U.S. NUCLEAR REGULATORY COMMISSION

U.S. ENVIRONMENTAL PROTECTION AGENCY

Joint Guidance on Testing Requirements for Mixed Radioactive and Hazardous Waste

Clarification of RCRA Hazardous Waste Testing Requirements for Low-Level Radioactive Mixed Waste—Final Guidance

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I. Background

Mixed waste is defined as waste that contains both hazardous waste subject to the requirements of the Resource Conservation and Recovery Act (RCRA) and source, special nuclear, or byproduct material subject to the requirements of the Atomic Energy Act (AEA).[1] This guidance addresses testing activities related to mixed low-level waste (LLW), which is a subset of mixed waste.[2] The term ''mixed waste,'' for the purposes of this document, will refer to mixed LLW. Additional information on the testing of hazardous wastes, which could apply to both mixed LLW and other types of mixed waste (e.g., high-level and transuranic mixed waste), is found in Appendix A. The information below is intended for use by Nuclear Regulatory Commission (NRC) licensees that may not be familiar with the hazardous waste characterization and testing requirements that apply to mixed waste. The guidance assumes that the reader is familiar with the NRC's regulations and regulatory framework for the management of radioactive material and focuses on compliance with the Environmental Protection Agency's (EPA's) requirements for the management of hazardous waste. Although it is written for commercial mixed waste generators, the guidance may also be useful for Federal facilities that generate mixed waste.

Users of this guidance should have a good understanding of how mixed waste is defined (see above), and what authority, or authorities, regulate mixed waste testing activities. The hazardous component of mixed waste is regulated by EPA in those States where EPA implements the entire RCRA Subtitle C hazardous waste program (i.e., unauthorized States). Currently, EPA regulates mixed waste in Alaska, Hawaii, Iowa, Puerto Rico, the Virgin Islands, and American Samoa. In most instances mixed waste is regulated by State governments. Thirty-nine States and one territory (Guam) have been delegated authority by EPA to implement the base RCRA hazardous waste program and to regulate mixed waste activities (see 51 *FR* 24504, July 3, 1986, and Appendix B). These States are referred to as ''mixed waste authorized States.'' Nine additional States are authorized for the RCRA base hazardous waste program but have not been delegated authority by EPA to regulate mixed waste.[3] In these States mixed waste is not regulated by EPA, but may be regulated by States under the authority of State law. It is important that licensees contact the State hazardous waste agencies in authorized States to determine the specific testing, analysis, and other hazardous waste requirements that may apply to mixed waste managed in their State, because their State may have more stringent requirements than the Federal requirements discussed in this guidance.

This guidance describes:

(1) The current regulatory requirements for determining if a waste is a RCRA hazardous waste;
(2) The role of waste knowledge for hazardous waste determinations;
(3) The waste analysis information necessary for proper treatment, storage, and disposal of mixed waste; and,
(4) The implications of the RCRA land disposal restrictions (LDRs) on the waste characterization and analysis requirements.

This information should be useful for:

(1) radioactive waste generators, who must determine if their waste is a RCRA hazardous waste, and therefore a mixed waste;

(2) for those generators storing mixed waste on-site in tanks, containers or containment buildings for longer than 90 days, that consequently become responsible for complying with RCRA and NRC storage requirements; and
(3) those facilities that accept mixed waste for off-site treatment, storage, or disposal.

Generators and/or treatment, storage, and disposal facilities (TSDFs) handling wastes under RCRA must characterize their waste for several purposes:

(1) To determine if their waste is a hazardous waste (40 CFR 262.11);
(2) To comply with general waste analysis requirements for new or permitted TSDFs, for TSDFs operating under interim status, and for certain generators that treat land disposal prohibited wastes in 40 CFR 264.13, 265.13 and 268.7, respectively. These analysis requirements include:
    (a) chemical/physical analysis of a representative sample (and/or, in some cases, use waste knowledge (see below); and,
    (b) preparation of a waste analysis plan.
(3) To meet the waste analysis requirements that apply to the specific waste management methods in 40 CFR 264.17, 264.314, 264.341, 264.1034(d), and 268.7;
(4) To ensure, prior to land disposal, that the restricted waste meets the required treatment standard (40 CFR 268.7).[4]

This guidance addresses the need for chemical analysis of mixed wastes to meet these purposes. The guidance also emphasizes ways in which unnecessary testing of mixed waste may be avoided. This is important when handling mixed waste, since each sampling, workup, or analytical event may involve an incremental exposure to radiation. This guidance encourages mixed waste handlers to use waste knowledge, such as process knowledge, where possible, in making RCRA hazardous waste determinations involving mixed waste. It also encourages the elimination of redundant testing by off-site treatment and disposal facilities, where valid generator-supplied, and certified, data are available.

Because mixed waste testing may pose the possibility of increased radiation exposures, this guidance also describes methods by which individuals who analyze mixed waste samples may reduce their occupational radiation exposure and satisfy the intent of the RCRA testing requirements. Testing to determine whether wastes are hazardous under the RCRA toxicity characteristic may pose special concerns which are examined in Section III of this guidance.

All of the activities described in this guidance are subject to the requirements of both the AEA and RCRA. The focus of this guidance is the RCRA requirements. NRC and NRC Agreement State licensees are authorized to receive, possess, use (which includes storing, sampling, testing, and treating), and dispose of AEA-licensed materials. NRC licensees handling mixed waste should ensure that their RCRA hazardous waste testing activities are consistent with NRC, or Agreement State, regulations and license conditions. Flexibility in the RCRA requirements is emphasized so that the As Low As is Reasonably Achievable (ALARA) concept can be incorporated into the mixed waste testing activities.[5] If other AEA requirements, or RCRA requirements are difficult to meet in a specific mixed waste management situation, licensees should seek resolution by requesting license amendments, approval of modifications to their RCRA permits or interim status Part A applications, or resolution under both authorities.

