3.	None	N/A
QAO: Accuracy The qualitative determinations, such as compiling and assessing AK documentation, do not lend themselves to statistical evaluations of accuracy. Therefore, accuracy requirements are not established for AK. However, AK must be confirmed if it is used as the sole characterization technique to meet a DQO. In addition, the AK process is subject to audits as specified in Permit Attachment R1.	Testing data are required to confirm AK if it is used as the sole characterization technique and the audit process will be used to ensure that the information was accurately collected.	Nqwly collected data under the WAP should not require additional confirmation. Only information brought into the program through the AK process requires confirmation and only if it is the only information used to meet one or more of the DQOs.
QAO: Completeness The AK record shall contain sufficient information to meet the DQO(s) in Section R-2 that are being supported using AK data or supplemental information must be collected. If additional AK information is part of the identified supplemental information, the additional AK information must be collected and documented to ensure AK completeness.	Only the information that is relevant to the intended DQO(s) must be 100% complete based on the site procedure.	Based on the performance-based approach, only the data related to the intended purpose need be collected.
QAO: Comparability Comparability is ensured through sites meeting the training requirements and minimum standards outlined in this RH WAP. Sites shall ensure appropriate U.S. EPA hazardous waste numbers are assigned in accordance with Permit Attachment R3 and ensure information regarding its waste is available to other sites.	None	N/A
QAO: Representativeness Representativeness will be satisfied by ensuring that the process of obtaining, evaluating, and documenting AK information is performed in accordance with the requirements established in Permit Attachment R3.	None	N/A

Table 3. (cont'd)

Acceptable Knowledge		
RH Requirement	**Difference from CH**	**Justification**
<u>AK Confirmation</u> If AK is used as the sole characterization method to meet a DQO, an AK confirmation program must be developed and implemented by the generator/storage site.	AK must only be confirmed if it is not supported by new testing to meet the DQO. Confirmation must be conducted on a representative sample rather than 100%.	If new testing is conducted, the results of that testing are used in addition to the AK information to meet the DQO providing an implicit confirmation of the AK information used. If no new testing is needed to meet the DQO, the AK information requires explicit confirmation with new testing data. Representative sampling meets the regulatory requirements for sampling.

Table 4. Differences between Proposed RH-TRU Mixed Waste Characterization Radiography Method and the CH TRU Mixed Waste Characterization Radiography Method.

	Radiography	
RH Requirement	Difference from CH	Justification
Material parameter category weight estimation	Not required for RH-TRU waste	Evaluation of the repository modeling indicates that the integrity of the repository is not affected by conservatively bounding the material parameters in RH waste.
Requirement to use other characterization technique if contents cannot be resolved due to interference If a site operates a radiography system that is not capable of X-ray penetration or image quality sufficient to provide information to meet the DQOs, then another suitable waste characterization technique must be used (i.e., AK or VE).	None	N/A
Complete Data Form A radiography data form is also used to document the physical form(s) of the waste and the overall summary category group, the absence of prohibited items and, to a limited extent, hazardous constituents that can be correlated to physical indicators, depending on the DQOs that are being met using radiography data.	None	N/A
Videotape Operation To perform radiography, the operator scans waste container while viewing a video image. A videotape recording (or equivalent) is made of the waste container scan.	None	N/A
Independent Observation Independent observations of the video output of the radiography process shall be performed under uniform conditions and procedures.	None	N/A

Radiography		
RH Requirement	**Difference from CH**	**Justification**
Replicate scan	Not required for RH-TRU waste	Independent observations of radiography are used to meet the accuracy QAO; therefore, any additional worker exposure associated with performing a replicate scan is not necessary.
Contents Test drum is required to contain items common to the waste streams to be generated/stored at the generator/storage site.	None	N/A
Formal and On-the-job Training Although the site-specific training programs will vary to some degree, the Permittees shall require each site's program to contain the following required elements based on the DQOs that are being met using data from radiography: Formal Training 1. Project Requirements 2. State and Federal Regulations 3. Basic Principles of Radiography 4. Radiographic Image Quality 5. Radiographic Scanning Techniques 6. Application Techniques 7. Radiography of Waste Forms 8. Standards, Codes and Procedures for Radiography 9. Site-specific instruction	Training curriculum and drum are only required to contain items that are relevant to the DQO that is being met with radiography data.	Training that is not relevant to the intended purpose of radiography is unnecessary.

Table 4. (cont'd)

Radiography		
RH Requirement	**Difference from CH**	**Justification**
On-the-Job Training 1. System Operation 2. Identification of Summary Category Groups (only required if radiography data are used to support determining the physical waste form) 3. Identification of Prohibited Items (only required if radiography data are used to support determining the absence of prohibited items) 4. Identification of Physical Indicator Parameters Used for Assigning U.S. EPA Hazardous Waste Numbers (only required if radiography data are used as a supplement to AK for ensuring appropriate U.S. EPA hazardous waste numbers are assigned)		
QAO: Precision The precision of the radiography image is verified prior to use of the system through viewing and being able to distinguish an image test pattern.	No change to image test pattern requirement. Relative percent difference (RPD) calculated for CH TRU waste material parameter weights not required.	Material parameter weights are not necessary to ensure the integrity of the repository and are not measured.
QAO: Accuracy An independent observation will be conducted by comparing the contents of a radiography data form to the videotape (or equivalent) of the associated radiography scan by a qualified independent reviewer at the frequency of one per testing batch or once per day, whichever is less frequent.	Use independent observation of radiography rather than VE to ensure accuracy.	Independent observations provide assurance that accuracy is maintained without additional worker exposure during visual examination.
QAO: Completeness A videotape (or equivalent) of the radiography examination and an associated complete data form will be obtained for all waste containers subject to radiography.	None	N/A
QAO: Comparability The comparability of radiography data from different sites shall be enhanced by using standardized radiography operator qualifications that comply with this RH WAP.	None	N/A
QAO: Representativeness Representativeness for waste selected for radiography will be ensured through random container selection.	RH WAP requires radiography of representative waste container selected randomly from the population. There is no CH QAO for representativeness due to the requirement to do 100% radiography	Additional worker exposure from performing 100% radiography is not necessary if a representative waste container is selected.

Table 5. Differences between Proposed RH-TRU Mixed Waste Characterization Visual Examination Method and the CH TRU Mixed Waste Characterization Visual Examination Method.

Visual Examination		
RH Requirement	**Difference from CH**	**Justification**
Material parameter category weight estimation	Not required for RH-TRU waste	Repository modeling demonstrates that the repository integrity is not affected by conservatively bounding the material parameters in RH-TRU waste.
Complete Data Form The results of VE documented on the data form shall clearly identify the physical form(s) and the overall summary category group, the absence of prohibited items and, to a limited extent, hazardous constituents that can be correlated to physical indicators depending on the DQOs that are being met using VE data.	None	N/A
Videotape Operation The VE shall consist of a qualitative evaluation of the waste container contents, and shall be recorded on videotape (or equivalent) or, if two trained operators perform the VE a videotape (or equivalent) is not required.	None	N/A
Independent Observation Oversight functions (i.e., data validation, Permit Attachment R2) include independent review of VE data forms by a qualified VE operator other than the individual who performed the first examination.	Independent observations are required if a single operator conducts the VE.	Independent observation of the VE is necessary to meet the accuracy QAO if two operators are not used.
Representative Sample	Perform VE on representative waste containers selected randomly from the population.	20.4.1.500 NMAC (incorporating 40 CFR 264.13(a)1) requires that a representative sample be taken; any additional worker exposure associated with additional VE is not necessary if a representative waste container is selected.

Table 5. (cont'd)

RH Requirement	Visual Examination: Difference from CH	Visual Examination: Justification
<u>Training Curriculum</u> Although site-specific training programs will vary to some degree, the Permittees shall require each site's program to contain the following required elements: <u>Form Training</u> 1. Project Requirements 2. State and Federal Regulations 3. Application Techniques 4. Site-Specific Instruction <u>On-the-Job Training</u> 5. Identification of Summary Category Groups (only required if VE data are used to support determining the physical waste form) 6. Identification of Prohibited Items (only required if VE data are used to support determining the absence of prohibited items) 7. Identification of Physical Indicator Parameters Used for Assigning U.S. EPA Hazardous Waste Numbers (only required if VE data are used as	Requires the training curriculum to cover material that is relevant to the DQO that is being met using visual examination data.	Training that is not relevant to the intended purpose of VE is unnecessary.
Training Drum Contents	Training drum is required to contain items that are relevant to the DQO that is being met with visual examination data.	Training that is not relevant to the intended purpose of VE is unnecessary.

Table 5. (cont'd)

Visual Examination		
RH Requirement	**Difference from CH**	**Justification**
Training Examinations Qualification of VE operators shall, at a minimum, encompass the following requirements: 1. Successfully pass a comprehensive exam based upon training enabling objectives. The comprehensive exam will address the VE training requirements and implementation stipulated in this RH WAP. A minimum score of 80% is required to pass the exam. 2. Demonstrate capability in the presence of the appointed site VE expert.	Successfully passing a comprehensive examination is required.	Passing an examination is required because standardized VE operator qualification is used to meet the comparability QAO.
QAO: Precision Precision - The qualitative determinations, such as identifying the summary category group, made during VE do not lend themselves to statistical evaluation of precision because of the qualitative nature of the inspection. Therefore, precision requirements are not established for VE. However, the VE information is subject to the Permittees' Audit and Surveillance Program.	VE provides qualitative data, so a precision is not established. There is no QAO for VE precision in the CH WAP.	N/A
QAO: Accuracy An independent observation will be performed by comparing the contents of a VE data form to the videotape (or equivalent) of the associated examination at the frequency of one per testing batch on once per day, whichever is less frequent. In the case of VE performed by two operators, dual signatures on the data form will verify accuracy in lieu of the independent observation.	Use independent observation or dual signatures for VE to ensure accuracy. There is no QAO for VE accuracy in the CH WAP.	Independent observations or signatures of both operators performing visual examination provide assurance that accuracy is maintained.

Table 5. (cont'd)

RH Requirement	Visual Examination Difference from CH	Justification
<u>QAO: Completeness</u> A videotape (or equivalent) of the VE and an associated complete data form will be obtained for all waste containers subjected to VE. In the case of VE performed by two operators, dual signatures on the data form will verify completeness.	Videotape of the VE of dual signatures on the data form. Data forms must be fully completed. There is no QAO for VE completeness in the CH WAP.	Fully completed data forms and videotapes or dual signatures provide assurance of completeness.
<u>QAO: Comparability</u> The comparability of VE data from different sites shall be enhanced by using standardized VE operator qualifications that comply with this RH WAP.	Standardized training that meets the WAP is required. There is no QAO for VE comparability in the CH WAP.	Using standardized training requirements ensure that comparability is enhanced.
<u>QAO: Representativeness</u> Representativeness for waste selected for VE will be ensured through random container selection.	Require representative sample taken randomly from the population. There is no QAO for VE representativeness in the CH WAP.	Using a representative sample meets the regulatory requirements.

Peer Review Criteria, Findings, and Recommendations of the Review Panel

PEER REVIEW CRITERIA AND FINDINGS

The findings of the RP with respect to the review criteria are as follows:

Criterion 1

Is the draft *RCRA Class 3 Permit Modification* (DOE 2001a) optimized in format and content to facilitate the regulatory review and approval process?