Section 1006(a) of RCRA states ''Nothing in this Act shall be construed to apply to (or authorize any State, interstate, or local authority to regulate) any activity or substance which is subject to * * * the Atomic Energy Act of 1954 * * * except to the extent that such application (or regulation) is not inconsistent with the requirements of such Acts.'' If a resolution cannot be achieved through the flexibility provided by the two regulatory frameworks, then and only then, should licensees seek resolution under Section 1006(a) of RCRA. Licensees should note that, if an inconsistency exists, relief will be limited to that specific RCRA requirement, and that the determination of an inconsistency would not relieve the licensee from all other RCRA requirements. Section 1006(a) and radiological hazard considerations are addressed more fully in Sections III and IV of this guidance. NRC licensees should also include the necessary flexibility in their RCRA permit waste analysis plans to accommodate the sampling and testing required to meet AEA requirements.

II. Use of Waste Knowledge for Hazardous Waste Determinations

The use of waste knowledge by a generator and/or a TSDF to characterize mixed waste is recommended throughout this document to eliminate unnecessary or redundant waste testing. EPA interprets ''waste knowledge'' or ''acceptable knowledge'' of a waste broadly to include, where appropriate:

- ''Process knowledge'';
- Records of analyses performed by generator or TSDF prior to the effective date of RCRA regulations; or,
- A combination of the above information, supplemented with chemical analysis.

Process knowledge refers to detailed information on processes that generate wastes subject to characterization, or to detailed information (e.g., waste analysis data or studies) on wastes generated from processes similar to that which generated the original waste. Process knowledge includes, for example, waste analysis data obtained by TSDFs from the specific generators that sent the waste off-site, and waste analysis data obtained by generators or TSDFs from other generators, TSDFs or areas within a facility that test chemically identical wastes.[6]

Waste knowledge is allowed by RCRA regulations for the following hazardous waste characterization determinations:

- To determine if a waste is characteristically hazardous (40 CFR 262.11(c)(2)) or matches a RCRA listing in 40 CFR Part 261, Subpart D (40 CFR 262.11(a) and (b));
- To comply with the requirement to obtain a detailed chemical/physical analysis of a representative sample of the waste under 40 CFR 264.13(a);
- To determine whether a hazardous waste is restricted from land disposal (40 CFR 268.7(a)); and,
- To determine if a restricted waste the generator is managing can be land disposed without further treatment (see the generator certification in 40 CFR 268.7(a)(3) and information to support the waste kn/wledge determination in 40 CFR 268.7(a)(6)).

Hazardous waste, including mixed waste, may be characterized by waste knowledge alone, by sampling and laboratory analysis, or a combination of waste knowledge, and sampling and laboratory analysis. The use of waste knowledge alone is appropriate for wastes that have physical properties that are not conducive to taking a laboratory sample or performing laboratory analysis. As such, the use of waste knowledge alone may be the most appropriate method to characterize mixed waste streams where increased radiation exposures are a concern. Mixed waste generators should contact the appropriate EPA regional office to determine whether they possess adequate waste knowledge to characterize their mixed waste.

III. Determinations by Generators That a Waste Is Hazardous

A solid waste is a RCRA hazardous waste if it meets one of two conditions:

(1) the waste is specifically ''listed'' in 40 CFR Part 261, Subpart D, or;
(2) the waste exhibits one of the four ''characteristics'' identified in 40 CFR Part 261, Subpart C. These characteristics are:

- Ignitability;
- Corrosivity;
- Reactivity; or,
- Toxicity.

(a) Listed Hazardous Wastes

Generators of waste containing a radioactive and solid waste component must establish whether the solid waste component is a RCRA hazardous waste. Determinations of whether a waste is a listed hazardous waste can be made by comparing information on the waste stream origin with the RCRA listings set forth in 40 CFR Part 261, Subpart D. These listings are separated into three major categories or lists, and are identified by EPA hazardous waste numbers. Most hazardous waste numbers are associated with a specific waste description, specific processes that produce wastes, or certain chemical compounds. For example, K103 waste is defined as ''process residues from aniline extraction from the production of aniline.'' A generator who produces such residues should know, without any sampling or analysis, that these wastes are ''listed'' RCRA hazardous wastes by examining the K103 hazardous waste description in the hazardous waste lists. Other hazardous waste numbers describe wastes generated from generic processes that are common to various industries and activities. These wastes are referred to as hazardous wastes from nonspecific sources. Radioactively contaminated spent solvents are the most likely mixed wastes to be nonspecific source listed wastes. For example, a generator using one of the F002 halogenated solvents (e.g., tetrachloroethylene, trichloroethylene, and chlorobenzene, etc.) to remove paint from a radiologically contaminated surface, can determine that this waste is a listed RCRA hazardous waste by examining the F002 waste definition for the solvent type, and for a solvent mixture/blend, the percent solvent by volume.

In addition to wastes that are specifically listed as hazardous, the ''derived from'' and ''mixture'' rules state that any solid waste derived from the treatment, storage, or disposal of a listed RCRA hazardous waste, or any solid waste mixed with a listed RCRA hazardous waste, respectively, is itself a listed RCRA hazardous waste until delisted (see 40 CFR 261.3).[7] (Note that soil and debris can be managed as hazardous wastes if they contain listed hazardous wastes or they exhibit one or more hazardous waste characteristics. See hazardous debris definition in 40 CFR 268.2.)

Exceptions to the ''mixture rule'' and ''derived from'' rules exist for certain solid wastes. For example, wastewater discharges subject to Clean Water Act permits, under certain circumstances, are not RCRA hazardous (see 40 CFR 261.3(a)(2)(iv)). Also, hazardous wastes which are listed solely for a characteristic identified in Subpart C of 40 CFR Part 261 (e.g., a F003 spent solvent which is listed only because it is ignitable) are not considered hazardous wastes when they are mixed with a solid waste and the resultant mixture no longer exhibits any characteristic of a hazardous waste (see 40 CFR 261.3(a)(2)(iii)). Likewise, waste pickle liquor sludge ''derived from'' the lime stabilization of spent pickle liquor (e.g., K062) is not a RCRA listed hazardous waste, if the sludge does not exhibit a hazardous waste characteristic (see discussion below on characteristic hazardous wastes). It should be noted, however, that wastes such as F003 and K062 *must* meet LDR treatment standards. Outside of the exceptions mentioned here and in the RCRA regulations, a hazardous waste that was generated via the "mixture rule" or the "derived from" rule must be delisted through a specific EPA petition process for the listed waste to be considered only a solid waste, and no longer managed as a listed hazardous waste under the RCRA Subtitle C system.