Finding of the RP

The draft *RCRA Class 3 Permit Modification* (DOE 2001a) is optimized in a format to facilitate the regulatory review and approval process. Throughout the document the text has been modified to show the new information added, and there are strike-outs to show the information deleted. The Overview section includes tables showing the regulatory references and their corresponding location in the document. In addition, Table 2 lists all of the sections of the document that have been modified. However, the draft *RCRA Class 3 Permit Modification* (DOE 2001a) is lacking some information that would facilitate the regulatory review and approval process as described in the Findings to several of the Criteria.

Criterion 2

Are the parameters—for which RH-TRU waste will be analyzed—appropriate, and the rationale for the selection of these parameters adequately justified in the draft *Request for RCRA Class 3 Permit Modification* (DOE 2001a)?

Finding of the RP

The draft *Request for RCRA Class 3 Permit Modification* (DOE 2001a) lists the appropriate parameters and attempts to justify the selection of these parameters in the "ITEM 2" section of the document. This section includes the characterization approach, characterization methods, and data reporting and validation requirements. Table 2-1 attempts to justify all of the modifications of CH-TRU parameters to account for RH-TRU. Table 2-2 addresses the differences for Data Quality Objectives (DQOs). Table 2-3 addresses the differences for the Acceptable Knowledge (AK) criteria. Table 2-4 addresses the differences for Radiography, and Table 2-5 addresses the differences for Visual Examination. However, some of the information is presented only as background information and is not referenced in the permit.

Criterion 3

Is the acceptability of relying on AK as the sole analysis tool to meet characterization requirements chosen in the draft *Request for RCRA Class 3 Permit Modification* (DOE 2001a) consistent with relevant regulations as interpreted jointly by the U.S. Environmental Protection Agency (EPA) and the U.S. Nuclear Regulatory Commission (USNRC) (1997)?

Finding of the RP

In many cases, reliance on AK as the analysis tool to meet the waste characterization requirements listed in the draft *Request for RCRA Class 3 Permit Modification* (DOE 2001a) as the sole analysis tool can be consistent with the relevant regulations as interpreted by the EPA and the USNRC. There may be cases where AK is not sufficient to meet the regulatory requirements. The WIPP has proposed additional characterization methodologies in a hierarchy of methods to allow for the characterization of all wastes accepted at the WIPP that will meet the DQOs. There will be cases where AK alone is sufficient, but this will be determined on a case-by-case basis depending on the nature of the AK available.

Criterion 4

Is AK alone sufficient to meet the DQOs?

Finding of the RP

In many cases, AK alone will be sufficient to meet the DQOs. Whether or not it is sufficient will be dependent on the nature of the waste and the source and completeness of the data that constitute the AK. For example, AK for waste generated from a chemical conversion process may consist of: 1) material balance and operating data; 2) historical records of the analyses of samples of the waste; and 3) inventory and custody records. Such AK should be sufficient to meet the DQOs. The AK for a drum of scrapped equipment and other waste (not specified) from a decommissioning activity may not provide sufficient information to meet the DQOs.

Criterion 5

Does the draft *Request for RCRA Class 3 Permit Modification* (DOE 2001a) make a clear distinction between characterization activities using AK versus supplementary; confirmatory; or verification activities involving physical and other measurements?

Finding of the RP

The draft *Request for RCRA Class 3 Permit Modification* (DOE 2001a) makes a distinction between characterization activities using AK versus supplementary, confirmatory, or verification activities involving physical and other measurements. Detailed records exist at the generating sites on many waste forms that will require disposal. Depending on process knowledge and other information sources, AK can be used successfully to fully characterize wastes to meet WIPP acceptance criteria. In some cases the existing information may be insufficient to meet the characterization requirements. When this occurs, supplementary information must be developed by other means. In the draft *Request for RCRA Class 3 Permit Modification* (DOE 2001a), several characterization methods—including AK, Radiography, and Visual Examination—are described, as well as their intended use in characterization activities. However, in the draft *Request for RCRA Class 3 Permit Modification* (DOE 2001a), figures such as R-2 do not provide for the use of other characterization methods should AK be insufficient.

Criterion 6

Is the application of the Performance-Based Measurement System approach consistent with the relevant EPA guidance on performance-based measurement systems?

Finding of the RP

The application of the Performance-Based Measurement System approach meets the EPA's guidance on performance-based measurement systems. The performance-based approach is designed to produce the desired results which eliminate characterization processes that do not produce information used to meet performance requirements. The DOE chose a performance-based approach to meet EPA's guidelines for RH-TRU waste. The characterization objectives for EPA requirements cover metals; residual liquids; cellulosic; plastics and rubber; total radioactivity; and surface dose rate. Baseline calculations for CH-TRU were used for comparisons to determine the relative effects of bounding assumptions regarding characterization data. The performance factors are specified in 40 CFR 191 (EPA 1993) and 40 CFR 194 (EPA 1996a). Section 40 CFR 194.24 (c)(3) of EPA regulations allows AK and requires the QA standards—as specified in 40 CFR 194.22—to be applied to the process. Furthermore, 40 CFR 194.24 (c)(4) requires a system of controls and packaging of waste components to confirm that the total amount of each waste component falls within the performance limits. It appears that the EPA expects the performance assessment of an RH-TRU package to include uncertainty estimates, and that the actual diverse RH waste steams radionuclide contents be below the estimates.

Criterion 7

Does the draft *Request for RCRA Class 3 Permit Modification* (DOE 2001a) present an RH-TRU waste characterization program that is consistent with the recommendations of the National Research Council?

Finding of the RP

The draft *Request for RCRA Class 3 Permit Modification* (DOE 2001a) presents an RH-TRU waste characterization program that is not consistent in all cases with the recommendations of the National Research Council. The draft *Request for RCRA Class 3 Permit Modification* (DOE 2001a) still includes characterization requirements which the National Research Council criticized as being self-imposed and overly conservative. The draft request presents evolutionary steps regarding characterization as site programs evolve.

Criterion 8

Does the *Waste Analysis Plan* (WAP) included in the draft *Request for RCRA Class 3 Permit Modification* (DOE 2001a) meet the requirements for characterizing hazardous waste?

Finding of the RP

The WAP included in the draft *Request for RCRA Class 3 Permit Modification* (DOE 2001a) broadly meets the requirements for characterizing hazardous waste. The RH-TRU waste analysis plan has been prepared for the management, storage, and disposal activities at the WIPP facility, to meet the requirements of the New Mexico Administrative Code (NMED 1997) that incorporates the EPA's 40 CFR 264.13 regulations. However, the WAP, as presented, is not sufficiently detailed and clear on the information that each waste-generating site must supply to the

WIPP—particularly with respect to AK (see also Findings 1 and 2). Guidance concerning the characterization of mixed, hazardous, and radioactive waste has been incorporated into the preparation of the RH WAP. This RH WAP addresses waste stream identification requirements; waste stream parameters; waste characterization and confirmatory methods; data validation; and reporting. Characterization requirements for RH-TRU mixed waste are the same regardless of waste stream designation (i.e., debris, homogeneous solids, soil/gravel) or when the waste was generated (i.e., newly generated versus retrievably stored).

Criterion 9

Does the WAP included in the draft *Request for RCRA Class 3 Permit Modification* (DOE 2001a) contain excessive requirements for characterizing hazardous waste?

Finding of the RP

Although the WAP follows guidance documents for characterizing hazardous waste, DOE has interpreted the requirements quite conservatively such that various proposed characterization methods have no legal or safety basis.

Criterion 10

Is the *Notification of Proposed Change to the EPA 40 CFR Part 194 Certification of the Waste Isolation Pilot Plant* (DOE 2001b) clear and descriptive of the nature and scope of the proposed RH-TRU waste Characterization Program?

Finding of the RP

Section 2.0 "Nature and Scope" of the *Notification of Proposed Change to the EPA 40 CFR Part 194 Certification of the Waste Isolation Pilot Plant* (DOE 2001b) describes the nature and scope of the proposed RH-TRU Waste Characterization Program. Attachment C is a matrix that lists 40 CFR Part 194 requirements and the manner that the RH-TRU program complies with the requirements. Attachment D is a checklist that demonstrates how the RH-TRU program—as compared to the CH-TRU program—complies with the EPA's Compliance Application Guidelines (CAG). All items are completed as suggested by the EPA's CAG. There are no items completed differently than suggested by the CAG, and there are no open items.

Criterion 11

Is the DOE's assessment of the consequences for compliance with EPA disposal regulations clearly and adequately presented in the *Notification of Proposed Change* (DOE 2001b) document?

Finding of the RP

Consistency with EPA disposal regulations is fully demonstrated and documented in resource documents. The performance assessment conducted by Sandia National Laboratory is complete and consistent with EPA regulations in 40 CFR 191 and 40 CFR 194. Also, this conclusion is validated by the recent National Research Council's analysis of disposing RH-TRU at WIPP. The RP fully concurs with the analysis as presented.

Criterion 12

Is the significance of the change in the *Notification of Proposed Change* (DOE 2001b) clearly and adequately addressed?

Finding of the RP

The significance of the change in the *Notification of Proposed Change* (DOE 2001b) is clearly and adequately addressed in section 2.0 "Nature and Scope" and section 3.0 "New Information." Section 2.0 reviews the historical record leading to the need to submit a change to the EPA's WIPP 40 CFR 194 certification to permit the disposal of RH-TRU in the WIPP. It also summarizes the RH-TRU Waste Characterization Program that is discussed in detail in Appendix A "RH-TRU Waste Characterization Implementation Plan." Section 3.0 explains the changes in the DOE's TRU waste characterization program to accommodate RH-TRU.

Criterion 13

Are the consequences for compliance determinations clearly stated in the *Notification of Proposed Change* (DOE 2001b) document and technically justified in the *RH TRU Inventory Impact Assessment Report* (DOE 2001b)?

Finding of the RP

The consequences for compliance determinations are clearly-stated in the *Notification of Proposed Change* (DOE 2001b) document and are technically justified in the *RH TRU Inventory Impact Assessment Report* (DOE 2001b) which is Attachment B of the *Notification of Proposed Change* (DOE 2001b) document. Attachment B demonstrates by analysis that the repository performance of the WIPP would not be compromised even for large deviations from the planned inventories of both radioactive and non-radioactive waste placed in the repository.

Criterion 14

Does the *RH TRU Waste Characterization Program Implementation Plan* (DOE 2001b) present a viable, effective, and efficient performance-based waste characterization program?

Finding of the RP

The *RH TRU Waste Characterization Program Implementation Plan* (DOE 2001b) presented meets the performance factors of the waste characterization program. Applying knowledge of the characteristics of the waste using available information minimizes additional risk and exposure due to RH-TRU. There is an overall balance in the program activities to characterize RH-TRU waste to the extent possible. The efficiencies are gained by balancing the requirements for providing definitive characterizations data of the waste streams with those circumstances where sampling and analysis are neither feasible nor necessary, given the need for the data. The AK—when used appropriately in combination with NDA/NDE—yields a viable, effective, and efficient performance-based waste characterization program. The *RH TRU Waste Characterization Program Implementation Plan* (DOE 2001b) provides the sites with considerable latitude in meeting the WIPP-Waste Acceptance Criteria (WAC) requirements; it would be better if WIPP provided definitive requirements for the different sites.