When applying the mixture rule to hazardous wastes, including mixed wastes, generators should be aware that EPA prohibits the dilution (i.e., mixing) of land disposal restricted waste or treatment residuals as a substitute for adequate treatment (see 40 CFR 268.3). An exception to the prohibition is the dilution of purely corrosive, and in some cases, reactive, or ignitable nontoxic wastes to eliminate the characteristic, or the aggregation of characteristic wastes in (pre)treatment systems regulated under the Clean Water Act (55 *FR* 22665).

(b) Characteristic Hazardous Wastes

Hazardous characteristics are based on the physical/chemical properties of wastes. Thus, physical/chemical testing of waste may be appropriate for determining whether a waste is a characteristic hazardous waste. *RCRA regulations, however, do not require testing. Rather, generators must determine whether the waste is a RCRA hazardous waste.* Such a determination may be made based on one's knowledge of the materials or chemical processes that were used. EPA's regulations are clear on this point. 40 CFR 262.11(c) states:

". . . if the waste is not listed [as hazardous waste] in Subpart D [of 40 CFR Part 261], the generator must then determine whether the waste is identified in Subpart C of 40 CFR Part 261 by either:

(1) Testing the waste according to the methods set forth in Subpart C of 40 CFR Part 261, or according to an equivalent method approved by the Administrator under 40 CFR 260.21; or
(2) Applying knowledge (emphasis added) of the hazardous characteristic of the waste in light of the materials or the processes used."

Therefore, where sufficient material or process knowledge exists, the generator need not test the waste to make a hazardous characteristic determination, although generators and subsequent handlers would be in violation of RCRA, if they managed hazardous waste erroneously classified as non-hazardous, outside of the RCRA hazardous waste system. For this reason, facilities wishing to minimize testing often assume a questionable waste is hazardous and handle it accordingly.

A generator must also comply with the land disposal restriction regulations in 40 CFR 268 which require the generator to determine whether the waste is prohibited from land disposal (refer to Section V for a detailed discussion of these requirements).[8] With respect to the hazardous characteristic, and the determination as to whether a waste is restricted from land disposal under 40 CFR 268.7(a), a generator may select the option of using waste knowledge. However, if the waste is determined to be land disposal restricted in 40 CFR 268.7(a), some testing will generally be required prior to land disposal, except where technologies are specified as the treatment standard. For mixed waste, EPA recommends that the frequency of such testing be held to a minimum, in order to avoid duplicative testing and repeated exposure to radiation.

In determining whether a radioactive waste is a RCRA hazardous waste, the generator may test a surrogate material (i.e., a chemically identical material with significantly less or no radioactivity) to determine the RCRA status of the radioactive waste. This substitution of a surrogate material may either partially or completely supplant the testing of the waste. A surrogate material, however, should only be used if the surrogate material faithfully represents the hazardous constituents of the mixed waste.[9] The following example discusses the use of surrogates. A generator is required to determine if a process waste stream containing lead (D008) exceeds the regulatory level of 5.0 milligrams per liter for the toxicity characteristic (40 CFR 261.24). If this determination cannot be made based on material and process knowledge only, the generator would need to test the hazardous material. Rather than testing the radioactive waste stream, the generator may opt to test a surrogate or chemically identical non-radioactive, or lower activity, radioactive waste stream generated by similar maintenance activities in another part of the plant. This substitution of materials is acceptable as long as the surrogate material faithfully represents the characteristics of the actual waste, and testing provides sufficient information for the generator to reasonably determine if the waste is hazardous under RCRA. Non-radioactive or lower activity quality control samples/species and spiked solutions, for instance, are acceptable to minimize exposure to radiation from duplicative mixed waste testing.

As part of the hazardous waste determination, a generator must document test results or other data and methods that it used. Specifically, 40 CFR 262.40(c) states that "a generator must keep records of any test results, waste analyses, or other determinations made in accordance with 40 CFR 262.11 for at least three years from the date that the waste was last sent to on-site or offsite treatment, storage, or disposal." Section V of this guidance contains information on record keeping requirements for land disposal restricted hazardous (and mixed) wastes.

In summary, testing listed wastes to make the hazardous waste determination is not necessary, because most RCRA hazardous waste codes or listings identify specific waste streams from specific processes or specific categories of wastes. Testing will most often occur to determine if a waste exhibits a hazardous characteristic. However, testing is not required if a generator has sufficient knowledge about the waste and its physical/chemical properties to determine that it is non-hazardous.[10] It is recognized that certain mixed waste streams, such as wastes from remediation activities or wastes produced many years ago, may have to be identified using laboratory analysis, because of a lack of waste or process information on these waste streams. Nonetheless, hazardous waste determinations based on generator knowledge can be used to reduce the sampling of mixed waste and prevent unnecessary exposure to radioactivity. The same principle holds for a generator's determination that a waste is subject to the RCRA land disposal restrictions in 40 CFR 268.7(a).

IV. Testing Protocols for Characteristics

When testing is conducted to determine whether a waste is a RCRA hazardous waste, there are acceptable test protocols or criteria for each of the four characteristics. Testing for characteristics must be done on a representative sample of the waste or using any applicable sampling methods specified in Appendix I of 40 CFR 261.[11]

Ignitability—For liquid wastes, other than aqueous solutions containing by volume less than 24 percent alcohol, the flash point is to be determined by a Pensky-Martens Closed Cup Tester, using the test method specified in American Society of Testing and Materials (ASTM) Standard D–93–79 or D–93–80, or a Setaflash Closed Cup Tester, using the test method specified in ASTM Standard D–3278–78, or as determined by an equivalent test method approved by the Administrator under procedures set forth in 40 CFR 260.20 and 260.21 (see ‘‘Test Methods for Evaluating Solid Waste, Physical/Chemical Methods,’’ 3rd Ed., as amended, EPA, OSWER, SW–846, Methods 1010 and 1020[12]). (Non-liquid wastes, compressed gases, and oxidizers may exhibit the characteristic of ignitability as described in 40 CFR 261.21 (a)(2–4).)

Corrosivity—For aqueous solutions, the pH is to be determined by a pH meter using either an EPA test method (i.e., SW–846, Method 9040 or an equivalent test method approved by the Administrator under procedures set forth in 40 CFR 260.20 and 260.21.) For liquids, steel corrosion is to be determined by the test method specified in National Association of Corrosion Engineers (NACE) Standard TM–01–69 as standardized in ‘‘Test Methods for Evaluating Solid Waste, Physical/Chemical Methods,’’ 3rd Ed., as amended (EPA, OSWER, SW–846, Method 1110), or an equivalent test method approved by the Administrator under procedures set forth in 40 CFR 260.20 and 260.21.

Reactivity—There are no specified test protocols for reactivity. 40 CFR 261.23 defines reactive wastes to include wastes that have any of the following properties:

(1) normally unstable and readily undergoes violent change without detonating;
(2) reacts violently with water;
(3) forms potentially explosive mixtures with water;
(4) generates dangerous quantities of toxic fumes, gases, or vapors when mixed with water;
(5) in the case of cyanide- or sulfide-bearing wastes, generates dangerous quantities of toxic fumes, gases, or vapors when exposed to acidic or alkaline conditions;
(6) explodes when subjected to a strong initiating force or if heated under confinement;
(7) explodes at standard temperature and pressure; or
(8) fits within the Department of Transportation’s forbidden explosives, Class A explosives, or Class B explosives classifications.[13]

EPA has elected to rely on a descriptive definition for these reactivity properties because of inherent deficiencies associated with available methodologies for measuring such a varied class of effects, with the exception of the properties discussed in No. 5, above. The method used, as guidance but not required, to quantify the reactive cyanide and sulfide bearing wastes is provided in Chapter 7 of ''Test Methods for Evaluating Solid Waste, Physical/Chemical Methods,'' 3rd Ed., as amended, EPA, OSWER, SW–846.

Toxicity Characteristic—The test method that may be used to determine whether a waste exhibits the toxicity characteristic (TC) is the Toxicity Characteristic Leaching Procedure (TCLP), as described in 40 CFR Part 261, Appendix II (SW–846, Method 1311). The TCLP was modified and revised in 55 *FR* 11798, March 29, 1990. Note that this revised TCLP is used (in most cases) for land disposal restriction compliance determinations as well. Differences between the TCLP and the previously required Extraction Procedure (EP) include improved analysis of the leaching of organic compounds, the elimination of constant pH adjustment, the addition of a milling or grinding requirement for solids (waste material solids must be milled to particles less than 9.5 mm in size), and other more detailed alterations.[14] Additionally, the TC rule added 25 organic compounds to the toxicity characteristic. The TCLP (Method 1311) recommends the use of a minimum sample size of 100 grams (solid and liquid phases as described in Section 7.2). *For mixed waste testing, sample sizes of less than 100 grams can be used, if the analyst can demonstrate that the test is still sufficiently sensitive to measure the constituents of interest at the regulatory levels specified in the TCLP and representative of the waste stream being tested*. Other variances to the published testing protocols are permissible (under 40 CFR 260.20–21), but must be approved prior to implementation by EPA. Use of a sample size of less than 100 grams is highly recommended for mixed wastes with concentrations of radionuclides that may present serious radiation exposure hazards. Additionally, Section 1.2 of the TCLP allows the option of performing a ''total constituent analysis'' on a hazardous waste or mixed waste sample, instead of the TCLP. Section 1.2 of Method 1311 states:

If a total analysis of the waste demonstrated that the individual analytes are not present in the waste, or that they are present, but at such low concentrations that the appropriate regulatory levels could not possibly be exceeded, the TCLP need not be run.

For homogenous samples, the use of total constituent analysis in this manner eliminates the need to grind or mill solid waste samples. The grinding or milling step in the TCLP has raised ALARA concerns for individuals who test mixed waste. The use of total constituent analysis, instead of the TCLP, may also minimize the generation of secondary mixed or radioactive waste through the use of smaller sample sizes and reduction, or elimination, of high dilution volume leaching procedures.

Flexibility in Mixed Waste Testing

Flexibility exists in the hazardous waste regulations for generators, TSDFs, and mixed waste permit writers to tailor mixed waste sampling and analysis programs to address radiation hazards. For example, upon the request of a generator, a person preparing a RCRA permit for a TSDF has the flexibility to minimize the frequency of mixed waste testing by specifying a low testing frequency in a facility's waste analysis plan. EPA believes, as stated in 55 FR 22669, June 1, 1990, that ''the frequency of testing is best determined on a case-by-case basis by the permit writer.''

EPA's hazardous waste regulations also allow a mixed waste facility the latitude to change or replace EPA's test methods (i.e., *Test Methods for Evaluating Solid Waste* (SW–846)) to address radiation exposure concerns. There are only fourteen sections of the hazardous waste regulations that require the use of specific test methods or appropriate methods found in SW–846 which are outlined in Appendix A.[15] However, any person can request EPA for an equivalent testing or analytical method that would replace the required EPA method (see 40 CFR 260.21).

In a recent amendment to the testing requirements, EPA added language to SW–846 that describes fourteen citations in the RCRA program (listed in Appendix A) where the use of SW–846 methods is mandatory (Update II, 60 FR 3089, January 13, 1995). In all other cases, the RCRA program functions under what we call the Performance Based Measurement System (PBMS) approach to monitoring. Language clarifying this approach was included in the final FR Notice which promulgated Update III (62 FR 32542, June 13, 1997) and in appropriate sections

(Disclaimer, Preface and Overview, and Chapter 2) of SW–846. Under PBMS, the regulation and/or permit focus is on the question(s) to be answered by the monitoring, the degree of confidence (otherwise known as the Data Quality Objective (DQO)) or the measurement quality objectives (MQO) that must be achieved by the permittee to have demonstrated compliance, and the specific data that must be gathered and documented by the permittee to demonstrate that the objectives were actually achieved. ''Any reliable method'' may be used to demonstrate that one can see the analytes of concern in the matrix of concern at the levels of concern. Additional reference documents on the characterization and testing methods are listed in Appendix C.