Criterion 15

Does the *RH TRU Waste Characterization Program Implementation Plan* (DOE 2001b) clearly identify and justify the waste components to be characterized?

Finding of the RP

Comprehensive RH-TRU inventory and waste streams were identified, along with a comparison between CH and RH-TRU disposal volume projections. The waste components have been identified and justified in a general sense, but a detailed description of waste streams from the waste-generating sites is lacking. The documents fail to adequately describe the contact and communication among WIPP and the RH-TRU generators.

Criterion 16

Is the associated DQO appropriate for each waste component and consistent with the relevant guidance of the EPA?

Findings of the RP

The documents and the Project Team presentation indicate that the DOE-Carlsbad Field Office has adopted DQOs for metals; liquids; and cellulosic, plastics, and rubber (CPR) materials. The programmatic AK steps outlined in the *RH TRU Waste Characterization Program Implementation Plan* (DOE 2001b) are sufficient to accomplish the DQOs adopted by the DOE-Carlsbad Field Office and can be reasonably relied upon to meet the DQOs for materials received at WIPP. The DQOs are somewhat conservative but they are consistent with the NMED and EPA requirements.

The WIPP-limiting values for radiological components in RH-TRU waste are based on surface-level exposure rates. The methodologies for determining exposure levels are well established, and these levels will be measured and documented for all shipments and disposal containers. These measured values constitute one of the criteria for meeting the DQOs for RH-TRU exposure levels, and therefore, supplement AK.

Criterion 17

Is the reliance on AK as the primary method to meet DQOs and satisfy characterization objectives fully-justified?

Finding of the RP

The acceptability of relying on AK as the primary method in order to: 1) meet the DQOs; and 2) satisfy the characterization objectives, is fully justified for those RH-TRU wastes that have well-documented information regarding their generation and control. The DQOs for the WIPP facility were established using the EPA's Guidance for the DQO's Process (EPA 2000c). Furthermore, the DQOs are identified in the proposed WAP, and they reflect parameters that must be known in order to dispose of waste at the WIPP facility. The DQOs are derived from making a determination of the following waste characteristics: physical form of the waste; absence of prohibited items; and hazardous constituents in the waste. In many cases, the existing documentation would allow these DQOs to be verified with no further characterization efforts required on the part of the waste generator. If the physical form or the absence of prohibited items can not be determined from AK, then other methods (such as radiography) can be used to supplement AK in making a determination that satisfies both the DQOs and the characterization objectives.

Criterion 18

Is the acceptability of relying on AK as the sole method to meet characterization requirements and any DQOs sufficiently explained in relation to the relevant regulations—as interpreted jointly by the EPA and USNRC?

Finding of the RP

The use of AK as a sole method is not sufficiently explained or justified. The AK can be the dominant measure for determining DQOs for RCRA-regulated materials and even for meeting the DQO for radionuclide concentration limits for RH-TRU materials. The explanation of the acceptability of sole reliance on AK represents an apparent inconsistency because as explained in Finding 16 of the RP, meeting the DQOs for RH components at WIPP relies on measured radiation levels for all containers which supplant AK. Therefore, although AK can be a dominant method and sometimes a completely adequate method, it is unlikely to be the sole method.

Criterion 19

Does the *RH TRU Waste Characterization Program Implementation Plan* (DOE 2001b) draw a clear distinction between characterization activities using AK versus supplementary; confirmatory; or verification activities involving physical measurement?

Finding of the RP

The distinction among the characterization activities, AK, supplementary, confirmatory, or verification is inadequate in the *RH TRU Waste Characterization Program Implementation Plan* (DOE 2001b), and is made particularly confusing by the definitions. All available information about the state of the waste should be used in deciding whether or not the characterization is adequate. It is inefficient to perform additional measurements unnecessarily. The AK is information that has already been obtained (such as process knowledge) before any specific WIPP RH-TRU requirements have been established and sometimes when the waste is already in a container. Supplementary information is used to fill in gaps in the required knowledge. Confirmatory and verification data determine whether the AK is reliable, but the distinction between confirmatory and verification is less clear. There are insufficient examples showing how the required information will be obtained using each of the various methods for each of the major types of waste.

Criterion 20

Does the *Notification of Proposed Change* (DOE 2001b) adequately explain and justify how AK and the WIPP Waste Information System are used to satisfy quantification and control requirements?

Finding of the RP

The *Notification of Proposed Change* (DOE 2001b) adequately explains and justifies how AK and the WIPP Waste Information System (WWIS) are used to satisfy the quantification and control requirements. The WWIS tracking and control system is currently in use in the CH-TRU waste program, and it is operating satisfactorily. To meet additional tracking and control requirements imposed on RH-TRU waste by the Land Withdrawal Act, WWIS will be modified by the addition of data fields. Each waste cannister will be assigned an identification number that will be entered into the WWIS. Characteristics such as curie content and surface dose rates (when the dose equivalent rate exceeds 100 rem/h) will be entered into WWIS to enable tracking and control for that particular container.

Criterion 21

Does the *RH TRU Waste Characterization Program Implementation Plan* (DOE 2001b) adequately describe a Quality Assurance program that meets or exceeds appropriate requirements?

Finding of the RP

In general, the *RH TRU Waste Characterization Program Implementation Plan* (DOE 2001b) describes a Quality Assurance program that addresses the appropriate requirements but lacks sufficient detail. However, to meet the WIPP WAC, the site must develop and implement a quality assurance program that addresses all the applicable requirements specified in the waste analysis plan. Sites may use AK, Radiography, and/or Visual Examination (VE) to assist in the characterization of the waste streams. Qualitative data generated by AK, Radiography, and VE are not amenable to statistical data quality analysis. Rather, these methods provide qualitative data useful for determining the Summary Category Group: EPA Hazardous Waste numbers; and the absence of prohibited items in a waste container. Quality Assurance Objectives (QAOs) complement the DQOs by defining the precision, accuracy, completeness, comparability, and representativeness for each of the characterization methods (AK, Radiography, VE) that may be used. The validation methods are appropriately described and evaluated in Attachment R3 of the *RH TRU Waste Characterization Program Implementation Plan* (DOE 2001b) .

Criterion 22

Does the Plan clearly and adequately explain how the provisions of 40 CFR 194.22 (b) will be utilized in the RH-TRU waste characterization program?

Finding of the RP

Use of the provisions of 40 CFR 194.22 in waste characterization is sufficiently-explained; however, it is important for DOE-CBFO to recognize that additional amplification (similar to that provided to the RP during the peer-review meeting) may be needed. The NMED's earlier limitation of its certification to CH-TRU was clearly based on the information provided which was deemed insufficient for inclusion of RH-TRU in the permit.

Criterion 23

Does the Plan present an RH-TRU waste characterization program that is consistent with recommendations from the National Research Council's Report, *Improving Operations and Long-Term Safety of the Waste Isolation Pilot Plant* (2000; 2001)?

Finding of the RP

The RH-TRU waste characterization program is reasonably consistent with the National Research Council's Report, *Improving Operations and Long-Term Safety of the Waste Isolation Pilot Plant* (2000; 2001), including its finding of self-imposed requirements that have no legal or safety basis.

Criterion 24

Are the *Request for RCRA Class 3 Permit Modification* (DOE 2001a) and *RH TRU Waste Characterization Program Implementation Plan* (DOE 2001b) consistent with the ALARA concept?

Finding of the RP

The *Request for RCRA Class 3 Permit Modification* (DOE 2001a) and *RH TRU Waste Characterization Program Implementation Plan* (DOE 2001b) are consistent with the ALARA concept. However, the reduction of worker exposure—as interpreted by the USNRC Guidance RM-30-2—is by itself not an argument for a modification, nor is it possible to use ALARA to justify repackaging in the interest of repository performance. In the proposed modification, there is no explicit explanation of why the AK-based waste characterization approach is needed to maintain repository integrity and avoid exposures. Reference is made to 40 CFR 194 and a presumption is made that if the requirements of 40 CFR 194 are met, the integrity of the repository will be maintained and such exposures will be ALARA.

Additional Findings of the RP

Finding 25

The AK is the key methodology proposed by the WIPP for characterization of RH-TRU waste. The AK can be most useful. However, its usefulness can be improved by ensuring that the stakeholders achieve a clear understanding of the basis for, and use of AK in a suite of analytical characterization tools.

Finding 26

The communication between the regulated and regulatory communities does not appear to be optimal for the efficient processing of permit modifications. It appears that there are not sufficient free and full exchanges to keep all parties fully informed of each other's needs and accomplishments. An example of this is the apparent lack of communication regarding the advances in nondestructive testing using radiography to identify the absence of prohibited items.

Finding 27

Although there is a clear statement of the regulatory requirements for the characterization of the waste, there is no statement of the scientific requirements for such characterization upon which the regulatory requirements are based. It would, for example, be useful to know that many safety factors are already included in these requirements before discussing whether or not the requirements can be met. A failure to discuss such matters inevitably results in requirements not justified by safety as decried by the National Research Council's review panel.

Finding 28

Communication between WIPP and the waste-generating sites is not at a level to foster efficient planning and implementation of WIPP WAC.

Finding 29

The draft *Request for RCRA Class 3 Permit Modification* (DOE 2001a) has a good basic structure but lacks—in many cases—sufficient details and specificity to facilitate regulatory review.

Finding 30

Audit plans were not provided to the RP.

Finding 31

It is unclear what fraction of the RH-TRU waste has already been containerized or packaged as compared to that which is still to be generated or is stored in bulk.

Finding 32

Significant emphasis is placed on determining EPA's Hazardous Waste Numbers for either listed or characteristic wastes, which in some cases may include organic compounds. Based on the impact study (Appendix B of the *Notification of Proposed Change* (DOE 2001b), there appears to be no impact on repository performance that depends on this identification.

Finding 33

In keeping with the National Research Council's recommendation to "think smart" good health physics practice and the ALARA philosophy, the efforts to swipe all RH-TRU waste containers is questionable. The containers hold sealed units that have been determined by waste generators and shippers to be "free" of contamination. The commitment to take and analyze six smears—because of the difficulty and complexity of the remote swiping operation—can be a single-point failure in an otherwise straightforward system of waste receipt and emplacement. This approach appears to have evolved from conservative health physics practices used in laboratories and facilities that are relatively clean and quite variable. Records of contamination detected on CH-TRU packages already received could provide a useful baseline of the effectiveness of the waste system in controlling contamination and the degree to which such information has affected WIPP operations. For example, is minimal contamination on one smear (or the absence of a smear result) a basis for not placing an RH-TRU container in the WIPP?

RECOMMENDATIONS

Based on a careful assessment of the information presented to the RP and the findings developed in response to the review criteria, the RP provides the following recommendations:

1. A detailed procedure for determining whether there is sufficient AK available on a waste, should be developed as part of the permit application. This procedure should be consistent across all waste- generating sites.
2. In the final *Request for RCRA Class 3 Permit Modification* (DOE 2001a) a detailed procedure should be provided to go to other characterization methods if AK is found to be insufficient. For example, figures such as Figure R-2 of the draft *Request for RCRA Class 3 Permit Modification* (DOE 2001a) and the accompanying text, should be reviewed.
3. The DOE should implement the National Research Council's recommendation that review of characterization and packaging requirements continue, especially implementation "... over the entire National TRU Program."