NRC regulations do not describe specific testing requirements for wastes to determine if a waste is radioactive. However, both NRC and Department of Transportation regulations contain requirements applicable to characterizing the radioactive content of the waste before shipment. For example, NRC's regulations in 10 CFR 20.2006 require that the waste manifest include, as completely as practicable, the radionuclide identity and quantity, and the total radioactivity. NRC regulations also require that generators determine the disposal Class of the radioactive waste, and outline waste form requirements that must be met before the waste is suitable for land disposal. These regulations are referenced in 10 CFR 20.2006, and are outlined in detail at 10 CFR 61.55 and 61.56. Mixed waste generators are reminded that both RCRA waste testing and NRC waste form requirements must be satisfied. Generators may also be required to amend their NRC or Agreement State licenses in order to perform the tests required under RCRA. In addition, if an NRC licensee uses an outside laboratory to test his or her waste, that laboratory may be required to possess an NRC or Agreement State license. It is the responsibility of the generator to determine if the outside laboratory possesses the proper license(s) prior to transferring the waste to the laboratory for testing.

Where radioactive wastes (or wastes suspected of being radioactive) are involved in testing, it has been suggested that the testing requirements of RCRA may run counter to the aims of the AEA. The AEA requirements that have raised inconsistency concerns with respect to RCRA testing procedures include ALARA, criticality, and security. Neither EPA nor NRC is aware of any specific instances where RCRA compliance has been inconsistent with the AEA. However, both agencies acknowledge the potential for an inconsistency to occur.[16] A licensee or applicant who suspects that an inconsistency may exist should contact both the AEA and RCRA regulatory agencies. These regulatory agencies may deliberate and consult on whether there is an unresolvable inconsistency and, if one exists, they may attempt to fashion the necessary relief from the particular RCRA provision that gives rise to the inconsistency. However, all other RCRA regulatory requirements would apply. That is, such a conclusion does not relieve hazardous waste facility owner/operators of the responsibility to ensure that the mixed waste is managed in accordance with all other applicable RCRA regulatory requirements. Owner/operators of mixed waste facilities are encouraged to address and document this potential situation and its resolution in the RCRA facility waste analysis plan which must be submitted with the Part B permit application, or addressed in a permit modification.

Both agencies also believe that the potential for inconsistencies can be reduced significantly by a better understanding of the RCRA requirements, a greater reliance on materials and process knowledge, the use of surrogate materials when possible, and the use of controlled atmosphere apparatuses for mixed waste testing. Where testing is conducted, the use of glove boxes and other controlled atmosphere apparatuses during the testing of the radioactive waste material lessens radiation exposure concerns significantly. These protective measures may also help to reconcile the required testing requirements (including milling) with concerns about maintaining exposures to radiation ALARA and complying with other AEA protective standards. If such protective measures do not exist, or do not adequately reduce individual exposure to radiation or address other factors of concern, relief may be available under Section 1006 of RCRA.

V. Determinations by Treatment, Storage, or Disposal Facility Owner/Operators and Certain Generators to Ensure Proper Waste Management

General Waste Analysis

Owner/operators of facilities that treat, store, or dispose of hazardous wastes must obtain a chemical and physical analysis of a representative sample of the waste (see 40 CFR 264.13 for permitted facilities, or 40 CFR 265.13 for interim status facilities).[17] The purpose of this analysis is to assure that owner/operators have sufficient information on the properties of the waste to be able to treat, store, or dispose of the waste in a safe and appropriate manner.

The waste analysis may include data developed by the generator, and existing, published, or documented data on the hazardous waste or on hazardous waste generated from similar processes. In some instances, however, information supplied by the generator may not fully satisfy the waste analysis requirement. For example, in order to treat a particular waste, one may need to know not only the chemical composition of the waste, but also its compatibility with the techniques and chemical reagents used at the treatment facility. Where such information is not otherwise available, the owner/operator will be responsible for gathering relevant data on the waste in order to ensure its proper management.

The analysis must be repeated only if the previous analyses are inaccurate or needs updating. EPA regulations at 40 CFR 264.13(a)(3) do require that, at a minimum, a waste must be re-analyzed if:

(1) The owner/operator is notified, or has reason to believe, that the process or operation generating the waste has changed [in a way such that the hazardous property or characteristics of the waste would change]; and (2) For off-site facilities, when the results of the verification analysis indicate that the [composition or characteristics of the] waste does not match the accompanying manifest or shipping paper.

The requirements and frequency of waste analysis for a given facility are described in the facility's waste analysis plan. As required by 40 CFR 264.13(b), the waste analysis plan must specify the parameters for which each hazardous waste will be analyzed; the rationale for selecting these parameters (i.e., how analysis for these parameters will provide sufficient information on the waste's properties); and the test methods that will be used to test for these parameters. The waste analysis plan also must specify the sampling method that will be used to obtain a representative sample of the waste to be analyzed; the frequency with which the initial analysis of the waste will be reviewed or repeated, to ensure that the analysis is accurate and up to date; and, for off-site facilities, the waste analyses to be supplied by the hazardous waste generators. Finally, the waste analysis plan must note any additional waste analysis requirements specific to the waste management method employed, such as the analysis of the waste feed to be burned in an incinerator.

The appropriate parameters for each waste analysis plan are determined on an individual basis as part of the permit application review process. To reduce the inherent hazards of sampling and analyzing radioactive material, and in particular, the potential risk to workers from exposure to radiation posed by duplicative testing of mixed wastes, redundant testing by the generator and off-site facilities should be avoided. In addition, waste analysis plans must include provisions to keep exposures to radiation ALARA, and incorporate relevant AEA-related requirements and regulations.

Analysis Required to Verify Off-site Shipments

The owner/operator of a facility that receives mixed waste from off-site must inspect and, *if necessary,* analyze each hazardous waste shipment received at the facility to verify that it matches the identity of the waste specified on the accompanying LDR notification or manifest (see 40 CFR 264.13 or 265.13(c)). This testing is known as verification testing. Such inspections and analysis will follow sampling and testing procedures set forth in the facility's waste analysis plan, which is kept at the facility.