4. The DOE should provide to the EPA a complete inventory of radionuclides and waste forms so that the EPA may verify the repository performance (that WIPP complies with 40 CFR 191 and 40 CFR 194) using its own methods for certification.
5. The DOE should initiate a more appropriate interaction with the EPA and the NMED, not only to determine and meet their respective requirements but also to ensure that the relevant recommendations—such as those by the National Research Council—are evaluated and implemented.
6. Prior to submission, all permit-related documents—in addition to currently planned reviews—should be reviewed in detail for completeness, specificity, and clarity by a team experienced in the permitting process.
7. The *Request for RCRA Class 3 Permit Modification* (DOE 2001a) must be expanded to include more specifics and examples for clarity and completeness.
8. The discussion for Table 1 of the draft *Request for RCRA Class 3 Permit Modification* (DOE 2001a) should be expanded to justify why sections of the documents require "no action" or "no changes".
9. As part of the permit application, supplemental information should be supplied detailing the waste characterization plans for each waste-generating site and DOE's procedures for determining that these plans meet the WIPP WAC.
10. Detailed audit procedures for WIPP and the waste-generating sites should be provided as part of the permit application.
11. More detail and specificity on WAC using AK, VE, and Radiography (including types of instrumentation to be used) should be provided in the permit application.
12. The DOE should evaluate the necessity of identifying waste streams by the EPA's Hazardous Waste Numbers or Characteristics. If there is no impact on WIPP performance and integrity, the DOE should work with the regulatory agencies to remove this requirement.
13. Whereas it is desirable to preclude contamination and its potential spread, a complete review should be made of what is gained from the remote swiping procedure for "clean" RH-TRU containers and how the information will be used.

Stakeholder Participation

INTRODUCTION

The request for peer review included a consideration for stakeholder participation. Recognizing the significance of the subject, the ASME Peer Review Committee established an ad hoc committee to evaluate possible approaches and procedures for stakeholder participation. The ad hoc committee evaluated a process developed by Love et al. and recommended appropriate revisions. The revised version of that approach was used during this review.

In preparation for stakeholder participation, two guides were prepared: one for the sponsoring agency and the other for stakeholders. In addition, a questionnaire was prepared to evaluate the validity of the approach. After the validity of the process was confirmed in subsequent reviews, Love et al. (2001) published a manual describing the process. One of the key issues advanced by Love et al. was the classification of stakeholders as Personally Impacted, Administratively Impacted, and Generally Concerned Stakeholders. Forms RSI-F-023 and RSI-F-024 in the appendix of this chapter show the guides for the sponsoring agency and the stakeholders respectively. Form RSI-F-025 in the appendix of this chapter is the questionnaire used to seek the views of the stakeholders.

THE PROCESS

Prior to the meeting, the DOE was provided a guidance document (RSI-F-023) containing the definition of stakeholders and certain rules governing participation in a professional society meeting. In addition, the planning of the meeting considered the tradition of all professional societies, indicating that all segments of the meeting—except the executive sessions of the Review Panel—were open to the public. All participants in the peer review meeting were registered and received a name badge. Their registration packets included a summary of the project; peer review criteria; an agenda of the meeting; guidance for stakeholders (RSI-F-024); and a questionnaire (RSI-F-025).

During the introduction, the rules of the stakeholder participation were described. Members of the audience were told that they could ask questions from the speakers and that they could also make statements during the program designated for that purpose. In every case, the individual who wanted to ask a question or make a statement had to indicate his/her name, affiliation, and the class of stakeholder—if any. Consistent with the peer review process, members of the Review Panel were not introduced to anyone. Review Panel members who wanted to ask questions were instructed to introduce themselves as "I am a panelist". The audience was also asked to fill out the questionnaire (RSI-F-025).

At the end of the meeting, the questionnaires were collected and subsequently evaluated. During the meeting, those who asked questions or made statements appeared to have no difficulties in placing themselves in the correct class.

RESULTS OF THE SURVEY

The respondents overwhelmingly agreed that the definitions of stakeholders as shown in the document provided to them were reasonable. Many respondents complained that the presentations were at a technical level that they could not follow. Even more respondents suggested that the one-to-two weeks notice of the meeting was too short. Most of the other questions were answered positively.

This and similar surveys performed since the initiation of this process suggest that:

1. The classification of stakeholders as Personally Impacted, Administratively Impacted, and Generally Concerned is reasonable.
2. Even those who were opposed to the activity being proposed found the stakeholder participation process as used in the peer review meeting to be fair.
3. Several stakeholders had difficulty assigning their questions or statements to a review criterion and needed help from organizers of the peer review meeting.

Appendix

INSTITUTE FOR REGULATORY SCIENCE STAKEHOLDER PARTICIPATION IN PEER REVIEW MEETINGS

GUIDANCE FOR ORGANIZATIONS REQUESTING STAKEHOLDER PARTICIPATION IN ASME/RSI PEER REVIEW MEETINGS

The American Society of Mechanical Engineers (ASME) and the Institute for Regulatory Science (RSI) have joined forces to provide peer review services to various government agencies. The decision to ask for the participation of stakeholders rests with the agency sponsoring the peer review. When such participation is authorized by the agency, the ASME/RSI team encourages the participation of stakeholders not only as observers, but also as active participants. The details of ASME/RSI peer review may be found at www.NARS.org.

Many federal and state agencies, as well as private industries, desire to include the views of stakeholders in their decision process. This guide is an excerpt from a report which is being prepared by Betty R. Love et al. to assist government agencies and private industry in identifying stakeholders and classifying them in accordance with their respective roles. This guide specifically applies to stakeholder participation in ASME/RSI peer review.

There are three classes of stakeholders as follows:

Personally Impacted Stakeholders: This class consists of individuals whose lives are directly impacted by the action under consideration.

Administratively Impacted Stakeholders: This class consists of elected, appointed, or employed individuals who must ensure that the action under consideration is prepared, reviewed, approved, or implemented in accordance with applicable laws, regulations, permits, licenses, or agreements.

Generally Concerned Stakeholders: This class includes individuals who, by virtue of their personal philosophies, beliefs, or ideologies, are interested in or concerned about the action under consideration.

The participation of stakeholders should be based on the priority placed by the sponsoring organization on the significance of the impact of the decisions to be made on each class of stakeholders. As a general rule, an affirmative outreach is necessary to ensure the participation of personally impacted stakeholders. Experience shows that these stakeholders are reluctant to participate in peer review unless they perceive a significant impact on their daily lives. Accordingly, an affirmative outreach approach is necessary to ensure their participation.

The participation of administratively impacted stakeholders is somewhat less complicated. The mayor of the town; state, federal, and other elected officials representing the locality in which the action under consideration will occur, are desirable stakeholders yet are unlikely to be willing to participate. In contrast, members of agencies responsible for preparation, regulation, and implementation of an action are easier to entice to participate. However, at a minimum, those immediately responsible for the action in these agencies should participate in a well-run program.

The generally concerned stakeholders are normally informed via public media. Their participation is normally determined by the sponsoring agency. As a general rule, they are accommodated after the other two classes are accommodated, and on a first-come first-served basis.

INSTITUTE FOR REGULATORY SCIENCE STAKEHOLDER PARTICIPATION IN PEER REVIEW MEETINGS

GUIDANCE FOR STAKEHOLDERS PARTICIPATING IN ASME/RSI PEER REVIEW MEETINGS

The American Society of Mechanical Engineers (ASME) and the Institute for Regulatory Science (RSI) have joined forces to provide peer review services to various government agencies. The decision to ask for the participation of stakeholders rests with the agency sponsoring the peer review. When such participation is authorized by the agency, the ASME/RSI team encourages the participation of stakeholders not only as observers, but also as active participants. The details of ASME/RSI peer review may be found at www.NARS.org.

The peer review is performed by a Review Panel consisting of individuals whose qualifications for the specific review have been approved by the ASME's Peer Review Committee. All presentations, statements, and discussions are intended to benefit the Review Panel in its deliberations, which result in the *Report of the Review Panel.* There is ample evidence suggesting that participation of stakeholders enhances the outcome of certain activities, notably peer reviews.

All peer review meetings are normally chaired by a representative of the Peer Review Program. All segments of a peer review meeting, except the executive sessions of the Review Panel, are open to the public. Stakeholders can attend these meetings, provided the following criteria are met:

1. Consistent with the tradition of professional societies, all attendees must register. All registered individuals will be provided a name tag, which must be worn while attending the meeting. All registrants will receive a registration package, which includes the list of review criteria provided to the Review Panel. There is no registration fee for these peer review meetings.
2. During the meeting, all attendees may ask questions of the speakers. These questions are limited to clarification of specific issues presented by the speaker.

A segment of the meeting has been slated for comments by stakeholders. Those making statements should be aware that their comments should be directly related to a specific review criterion. General statements that are not related to the review criteria are not considered by the Review Panel and thus, cannot be permitted.

Due to time constraints, lengthy statements should be avoided as there may not be enough time to accommodate all who wish to participate. Therefore, stakeholders designated by the sponsors of the peer review will be provided specific times with a specific duration in the program to state their case. All other stakeholders wishing to make a statement should limit their statements to only a few minutes to allow as many people as possible to make their concerns and questions known during the time allotted for stakeholders' comments.

Members of the Review Panel may ask questions from all speakers, including those asking questions. However, no question may be directed to the members of the Review Panel.

The Chair of the peer review meeting will be responsible for ensuring that the audience adheres to these requirements.

INSTITUTE FOR REGULATORY SCIENCE

ASME Peer Review
Requirements for Disposal of Remote Handled Transuranic Wastes at the Waste Isolation Pilot Plant
July 30 - August 3, 2001 - Carlsbad, NM

QUESTIONNAIRE FOR STAKEHOLDERS

THE PROCESS

1. Was the notification process adequate?
❑Yes ❑No Comments____________________

2. Were the stakeholders provided sufficient time to identify and describe their concerns?
❑Yes ❑No Comments____________________

PRESENTATIONS

1. Did presenters explain the sometimes highly technical issues in a language understandable to an audience of knowledgeable non specialists?
❑Yes ❑No Comments____________________

2. Did presenters explain technical terms in understandable form?
❑Yes ❑No Comments____________________

3. Did the presentations address the peer review criteria?
❑Yes ❑No Comments____________________

4. Were the questions from the stakeholders responsive to peer review criteria?
❑Yes ❑No Comments____________________

5. Were the statements by the stakeholders responsive to peer review criteria?
❑Yes ❑No Comments____________________

6. Did questions from the Review Panel directly relate to peer review criteria?
❑Yes ❑No Comments____

____

____

LOCAL ARRANGEMENTS:

1. Was registration performed in a professional manner?
❑Yes ❑No Comments____

____

____

2. Was the registration form acceptable?
❑Yes ❑No Comments____

____

____

3. Was the organization of the meeting room acceptable?
❑Yes ❑No Comments____

____

____

4. Were audiovisual arrangements acceptable?
❑Yes ❑No Comments____

____

____

DEFINITION OF STAKEHOLDERS:

Personally Impacted Stakeholders (PI): This class consists of individuals whose lives are directly impacted by the action under consideration.

Administratively Impacted Stakeholders (AI): This class consists of elected, appointed, or employed individuals who must ensure that the action under consideration is prepared, reviewed, approved, or implemented in accordance with applicable laws, regulations, permits, licenses, or agreements.

Generally Concerned Stakeholders (GC): This class includes individuals who, by virtue of their personal philosophies, beliefs, or ideologies, are interested in or concerned about the action under consideration.

1. Is the definition of various classes of stakeholders as described above reasonable?
❑Yes ❑No Comments____

____

____

____

2. Please tell us to which class of stakeholders you belong:
❑PI ❑AI ❑GC

References

ASME (The American Society of Mechanical Engineers). Assessment of technologies supported by the US Department of Energy. Results of the peer review for fiscal year 1997, CRTD Vol.47. New York, NY: ASME; 1997.

ASME (The American Society of Mechanical Engineers). Assessment of technologies supported by the US Department of Energy. Results of the peer review for fiscal year 1998, CRTD Vol. 50. New York, NY: ASME; 1998.

ASME (The American Society of Mechanical Engineers). Assessment of technologies supported by the US Department of Energy. Results of the peer review for fiscal year 1999, CRTD Vol. 56. New York, NY: ASME; 1999.

ASME (The American Society of Mechanical Engineers). Assessment of technologies supported by the US Department of Energy. Results of the peer review for fiscal year 2000; CRTD Vol.61. New York, NY: ASME; 2000.

Cochran, W. G. Sampling techniques. New York, NY: John Wiley & Sons; 1977.

EG&G. Description of the SWEPP certified waste sampling program for FY-94. Engineering design file, RWMC-363, revision 6. Idaho Falls, ID: EG&G-Idaho; 1994.

Gilbert, R. O. Statistical methods for environmental pollution monitoring. New York, NY: Van Nostrand Reinhold; 1987.

DOE (U.S. Department of Energy). National security and military applications of Nuclear Energy Authorization Act of 1980; Public Law 96-164, 1979.

DOE (U.S. Department of Energy). Transuranic quality assurance program plan. DOE/CAO-94-1010, rev. 0. Carlsbad, NM: DOE Carlsbad Operating Office; 1995.

DOE (U.S. Department of Energy). Waste isolation pilot plant disposal phase final supplemental environmental impact statement. Vol. I, DOE/EIS-0026-S-2. Carlsbad, NM: DOE; 1997.

DOE (U.S. Department of Energy). Request for RCRA class 3 permit modification in accordance with 20.4.1.900 NMAC (incorporating 40 CFR Part 270), draft. Carlsbad, NM: DOE Carlsbad Field Office; 2001a.

DOE (U.S. Department of Energy). Notification of proposed change to the EPA 40 CFR Part 194 certification of the Waste Isolation Pilot Plant, draft. Carlsbad, NM: DOE Field Office; 2001b.

EPA (U.S. Environmental Protection Agency). Environmental radiation protection standards for the management and disposal of spent nuclear fuel, high-level and transuranic radioactive wastes; final rule, 40 CFR 191. Fed. Reg. 58:66398-66416; 1993.

EPA (U.S. Environmental Protection Agency). Waste analysis: EPA guidance manual for facilities that generate, treat, store and dispose of hazardous waste. Washington, DC: EPA;1994.

EPA (U.S. Environmental Protection Agency). Criteria for certification and re-certification of the waste isolation pilot plant's compliance with the disposal regulations: Certification decision; Final rule, 40 CFR 194. Fed. Reg. 61:27354-27406; 1996a.

EPA (U.S. Environmental Protection Agency). Test methods for evaluating solid waste, SW-846. Washington, DC: EPA Office of Solid Waste and Emergency Response; 1996b.

EPA (U.S. Environmental Protection Agency); USNRC (US Nuclear Regulatory Commission). Joint USNRC/EPA guidance on the testing requirements for mixed waste. Fed. Reg. 62:62079-62094; 1997.

EPA (U.S. Environmental Protection Agency). Criteria for certification and recertification of the Waste Isolation Pilot Plant's compliance with the disposal certification decision regulations, 40 CFR 194. Fed. Reg. 63:27354-27406; 1998.

EPA (U.S. Environmental Protection Agency). Standards for owners and operators of hazardous waste treatment, storage, and disposal facilities, 40 CFR 260 through 265, 268, and 270. Code of Federal Regulations. Washington, DC: Government Printing Press; 2000a.

EPA (U.S. Environmental Protection Agency). Guidance to the U. S. Department of Energy on preparation for recertification of the Waste Isolation Pilot Plant, 40 CFR Parts 191 and 194. Code of Federal Regulations. Washington, DC: Government Printing Press; 2000b.

EPA (U.S. Environmental Protection Agency). Guidance for data quality objectives process, EPA/600/R-96/055 Code of Federal Regulations. Washington, DC: Government Printing Press; 2000c.

Love, B. R., Straja, S. R., Moghissi, A. A. Manual for stakeholder participation. Columbia, MD: Institute for Regulatory Science; 2001.

LWA (Waste Isolation Pilot Plant Land Withdrawal Act) Public Law 102-579.

NMED (New Mexico Environment Department). New Mexico hazardous waste regulations. Title 20 New Mexico Administrative Code, Chapter 4, Part 1 (20 NMAC 4.1), subparts I through VI, subpart VIII, and subpart IX. Santa Fe, NM: NMED; 1997.

NMED (New Mexico Environment Department) WIPP permit number, NM4890139088-TSDF. Santa Fe, NM: NMED; 1999.

NRC (National Research Council). Disposal of radioactive wastes on land. Washington, DC: National Academy Press; 1957.

NRC (National Research Council). Disposal of solid radioactive waste in bedded salt deposits. Washington, DC: National Academy Press; 1970.

NRC (National Research Council). A study of the isolation system for geologic disposal of radioactive wastes. Washington, DC: National Academy Press; 1983.

NRC (National Research Council). Review of scientific and technical criteria for Waste Isolation Pilot Plant (WIPP). Washington, DC: National Academy Press; 1984.

NRC (National Research Council). The Waste Isolation Pilot Plant; a potential solution for the disposal of transuranic waste. Washington, DC: National Academy Press; 1996.

NRC (National Research Council). Improving operations and long-term safety of the Waste Isolation Pilot Plant. Interim report. Washington, DC: National Academy Press; 2000.

NRC (National Research Council). Improving operations and long-term safety of the Waste Isolation Pilot Plant. Final report. Washington, DC: National Academy Press; 2001.

RCRA (Resource Conservation and Recovery ACT) Public law 94-580, 1976.

RSI (Institute for Regulatory Science). Handbook of peer review. Columbia, MD: Institute for Regulatory Science; 2000.

Biographical Summaries

Gary A. Benda* is President of U.S. Energy Corp.—an environmental management firm specializing in radioactive mixed waste management, health physics, decontamination and decommissioning, and technology development. Previously, he was Vice-President, General Manager of the Programs Division for NUKEM Nuclear Technologies, Inc. His responsibilities included developing and maintaining federal programs in North America that specialized in engineering and waste-processing services. Prior to NUKEM, he spent over 17 years with Chem-Nuclear Systems/WMX Technologies in various management roles. He also directed the site investigation, geophysical analysis, site screening, and license application, as well as managed the public hearings and licensing operations associated with local and national regulatory agencies for new low-level waste sites. He has over 20 years of experience in environmental restoration, technology development, and waste management, and has instructed over 20 national and international professional courses on radioactive waste management, mixed waste, and technology development. He is a member of the American Society of Mechanical Engineers (ASME), American Nuclear Society, and Health Physics Society. He has served as Chair of the ASME National Mixed Waste Committee, Environmental Remediation Committee, and Environmental Engineering Division. He has also chaired over 100 technical sessions at numerous national and international conferences on environmental management. He has authored and coauthored various scientific papers, reports, book chapters, and articles on the nuclear environment. Gary Benda is a Certified Health Physicist. He received a B.S. in Health Physics from Oklahoma State University, an M.S. in Applied Nuclear Science from Georgia Institute of Technology, and an M.B.A. from Seattle City University.

Erich W. Bretthauer* is currently President of the Bryce Meadows Development Corporation. He held the position of research professor at the University of Nevada-Las Vegas from January 1993 to March 1995. In that capacity, he served as Executive Director of Nevada Industry, Science Engineering & Technology, a public-private partnership which developed programs to enhance the scientific infrastructure of the state of Nevada. He was Assistant Administrator for Research and Development at the U.S. Environmental Protection Agency (EPA) from March 1990 until January 1993. In that capacity, he managed the Research and Development activities of a large and multi-disciplinary agency. Erich Bretthauer rose through the ranks of the EPA and served in a number of capacities ranging from a bench scientist to policy manager at national and international levels. He directed the EPA's emergency and long-term monitoring program after the accident at Three Mile Island, as well as its bioremediation program in Prince William

Sound after the Valdez oil spill. He also directed the EPA's ecological research program from 1983-1986 and was Director of EPA's Environmental Monitoring Systems Laboratory in Las Vegas from 1986-1990. He is a member of Sigma Xi, the American Chemical Society, the American Association for the Advancement of Science, and the American Water Works Association, and has served on the Federal Advisory Committee to the Civil Engineering Research Foundation. Erich Bretthauer is the author and coauthor of numerous papers, reports, and other publications. He received his B.S. and M.S. in chemistry from the University of Nevada, Reno.

Alan S. Corson is a consultant in hazardous waste issues. He has over 25 years of experience in a number of environmental issues, notably those related to the regulations and management of hazardous waste. Subsequent to his retirement from the U.S. Environmental Protection Agency (EPA), he served in an advisory role to Jacobs Engineering Group and to the Versar Corporation for both government and private sector clients regarding hazardous waste management programs. During his employment at the EPA, he worked at the Office of Solid Waste where he was responsible for regulatory programs and establishing national standards for generators and transporters of hazardous waste; development of sampling and analytic methods for evaluating solid/hazardous waste including the quality assurance/quality control program; and development and management of programs to establish risk assessment of hazardous waste management practices. Alan Corson was instrumental in the development of the original regulatory program defining standards for solid waste and hazardous waste, and setting national standards for recycling hazardous waste. He also initiated, developed, and managed the original program for restricting hazardous wastes from land disposal management options. The framework developed under this program is currently in-place and used for all evaluations in the land-ban program. Alan Corson served as the EPA Office of Solid Waste representative on many intra- and inter-agency workgroups including PCBs, Reportable Quantities, chlorinated solvents, and transportation of hazardous materials. He developed a guide for effective management of infectious wastes—a predecessor to the current regulatory program for medical wastes; characteristics and listings of hazardous waste; and many regulatory options papers for presentation. Alan Corson managed the preparation of numerous regulatory packages for all aspects of the program implementing the Resource Conservation and Recovery Act (RCRA). He has spoken widely and has taught numerous courses on RCRA and its various regulations. He served on numerous national and international panels including review panels of the American

Society of Mechanical Engineers. He received a B.S. in Electrical Engineering and an M.S. in Engineering Management from the Drexel Institute of Technology in Philadelphia, PA.