It should also be emphasized that, where analysis is necessary, *RCRA regulations do not necessarily require the analysis of every movement of waste received at an off-site facility*. As explained above, the purpose of the waste analysis is to verify that the waste received at off-site facilities is correctly identified, and to provide enough information to ensure that it is properly managed by the facilities.

For example, if a facility receives a shipment of several sealed drums of mixed waste, a representative sample from only one drum may be adequate, if the owner/operator has reason to believe that the chemical composition of the waste is identical in every drum. In such a case, the drum containing the least amount of measurable radioactivity could be sampled to minimize radiation exposures (variations in radioactivity do not necessarily suggest different chemical composition). This procedure also would apply to a shipment of several types of waste. If the owner/operator has reason to believe that the drums in the shipment contain different wastes, then selecting a representative sample might involve drawing a sample from each drum or drawing a sample from one drum in each "set" of drums containing identical wastes. Once this waste analysis requirement has been satisfied, routine retesting of later shipments would not be required if the owner/operator can determine that the properties of the waste he or she manages will not change.

Fingerprint Analysis Versus Full Scale Analysis

Full scale analysis (i.e., detailed physical and chemical analysis) may be used to comply with the waste analysis plan, including verification of off-site shipments. However, for mixed waste, abbreviated analysis or "fingerprint analysis" may be more appropriate to meet general waste analysis requirements. The test procedure should be determined on a case-by-case basis.

Fingerprint analysis (which may involve monitoring pH, percent water, and cyanide content) is particularly recommended for mixed waste streams with high radiation levels that are received by an off-site TSDF for RCRA waste manifest verification purposes. It may be appropriate to use full scale analysis, instead of, or after, fingerprint analyses, if the facility suspects that the waste was not accurately characterized by the generator, information provided by a generator is incomplete, waste is received for the first time, or the generator changes a process or processes that produced the waste.

Generators Who Treat LDR Prohibited Waste In Tanks, Containers or Containment Buildings To Meet LDR Treatment Requirements

Hazardous waste generators may treat hazardous wastes in tanks or containers without obtaining a permit if the treatment is done in accordance with the accumulation timeframes and requirements in 40 CFR 262.34. However, generators who treat hazardous waste (including mixed wastes) to meet the EPA treatment standards for land disposal prohibited wastes must also prepare a waste analysis plan similar to that prepared by TSDFs.

The plan must be based on a detailed analysis of a representative sample of the LDR prohibited waste that will be treated. In addition, the plan should include all the information that is necessary to treat the waste, including the testing frequency (See 40 CFR 268.7(a)(5)).

VI. Determinations Under the Land Disposal Restrictions

Generators, as well as treatment facilities and land disposal facilities, that handle mixed waste may have to obtain or amend their radioactive materials licenses if they test or treat mixed waste under the LDRs. The following discussion assumes that generators and treatment and disposal facilities have satisfied the requirement to obtain, or amend, their radioactive materials licenses, as appropriate.

Waste knowledge may also be used to satisfy certain waste characterization requirements imposed by the LDRs for mixed wastes. The Hazardous and Solid Waste Amendments (HSWA) to RCRA (P.L. 98–616), enacted on November 8, 1984, established the LDR program. This Congressionally mandated program set deadlines (RCRA Sections 3004(d)-(g)) for EPA to evaluate all hazardous wastes and required EPA to set levels, or methods, of treatment which would substantially diminish the toxicity of the waste, or minimize the likelihood of migration of hazardous constituents from any RCRA waste. Beyond specified dates, prohibited wastes that do not meet the treatment standards before they are disposed of, are banned from land disposal unless they are disposed of in a so-called ‘‘no-migration’’ unit (i.e., a unit where the EPA Administrator has granted a petition which successfully demonstrated to a reasonable degree of certainty that there will be no migration of hazardous constituents from the disposal unit for as long as the wastes remain hazardous) (40 CFR 268.6). Certain categories of prohibited wastes also may be granted extensions of the effective dates of the land disposal prohibitions (i.e., case-by-case and national capacity variances (40 CFR 268.5 and Subpart C, respectively). However, these wastes are still restricted and, if disposed in landfills or surface impoundments, must be disposed of in units meeting the minimum technology requirements.[18]

The requirements of the LDR program apply to generators, transporters, and owner/operators of hazardous waste treatment, storage, and disposal facilities. Not all hazardous wastes are subject to 40 CFR Part 268. For instance, certain wastes that are identified or listed after November 8, 1984, such as newly identified mineral processing wastes for which land disposal prohibitions or treatment standards have not yet been promulgated, are not regulated under 40 CFR Part 268.[19]

Determinations by Generators

Under 40 CFR 268.7(a), generators must determine whether their waste is restricted from land disposal (or determine if they are subject to an exemption or variance from land disposal (40 CFR 268.1)) by testing their waste (or a leachate of the waste developed using the TCLP or, in certain cases, the Extraction Procedure Toxicity Test (EP), or by using waste or process knowledge). If the waste exhibits the characteristic of ignitability (and is not in the High Total Organic Constituents (TOC) Ignitable Liquids Subcategory or is not treated by the "CMBST" or "RORGS" treatment technology in 40 CFR 268.42, Table 1), corrosivity, reactivity and/or organic toxicity, the generator must also determine the underlying hazardous constituents (UHCs) in the waste. Two exceptions to this requirement are:

(1) if these wastes are treated in wastewater treatment systems subject to the Clean Water Act (CWA) or CWA equivalent; or,
(2) if they are injected into a Class I, nonhazardous Underground Injection Control well. A UHC is any constituent listed in 40 CFR 268.48, Table UTS Universal Treatment Standards, with the exceptions of nickel, zinc and vanadium, which can reasonably be expected to be present at the point of generation of the hazardous waste, at a concentration above the constituent-specific UTS treatment standard. Determining the presence of the UHCs may be made based on testing or knowledge of the waste. The UHCs must meet the UTS before the waste may be land disposed.

If a generator chooses to test the waste rather than use waste or process knowledge for hazardous waste that is not listed and exhibits a characteristic only, the generator must use the TCLP. The only exception is TC metals.