Ernest L. Daman* is Chairman Emeritus of Foster Wheeler Development Corporation where he previously served as Director of Research and Chairman of the Board. He also held the position of Senior Vice President at the parent company, FWC. He is a Past President of the American Society of Mechanical Engineers (ASME) and was elected to the National Academy of Engineering. Ernest Daman is a Fellow of the Institute of Energy (England) and the American Association for the Advancement of Science, and Past Chairman of the American Association of Engineering Societies. He served on several ASME committees as member or chairman. Ernest Daman is the author of numerous papers and holds 18 patents. He was responsible for the design and development of a combined steam gas turbine plant, fluidized bed combustion, fast breeder reactor components, supercritical steam generators, environmental control processes, and advanced high-efficiency power generation systems. Ernest Daman received his B.M.E. from the Polytechnic Institute of Brooklyn.

Irwin Feller* is Director of the Institute for Policy Research and Evaluation (IPRE) and Professor of Economics at The Pennsylvania State University, where he has been on the faculty since 1963. His current research interests include the economics of academic research, the University's role in technology-based economic development, and the evaluation of federal and state technology programs. He is the author of *Universities and State Governments*: A Study in Policy Analysis, and over 100 refereed journal articles, final research reports, book chapters, reviews, and numerous papers presented to academic, professional, and private organizations. He is former Chair of the Committee on Science, Engineering, and Public Policy, American Association for the Advancement of Science. Irwin Feller was the American Society of Mechanical Engineers Pennsylvania State Fellow in 1996-1997. He has been appointed to the National Academy of Science's Committee on Science, Engineering, and Public Policy, International Benchmarking of U.S. International Competitiveness-Immunology; Transportation Research Board, Research and Technology Coordinating Committee, National Research Council; and National Institute of Standards and Technology-Manufacturing Extension Partnership National Advisory Board. Irwin Feller is Chair of the National Science Foundation's Advisory Committee on Social, Behavioral, and Economic Sciences.

He received a B.B.A. in Economics from the City University of New York and a Ph.D. in Economics from the University of Minnesota.

Robert A. Fjeld* is Dempsey Professor of Environmental Engineering and Science at Clemson University. He coordinates the Department's nuclear environmental focus area, which is concerned with the environmental aspects of nuclear technologies including environmental health physics, radioactive waste management, and risk assessment. Previously, he served as a faculty member in the Nuclear Engineering Department at Texas A&M University. Robert Fjeld is a member of the Health Physics Society, American Nuclear Society, Society for Risk Analysis, and the American Society of Mechanical Engineers, where he serves as newsletter editor for the Mixed Waste Committee. He has served on two National Research Council Committees studying decontamination and decommissioning issues. Robert Fjeld has over 80 technical publications and presentations on topics such as radiation measurements, environmental transport of radionuclides, risk assessment, and aerosol physics. He has active research on actinide transport in soils, instrumentation for measuring radioactivity in environmental samples, and environmental risk assessment. Robert Fjeld received a B.S. from North Carolina State University, and an M.S. and Ph.D. from The Pennsylvania State University. All three degrees are in Nuclear Engineering. He is a registered Professional Engineer.

John T. Greeves* is currently Director of the Division of Waste Management at the U.S. Nuclear Regulatory Commission (USNRC). His experience in the field of nuclear materials management spans 30 years, and includes work in both the private sector and the federal government. Prior to joining the USNRC, he worked for the Bechtel Power Corporation as an engineer responsible for the design and construction of nuclear and conventional power plants. John Greeves has worked for the U.S. government since 1974—with increasing responsibilities in various divisions—including Industrial and Medical Nuclear Safety, and Fuel Cycle Safety and Safeguards. John Greeves has served on a number of national and international panels regarding waste management activities. He is the USNRC's representative to the Waste Safety Standards Advisory Committee of the International Atomic Energy Agency, and has participated extensively in the development of the International Radioactive Waste Management Convention. John Greeves is the recipient of the Presidential Meritorious Rank Award and a member of the

American Society of Civil Engineers. He received a B.S. from the University of Maryland and is a registered Professional Engineer.

William T. Gregory, III* is currently Principal of Vinculum Marketing Solutions. Prior to forming Vinculum, he was Director of Government Programs for Foster Wheeler Environmental Corporation, an engineering and construction firm providing environmental and waste management services to government and private sector clients world-wide. Previously, he held a number of operational and business development positions at equipment manufacturing and service provision firms supporting nuclear utilities, industrial and process industries, and government agencies. His work has involved the management, processing, and disposition of hazardous, radioactive, and mixed wastes. He has also worked on the decontamination and decommissioning of nuclear facilities and on providing a wide range of environmental services in response to regulatory drivers. Prior to entering the private sector, he served with the U.S. Navy on nuclear submarines and at the operational command center for submarine operations in the Atlantic Fleet. William Gregory is actively involved with a number of international, national, and local organizations including: the American Society of Mechanical Engineers (ASME); the American Nuclear Society; and he is a founding member of the Board of Directors for the annual international Waste Management Symposium. William Gregory has served as an elected officer of several ASME divisions. He received a B.S. in Geology from the University of New Mexico, and an M.B.A. from Lamar University. He also attended naval nuclear power, nuclear weapons, and engineering schools as a U.S. Naval officer.

Tom A. Hendrickson is currently an Independent Consultant in the fields of energy, engineering, and technology. His career encompassed service to both government and industry. He was a Senior Executive of Raytheon Federal Engineers & Constructors Company, developing high technology projects which included a privately-financed New Production Reactor; the Accelerator Production of Tritium; and the North Korean nuclear energy program. While working at DOE during the previous Bush Administration, he was Principal Deputy Assistant Secretary of the Office of Nuclear Energy including: Civilian Reactor Development; the Naval Nuclear Propulsion Program; Uranium Enrichment; Space and Defense Power Systems; Isotope Production; and Nuclear Safety Policy. He later became the Director of the New Production Reactors for the DOE, responsible for designing and building new trituim production capacity for nuclear weapons;

research and development; safety and environmental compliance; and construction. Concurrently, he served as acting Under Secretary of Energy responsible for all defense and nuclear energy activities of the department. Early in his career, he served on Admiral H. G. Rickover's staff of the Atomic Energy Commission in Washington, DC. He directed the headquarters staff and contractors involved in submarine nuclear propulsion engineering including: research, development, design, and construction of all new design nuclear powered submarines and land-based prototypes. During this period, he also served as Project Officer for all new submarine developments including the NR-1; the USS Los Angeles SSN-688 class of over 60 attack submarines, and the electric drive submarine. He helped with the development of port-entry safety procedures and sea trials of the United States' first nuclear powered surface ships, the USS Long Beach and the USS Enterprise; as well as the first refueling of the Shippingport Atomic Power Station. He is a member of the following professional organizations: The American Nuclear Society; The American Society of Mechanical Engineers; and The American Physical Society. Tom Hendrickson received a B.A. degree in Physics from Harvard College and an M.S. degree in Physics from Georgetown University. He is a Licensed Professional Engineer.

Nathan H. Hurt* is a consultant in management and engineering with Technical and Management Consulting. He provides services to industrial firms and government agencies involved in environmental clean-up and waste management—both chemical and radioactive. He has extensive experience in the areas of executive management; plant management; engineering management; project management; marketing; and sales. He specializes in the areas of: uranium enrichment/production; engineering; development and marketing; plant management of rubber chemicals; petrochemicals; and thermoplastics. He also specializes in the engineering management of synthetic rubber and lattices; vinyl monomers and copolymers; polyesters; DOE weapons plants; quality assurance management; and operational readiness review. Nathan Hurt has been involved with the decommissioning of nuclear facilities. He was the Corporate Sponsor or Program Manager for seven decommissioning contracts at the DOE Complexes in Oak Ridge, TN; and Pinellas, FL. Previously, Nathan Hurt worked for Sharp and Associates, Inc. as the Director and Project Manager at the Oak Ridge Office. He was Vice President and Director of Oak Ridge Operations for IDM Environmental Corp., where he was responsible for the marketing and sales of decontamination, decommissioning, and waste management. He served as Project Manager for the laboratory quality assurance program at Westinghouse Hanford; DOE's Rocky Flats Plant—plant-wide identification of electrical equipment. He managed a study for a waste treatment and storage facility at the Portsmouth Area Uranium Enrichment Facility which included incineration and compaction of low-level radioactive wastes. He also worked for The Goodyear Tire and Rubber Company, including Goodyear Atomic, as Director of Research and Development, and President, where he was responsible for the operation of the Portsmouth Area Uranium Enrichment Facility. Nathan Hurt is a past President of, the American Society of Mechanical Engineers. He has been a member of: the American Association of Engineering Societies' Board of Governors; the American Institute of Chemical Engineers; and the Institute of Nuclear Materials Management. He is also a member of Tau Beta Pi Honorary Engineering Society; Pi Tau Sigma Honorary Mechanical Engineering Society; and was a member of The Nuclear Engineering Advisory Board of Worcester Polytechnic Institute. Nathan Hurt received a B.S. degree in Mechanical Engineering from the University of CO and has done Graduate, Technical, and Management course work at Pennsylvania State University. He is a registered professional Engineer in OH.

Michael C. Kirkland is an independent consultant who led a team that performed a Congressionally-mandated External Independent Review of the $1.3 billion Spallation Neutron Source Project at Oak Ridge. He assisted in the planning and review of a management assessment at a U.S. Department of Energy (DOE) Site that involved the restart of a plutonium facility. He participated in planning, procurement, and review activities in the environmental remediation area that included decommissioning activities at a shut down nuclear test reactor; designed and installed a ground water cleanup technology. He also provided design oversight for a new facility related to the DOE weapons complex. During his tenure at Savannah River Site (SRS), Michael Kirkland was a Technical Advisor, Project Manager, and Director of the Project Engineering Division. He evaluated nuclear and mixed waste conditions and aspects of high level wastes and spent nuclear fuel; determined material inventories; performed pollution prevention and environmental health and safety evaluations for a proposed waste treatment facility; served as technical advisor to a study administered by the Savannah River Operations Office; and developed integrated schedules defined for this project. Michael Kirkland was director of the Project Engineering Division and managed the SRS design and construction program. He has been involved with waste management and environmental projects; cutting edge technology programs; and worked with lasers and magnetic containment. He served as Director of the Waste and Fuel Cycle Technology Office and planned and coordinated the programs of the DOE National High Level Waste Technology Office; the SR Fuel Cycle Technology Program; and the Commercial Interim Spent Fuel Management Program. He planned the initial construction of the Consolidated Incinerator Facility which thermally destroys excess benzene created by the In Tank Precipitation process that was to prepare feed material for the Defense Waste Processing Facility. Michael Kirkland was Director of the Commercial Nuclear Spent Fuel Storage Project Office and managed a contract between DOE and the Barnwell Commercial Nuclear Fuel Reprocessing Facility constructed by Allied General Nuclear Services. Michael Kirkland holds a B.S. in Mechanical Engineering from the University of South Carolina. He is registered as a Professional Engineer in South Carolina.

Peter B. Lederman* is a consultant with over 48 years of experience in all facets of process engineering, environmental management, control, and policy development. This includes hazardous substance management; environmental remediation; environmental audit; pollution prevention; development of air pollution control devices; and reuse of waste products. He recently retired as Executive Director of the Center for Environmental Engineering & Science, Executive Director for Patents and Licensing, and Research Professor of Chemical Engineering and Environmental Policy at the New Jersey Institute of Technology. Peter Lederman managed major programs in industrial waste treatment research and development,and in oil and hazardous material spill control and remediation. Most recently, he was responsible for a study of the Economic Impact of Environmental Regulations. He has been responsible for technology transfer efforts including the maturing and licensing of innovative environmental technologies. He is a Fellow of the American Institute of Chemical Engineers (AIChE); a Diplomat of the American Academy of Environmental Engineers; and a member of the American Society of Mechanical Engineers. He has served on several committees of the National Research Council and is the chair of the NRC Committee on Review and Evaluation of the Army Chemical Stockpile Disposal Program. He chaired AIChE's Environmental Division and is currently chair of its Societal Impacts Operating Council. Peter Lederman received a B.S.E., M.S.E., and Ph.D. (All in Chemical Engineering) from the University of Michigan in Ann Arbor, MI and is a registered Professional Engineer.

Betty R. Love is currently Executive Vice President of the Institute for Regulatory Science (RSI). In that capacity, she is responsible for the management of day-to-day operations of RSI, and for administration of several projects with an estimated annual operating budget of $2 million dollars. She is the administrative manager of a large-scale peer review program in collaboration with the American Society of Mechanical Engineers (ASME) for the U.S. Department of Energy (DOE). Her current research activities center around the development and implementation of systematic approach to stakeholder participation, notably in scientific meetings. Previously, Betty Love was Director, Department of Training and Information within Office of Environmental Health and Safety of Temple University in Philadelphia, PA. During that period she was instrumental in the development of a "Handbook of Environmental Health and Safety." She also developed and implemented a large-scale training program not only for the faculty and staff of the University but also for others. Betty Love is currently Managing Editor of *Technology*. She has published several papers in peer-reviewed journals and is the primary author of *Manual for Stakeholder Participation* and *Stakeholder participation in Scientific Meetings*. Betty Love received a B.S. in Business Administration from Virginia State University in Petersburg, VA and an M.S. in Developmental Clinical Psychology from Antioch College in Yellow Springs, OH.

Jeffrey A. Marqusee* is currently the Technical Director of the Strategic Environmental Research and Development Program (SERDP) and the Director of the Environmental Security Technology Certification Program (ESTCP). SERDP is a tri-agency (DoD, DOE and EPA) environmental research and development program managed by the Department of Defense. SERDP supports research and development to solve environmental issues of relevance to DoD in the areas of cleanup, compliance, conservation and pollution prevention. ESTCP is a DoD-wide program designed to demonstrate innovative environmental technologies at DoD facilities. ESTCP provides for rigorous validation of the cost and performance of new environmental technologies in cooperation with the regulatory and end-user communities. Prior to his current position, Jeffrey Marqusee served as a program manager for environmental technology in the Office of the Deputy Under Secretary of Defense for Environmental Security. He was the principal advisor to the Deputy Under Secretary on environmental technology issues. Before joining DoD, he worked at the Institute for Defense Analyses, where he advised both DoD and NASA in the areas of remote sensing, environmental matters and military surveillance. Jeffrey Marqusee has worked at Stanford University, the University of California and the National Institute of Standards and Technology. He has a Ph.D. from the Massachusetts Institute of Technology in Physical Chemistry.

James E. Martin is currently Associate Professor of Radiological Health at the University of Michigan's Department of Environmental and Industrial Health where he is involved in research and teaching related to radiation protection. His interests include: radiation physics; radiological assessment; radio-analytical measurements; internal radiation dosimetry; radioactive waste management; and radiation protection standards and their regulatory aspects. After a 25-year career with the U.S. Public Health Service and the Environmental Protection Agency, he served as Chief of the Hazardous and Solid Waste Program at the Colorado State Health Department which included consultations with the legislature and EPA. James Martin is Certified in Health Physics by the American Board of Health Physics. He has been involved in numerous scholarly and policy activities including: chair of the Michigan Toxic Substance Control Commission; committee member of the National Research Council on CDC Radiation Studies; member of the EPA's National Advisory Committee on Environmental Protection for Radwaste; member of the Environmental Management Board of the U.S. Department of Energy; Chair of the Committee on Formerly Utilized Sites Remedial Action Program (FUSRAP); member of the Advisory Committee on Nuclear Facility Safety to the Secretary of Energy; and a member of EPA's Science Advisory Board-Radiation Advisory Committee. Professor Martin received the Meritorious Service Award from the U.S. Public Health Service, and has published numerous papers in peer-reviewed journals on radiation measurements, radioactive waste, and radiation protection. He received a B.A. degree in physics from Vanderbilt University in Nashville, TN; an MPH degree in radiological health; and a Ph.D. degree in radiological health from the University of Michigan in Ann Arbor, MI.

A. Alan Moghissi* is currently President of the Institute for Regulatory Science (RSI), a non-profit organization dedicated to the idea that societal decisions must be based on best available scientific information. The activities of the Institute include research, scientific assessment, and science education at all levels—particularly the education of minorities. Previously, Alan Moghissi was Associate Vice President for Environmental Health and Safety at Temple University in Philadelphia, PA and Assistant Vice President for Environmental Health and

Safety the University of Maryland at Baltimore. In both positions, he established an environmental health and safety program and resolved a number of relevant existing problems in those institutions. As a charter member of the U.S. Environmental Protection Agency (EPA), he served in a number of capacities, including Director of the Bioenvironmental/Radiological Research Division; Principal Science Advisor for Radiation and Hazardous Materials; and Manager of the Health and Environmental Risk Analysis Program. Alan Moghissi has been affiliated with a number of universities. He was a visiting professor at Georgia Tech and the University of Virginia, and was also affiliated with the University of Nevada and the Catholic University of America. Alan Moghissi's research has dealt with diverse subjects ranging from measurement of pollutants to biological effects of environmental agents. A major segment of his research has been on scientific information upon which laws, regulations, and judicial decisions are based—notably risk assessment. He has published nearly 400 papers, including several books. He is the Editor-in-Chief of *Technology: A Journal of Science Serving Legislative, Regulatory*, and *Judicial Systems*, which traces its roots to the *Journal of the Franklin Institute*—one of America's oldest continuously published journals of science and technology. Alan Moghissi is a member of the editorial board of several other scientific journals and is active in a number of civic, academic, and scientific organizations. He has served on a number of national and international committees and panels. He is a member of a number of professional societies including the American Society of Mechanical Engineers and is past chair of its Environmental Engineering Division. He is also an academic councilor of the Russian Academy of Engineering. Alan Moghissi received his education at the University of Zurich, Switzerland, and Technical University of Karlsruhe in Germany, where he received a doctorate degree in physical chemistry.

Lawrence C. Mohr, Jr.* is currently Professor of Medicine, Biometry, and Epidemiology; and Director of the Environmental Biosciences Program at the Medical University of South Carolina. His areas of research and special interest include internal medicine and pulmonary disease—specifically diseases of the chest and respiratory system. An area of particular interest to Lawrence Mohr is environmental medicine, including molecular epidemiology and biomarker applications. He has been involved in studies related to environmental lung disease; pathophysiology; prevention and treatment of high altitude illness; high altitude physiology; risk assessment of environmental hazards and clinical epidemiology.

Other areas of considerate interest to Lawrence Mohr are assessment of clinical outcomes; health policy analysis; and international health. This latter area includes: global epidemiology; medical relief operations; and health care in Central and Eastern Europe, as well as medical history—the impact of illness on world leaders. Previously, he held academic appointments as a Teaching Fellow in Medicine at the Uniformed Services University of the Health Sciences in Bethesda, MD. He was Associate Clinical Professor of Medicine and Emergency Medicine at George Washington University, Washington, DC. While in these institutions, he was a staff member of the Medical Support Group for the President of the United States. Lawrence Mohr was on the Medical Staff of Walter Reed Army Medical Center—where he completed his Internship and Residency in Internal Medicine—as well as George Washington University Hospital, both in Washington, DC. He has held Visiting Professorships at various universities. He served as Visiting Chief Resident at Presbyterian Hospital and Visiting Professor at the School of Nursing, both at Columbia University. Additionally, Lawrence Mohr was Visiting Professor of: William Beaumont Army Medical Center, Tulane University, University of Cincinnati, New York University, Brown University, East Carolina University, and the Mayo Clinic. Lawrence Mohr is a Fellow of the American College of Physicians and the American College of Chest Physicians. He is a member of several professional societies including: the American Federation for Medical Research; the Society for Risk Analysis; and the Wilderness Medical Society. Previously, he was on the Scientific Advisory Board for the Consortium in Environmental Risk Evaluation and the Savannah River Health Information System. He has authored or coauthored more than 60 articles, books, or technical publications. He received an A.B. degree in Chemistry as well as an M.D. degree, both from the University of North Carolina, Chapel Hill. Lawrence Mohr, Jr., is certified by the American Board of Internal Medicine.

Goetz K. Oertel* is President Emeritus and former CEO of the Association of Universities for Research in Astronomy, Inc. (AURA). AURA is a $150 Million per year non-profit corporation that operates the Hubble Space Telescope Science Institute and ground-based astronomical observatories around the world and is building international Gemini 8-meter telescopes in Hawaii and in Chile. Previously, he was a Senior Executive in the U.S. Department of Energy. Assignments included Deputy Assistant Secretary for Safety, Health, and Quality Assurance; Deputy Manager of the Albuquerque Operations Office; Deputy and

Acting Manager of the Savannah River Operations Office; and Director of the Office of Byproducts and Waste Management in Defense Programs in Washington. Previously, he was Chief of Solar Physics and manager of several space science programs in NASA Headquarters—and before that—aerospace engineer and group leader at NASA's Langley Research Center. He held career development positions with the President's Science Advisor and in the Office of Management and Budget in the Executive Office of the President. He authored numerous publications in science and engineering and holds patents. He has served on and chaired professional committees in engineering and other sciences—including a committee of the National Research Council. He is the U.S. representative to the Commission on DATA (CODATA) at the International Council of Scientific Unions and serves on several non-profit Boards in Education and science. He is a fellow of the American Association for the Advancement of Science and member of numerous national and international professional organizations. He graduated from the University of Kiel, Germany with major in physics and minors in chemistry and mathematics. As a Fulbright grantee, he earned a Ph.D. in physics from the University of Maryland in College Park.