Until the "Phase IV" LDR rule is promulgated in the spring of 1998, generators who characterize their wastes as TC toxic only for metals may use the EP instead of the TCLP result to determine if their waste is land disposal restricted, because the TC wastes do not have final EPA treatment standards whereas, at this time, the EP metals do. If the EP result is negative, the waste will still be considered hazardous, but is not prohibited from land disposal. The TCLP generally yields similar results as the EP. However, in certain matrices the TCLP yields higher lead and arsenic concentrations than the EP. The rationale for using the EP instead of the TCLP for characteristic wastes is explained in 55 FR 3865, January 31, 1991. For further guidance on using the EP for the land disposal restriction determination, refer to the Figures 1 and 2, of this guidance.

If a waste is found to be land disposal restricted, generators must determine if the waste can be land disposed without further treatment. A prohibited waste may be land disposed if it meets applicable treatment standards (whether through treatment or simply as generated), or is subject to a variance from the applicable standards. As explained above, this determination can be made either based on knowledge of the waste or by testing the waste, or waste leachate using the TCLP.

Generators who determine that their listed waste meets the applicable treatment standards must certify to this determination and notify the treatment, storage, or land disposal facility that receives the waste (40 CFR 268.7(a)(3)). Notification to the receiving facility must be made with the initial shipment of waste and must include the following information:

- EPA Hazardous Waste Number;
- Certification that the waste delivered to a disposal facility meets the treatment standard, and that the information included in the notice is true, accurate, and complete;
- Waste constituents that will be monitored for compliance if monitoring will not include all regulated constituents, for wastes F001-F005, F039, D001, D002, and D012-D043;
- Whether the waste is a non-wastewater or wastewater;
- The subcategory of the waste (e.g., ''D003 reactive cyanide''), if applicable;
- Manifest number; and,
- Waste analysis data (if available).

If a generator determines that a waste that previously exhibited a characteristic is no longer hazardous, or is subject to an exclusion from the definition of hazardous waste, a onetime notification and certification must be place in the generator's files (40 CFR 268.7(a)(7) or 268.9).

Generators who determine that their waste does not meet the applicable treatment standards must ensure that this waste meets the applicable standards prior to disposal. These generators may treat (or store) their prohibited wastes on-site for 90 days or less in qualified tanks, containers (40 CFR 262.34), or containment buildings (40 CFR 268.50), and/or send their wastes off-site for treatment.[20] When prohibited listed wastes are sent off-site, generators must notify the treatment facility of the appropriate treatment standards (40 CFR 268.7(a)(2)). This notification must be made with the initial shipment of waste and must include the following information:

• EPA Hazardous Waste Number;
• Waste constituents that the treater will monitor if monitoring will not include all regulated constituents, for wastes F001–F005, F039, D001, D002, and D012–D043;
• Whether the waste is a non-wastewater or wastewater;
• The subcategory of the waste (e.g., ''D003 reactive cyanide''), if applicable;
• Manifest number; and,
• Specified information for hazardous debris.

Generators whose wastes are subject to an exemption such as a case-by-case extension under 40 CFR 268.5, an exemption under 40 CFR 268.6 (a no-migration variance), or a nationwide capacity variance under 40 CFR 268, Subpart C must also notify the land disposal facility of the exemption. In addition, records of all notices, certifications, demonstrations, waste analysis data, process knowledge determinations, and other documentation produced pursuant to 40 CFR Part 268 must be maintained by the generator for at least three years from the date when the initial waste shipment was sent to on-site or off-site treatment, storage, or disposal (40 CFR 268.7(a)(8)).

Determinations by Treaters and Disposers

Owner/operators of treatment facilities that receive wastes that do not meet the treatment standards are responsible for treating the wastes to the applicable treatment standards or by the specified technology(ies). In addition, the owner/operators of treatment facilities must determine whether the wastes meet the applicable treatment standards or prohibition levels by testing:

(1) The treatment residues, or an extract of such residues using the TCLP, for wastes with treatment standards expressed as concentrations in the waste extract (40 CFR 268.40); and
(2) The treated residues (not an extract of the treated residues) for wastes with treatment standards expressed as concentrations in the waste extract (40 CFR 268.40).

This testing should be done at the frequency established in the facility's waste analysis plan. Owner/operators of treatment facilities, however, do not need to test the treated residues or an extract of the residues if the treatment standard is a specified-technology (i.e., a technology specified in 40 CFR 268.40 or 268.45, Table 1.—Alternative Treatment Standards for Hazardous Debris).

Owner/operators of land disposal facilities under the LDRs are responsible for ensuring that only waste meeting the treatment standards (i.e., wastes not prohibited from disposal or wastes that are subject to an exemption or variance) is land disposed. Like a treatment facility, a disposal facility must test a treatment residue or an extract of the treatment residue, except where the treatment standard is a specified technology.

Owner/operators must periodically test wastes received at the facility for disposal (i.e., independent corroborative testing) as specified in the waste analysis plan to ensure the treatment has been successful and the waste meets EPA treatment standards, except where the treatment standard is expressed as a technology.[21] The results of any waste analyses are placed in a TSDF's operating records along with a copy of all certifications and notices (40 CFR 264.73 or 40 CFR 265.73).[22]

Mixed Waste Under the LDRs

As clarified in the Land Disposal Restrictions rule published on June 1, 1990 (see EPA's "Third Third rule," 55 FR 22669, June 1, 1990), the frequency of testing, such as corroborative testing for treatment and disposal facilities, should be determined on a case-by-case basis and specified in the RCRA permit. This flexibility is necessary because of the variability of waste types that may be encountered. Mixed waste is unique for its radioactive/hazardous composition and dual management requirements. Each sampling or analytical event involving mixed waste may result in an incremental exposure to radiation, and EPA's responsibility to protect human health and the environment must show due regard for minimizing this unique risk. These are factors which should be considered in implementing the flexible approach to determining testing frequency spelled out in the Third Third Rule language. This flexible approach encourages reduction in testing where there is little or no variation in the process that generates the waste, or in the treatment process that treats the waste, and an initial analysis of the waste is available. Also, the approach may apply to mixed wastes shipped to off-site facilities, where redundant testing is minimized by placing greater reliance on the characterization developed and certified by earlier generators and treatment facilities. On the other hand, where waste composition is not well-known, testing frequency may be increased. Waste analysis plan conditions in the permits of mixed waste facilities should reflect these principles.