Sorin R. Straja is currently Vice President for Science and Technology of the Institute for Regulatory Science. He has over 20 years of expertise in mathematical modeling and software development as applied in chemical engineering and risk assessment. Previously he served as Assistant Professor of Biostatistics with Temple University, Philadelphia; as Director of the Department of Occupational Health and Safety of Temple University, Philadelphia; and as a chemist with University of Maryland at Baltimore. Sorin Straja has extensive experience in the chemical industry where he worked as a senior R&D consultant with the Chemical and Biochemical Energetics Institute, and as a plant manager with Chemicals Enterprise Dudesti and Plastics Processing Bucharest from Romania. He was an Assistant/Adjunct Professor of Chemical Engineering with the Polytechnic Institute Bucharest. Sorin Straja is the author of two books and 44 scientific papers published in internationally recognized and peer reviewed journals. He was an editor of *Environment International,* and currently is a contributing editor of *Technology*. Sorin Straja received a Certificate of Appreciation for Teaching from Temple University, the "Nicolae Teclu" Prize of the Romanian Academy, and a Certificate of Appreciation from U.S. Department of Agriculture for significant volunteer contributions. He is a Fellow of the Global Association of Risk Professionals, and a member of the American Chemical Society, American Institute of Chemical Engineers, Society for Risk Analysis, and New York Academy of Sciences. Sorin Straja holds a M.S. in Industrial Chemistry and a Ph.D. in Chemical Engineering both from Polytechnic Institute Bucharest.

Glenn W. Suter* is currently Science Advisor at the National Center for Environmental Assessment of the U.S. Environmental Protection Agency (EPA) in Cincinnati, OH. Previous to his current position, he was at Oak Ridge National Laboratory, initially as Research Associate and gradually rising to Science Leader at the Environment Science Division of the Laboratory. His interest has focused on Ecotoxicology in general and Ecological Risk Assessment in particular. He is one of the developers of the most widely-used methodology for Ecological Risk Assessment. This method has been applied to the impact of pollutants on fish, contaminated soils, production of synthetic fuels, and various other ecosystems. Glenn Suter has lectured widely, both nationally and internationally on Ecological Risk Assessment. He is currently a member of the U.S. EPA's Risk Assessment Forum. He has been a member of numerous panels and has consulted with various governmental agencies and private organizations, including the Council of Environmental Quality. He was a member of the Scientific Review Panel for Savannah River Ecology Laboratory; the National Science Foundation Panel on Decision Making and Valuation for Environmental Policy; and the U.S. EPA Science Advisory Board and Conservation Foundation, Ecosystem Valuation Forum. In addition, he was a member of the International Institute of Applied Systems Analysis Task Force on Risk and Policy Analysis and the Council on Environmental Quality. He was a member of the Board of Directors, for the Society for Environmental Toxicology and Chemistry. Glenn Suter is presently on the Editorial Board of *Environmental Health Perspectives* and *Human and Ecological Risk Assessment.* Previously, he was on the Editorial Board of *Handbook of Environmental Risk Assessment and Management* and *Environmental Toxicology and Chemistry.* Glenn Suter is the author of three books and is author and coauthor of over 200 publications. He received a B.S. degree in Biology from Virginia Polytechnic Institute and a Ph.D. in Ecology from the University of California, Davis.

Wade O. Troxell is President/Chief Operating Officer and Founder of Sixth Dimension, Inc., a development stage company offering Internet-based products to the electric power industry. He is currently on a leave-of-absence as Associate Professor of Mechanical Engineering at Colorado State University (CSU); and Director of Robotics and Autonomous Machines Laboratory at CSU. His research interests consist of product realization processes; design support systems; and behavior-based robots (task-structured approach to building robust and reliable autonomous intelligent systems). His research interests also include robot programming and control (high-level formalisms, complexity measures, and verification). His professional experience is extensive and includes his positions as: Executive Director of the U.S. National Institute of Standards and Technology (NIST)/Mid-America Manufacturing Technology Center, Colorado Regional Office; Director of the Manufacturing Excellence Center at CSU; and Assistant Professor of Mechanical Engineering at CSU. He was also a Director of the Manufacturing and Robotic Systems Laboratory, Mechanical Engineering at CSU; Robotic Consultant to the Public Service Company of Colorado, Nuclear Engineering Division (Fort St. Vrain Station on the controller retrofit of the fuel handling robot); and NATO Postdoctoral Fellow at the University of Edinburgh in the Department of Artificial Intelligence. He was a Consultant, specializing in product design and process automation; a Mechanical Engineer for the Eastman Kodak Company; and a Consulting Bioengineer with Staodynamics, Inc. He has provided services as an expert witness related to legal cases involving trade secrets, patent infringements, and product liability. Wade Troxell is currently Advisor to the Senior Vice President of the ASME Council of Member Affairs. He serves on the ASME Inter-Council Committee for Federal R&D; the ASME/NIST Interaction Committee; and is the Chair of the ASME Distinguished Lecturers' Program. In addition, he served as the ASME Vice President for Region XII (Rocky Mountains), and serves as Chair of the Mechanical Engineering MS Program for the National Technological University. He serves on the Board of Directors for Sixth Dimension, Inc, and is Advisor to the Board of Directors for the Boulder Technology Incubator. He is the recipient of the ASME Dedicated Service Award. Wade Troxell is a member of Tau Beta Pi. He is the author or coauthor of over 50 refereed publications, technical reports, and conference proceedings. Wade Troxell received a B.S. degree in Engineering Science, an M.S. degree, and a Ph.D. degree in Mechanical Engineering, all from CSU.

Charles O. Velzy* is a consultant in the field of waste treatment and disposal. Previously, he held increasingly responsible positions with the environmental consulting engineering firm, Charles R. Velzy Associates, Inc., becoming president in 1976. In 1987, when Velzy Associates merged with Roy F. Weston, Inc., Charles Velzy became Vice President of Weston, a position which he held until retiring in 1992. He has over 35 years of experience as an environmental engineering consultant specializing in: the analysis of waste management problems; design of wastewater treatment and waste disposal systems; and design of new, retrofit of existing, testing, and permitting of waste combustion facilities. He has authored or co-authored over 80 publications—primarily in the field of solid waste management. He has served on the Science Advisory Board of the U.S. Environmental Protection Agency; as President of the American Society of Mechanical Engineers (ASME); and as Treasurer of the American Academy of Environmental Engineers (AAEE). He has served on numerous committees of the ASME, the AAEE, the American National Standards Institute, and the American Society for Testing and Materials. He is a registered professional engineer in New York and eleven other states. Charles Velzy received B.S. degrees in Mechanical and Civil Engineering, and an M.S. in Sanitary Engineering from the University of Illinois at Urbana-Champaign.

Richard Wilson is currently emeritus Mallinckrodt Research Professor of Physics at Harvard University in Cambridge, MA. He is also an affiliate of the Center for Middle Eastern Studies; the Harvard Center for Risk Analysis; and of the Program on Science and International affairs at the Kennedy School of Government. He used the principle of detailed balance to measure the spin of the pi-zero meson and studied nucleon-nucleon scattering at the Harvard Cyclotron Laboratory. He was involved in converting the Harvard University Cyclotron from nuclear physics use to medical treatment. He was the first to analyze elastic scattering data in terms of the electric and magnetic form factors. He studied nucleon structure by electron-proton scattering and muon proton scattering. He was a participant in the Cambridge Electron Accelerator "by-pass" program, which demonstrated an unusually large cross-section for producing hadrons. Richard Wilson closely followed the Russian and Ukrainian radiation accidents at Chernobyl in the Ukraine, and the accidents at the Techa River and the Mayak production complex in the Ural Mountains. He performed research on the risk assessment of chemical carcinogens. Richard Wilson is Chairman of the visiting committee of the radiation medicine department at Massachusetts General Hospital. He is Chairman of an International Advisory Committee to the newly formed Sakharov College of Radioecology in Minsk, Belarus, and serves as a member of the Board of Directors of the Andrey Sakhorov Foundation of New York and Moscow. He was the first Chairman of the Harvard Cyclotron Operating Committee and is still a member. He is a Fellow of the American Physical Society, Chaired its committee to study the radiological consequences of severe nuclear power accidents, and received its

"Forum Award". Richard Wilson chaired an advisory committee for the Minister of Economic Affairs of the Republic of China. He is a founder/member of the Society of Risk Analysis, as well as the recipient of its Distinguished Service Award. He is a member of the American Nuclear Society and the Society of Toxicology. He served as the Director of the NE Regional Center of the National Institute of Global Environmental Change. He has held various positions as a Visiting Professor, Scholar, and Scientist and served on numerous government advisory committees in many different agencies and countries. Richard Wilson is the author or coauthor of more than 800 published papers. He is the editor of the English translation of the Russian Journal, *Radiation and Risk,* which is published by the Russian Medical Research Laboratory in Obninsk and is mainly about the effects of Chernobyl. Richard Wilson holds a B.A. degree; an M.A. degree and a Ph.D. degree; all in Physics and all from Christ Church, Oxford University, Oxford, England.

* Members of ASME Peer Review Committee

List of Acronyms

AK	Acceptable Knowledge
ALARA	As Low As Reasonably Achievable
ASME	American Society of Mechanical Engineers
CAG	Compliance Application Güidelines
CBFO	Carlsbad Field Office
CCA	Compliance Certification Application
CERCLA	Comprehensive Environmental Response Compensation and Recovery Act
CFR	Code of Federal Regulations
CH	Contact-Handled
CPR	Cellulosic, Plastic, and Rubber
DOE	U. S. Department of Energy
DOT	U. S. Department of Transportation
DQA	Data Quality Objective
EIS	Environmental Impact Statement
EP	Executive Panel
EPA	U. S. Environmental Protection Agency
FEIS	Final Environmental Impact Statement
FTIRS	Fourier Transform Infrared System
GC	Gas Chromathography
HPLC	High Pressure Liquid Chromatography
HWFP	Hazardous Waste Facility Permit
LWA	Land Withdrawal Act
MS	Mass Spectrometry
NDA	Non-Destructive Assay
NDE	Nondestructive Evaluation
NEPA	National Environmental Policy Act
NMAC	New Mexico Administrative Code
NMED	New Mexico Environmental Department
NQA	Nuclear Quality Assurance
NRC	National Research Council
NUREG	Nuclear Regulatory Guidelines
OST	Office of Science and Technology
PA	Performance Assessment
PAN	Passive/Active Neutron
PBMS	Performance-Based Measurement System
PCB	Polychlorinated Biphenyl
PRC	Peer Review Committee (of ASME)
PREPP	Process Experimental Pilot Plant

QA	Quality Assurance
QAO	Quality Assurance Objective
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
RH	Remote-Handled
RP	Review Panel
RSI	Institute for Regulatory Science
SEIS	Supplemental Environmental Impact Statement
SGS	Segmented Gamma Scans
SPC	Statistical Process Control
SWB	Standard Waste Box
TDOP	Ten-Drum Overpack
TIC	Tentatively Identified Compound
TRU	Transuranic
TRUDOCK	Waste handling area of WIPP
TRUPACT-II	Transuranic Package Transporter, Model 2
TSDF	Permit Treatment, Storage and Disposal Facility
TSDF-WAC	Permit Treatment, Storage and Disposal Facility Waste Acceptance Criteria
UCL	Upper Confidence Limit
USNRC	U. S. Nuclear Regulatory Commission
VE	Visual Examination
VOC	Volatile Organic Compound
WAC	Waste Acceptance Criteria
WAP	Waste Analysis Plan
WHB	Waste Handling Building
WIPP	Waste Isolation Pilot Plant
WSPF	Waste Stream Profile Form
WWIS	WIPP Waste Information System