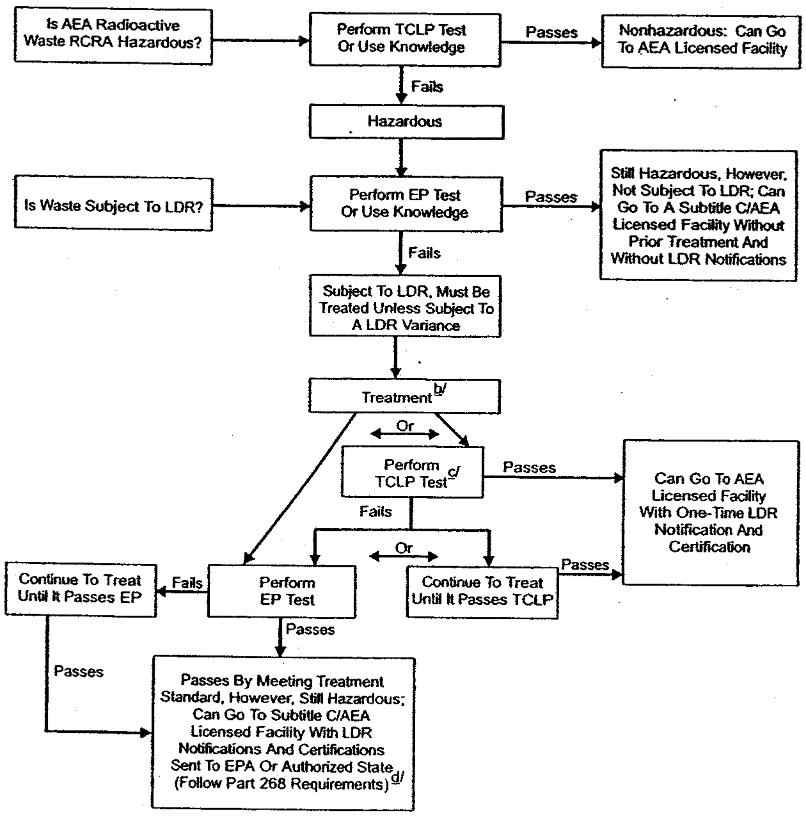
Revised Treatment Standards for Solvent Wastes

EPA promulgated revised treatment standards for wastewater and non-wastewater spent solvent wastes (F001–F005) in 57 FR 37194, August 18, 1992. The revision essentially converts the treatment standards for the organic spent solvent waste constituents (F001–F005) from TCLP based to total waste constituent concentration based. This conversion of the spent solvent treatment standards is particularly advantageous to mixed waste generators, since the entire waste stream or treatment residual must be analyzed (instead of a waste or treatment residual extract). This holds true for other mixed waste streams where the hazardous component is measured using a total waste analysis. As discussed in Section IV of this guidance, total constituent analysis has several advantages over the use of the TCLP for high activity waste streams.

EPA and NRC are aware of potential hazards attributable to testing hazardous waste. Moreover, EPA and NRC recognize that the radioactive component of mixed waste may pose additional hazards to laboratory personnel, inspectors, and others who may be exposed during sampling and analysis. All sampling should be conducted in accordance with procedures that minimize exposure to radiation and ensure personnel safety. Further, testing should be conducted in laboratories licensed by NRC or the appropriate NRC Agreement State authority. EPA and NRC believe that a combination of common sense, modified sampling procedures, and cooperation between State and Federal regulatory agencies will minimize any hazards associated with sampling and testing mixed waste.

Note: Section V, ‘‘Determinations under the Land Disposal Restrictions (LDRs)’’ and the following flow charts represent a brief summary of the Land Disposal Restriction Regulations. They are not meant to be a complete or detailed description of all applicable LDR regulations. For more information concerning the specific requirements, consult the **Federal Registers** cited in the document and the Code of Federal Regulations, Title 40 Parts 124, and 260 through 271.

FIGURE ONE: TESTING REQUIREMENTS FOR CHARACTERISTIC LEAD AND ARSENIC NONWASTEWATERS ONLY[a/]



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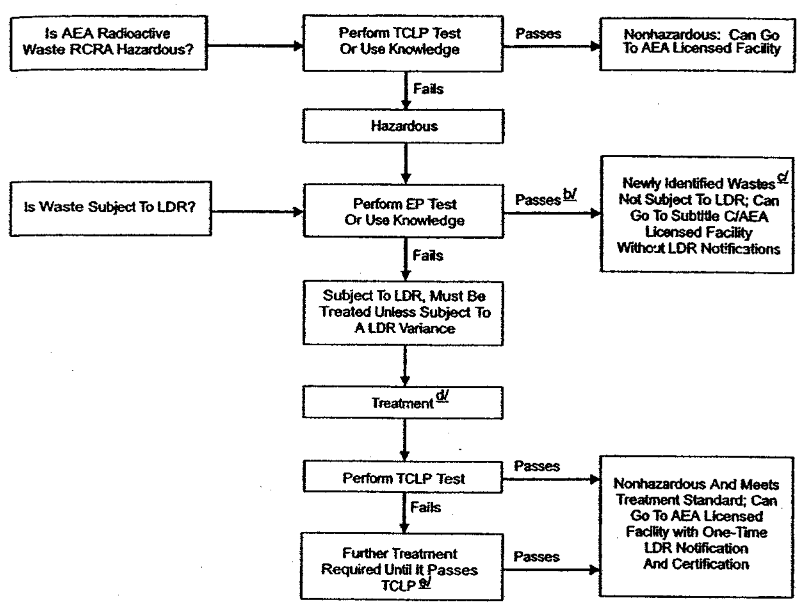
a/ Logic tree assumes the waste also contains AEA regulated radioactive waste.

b/ If the treatment standard is expressed as a specified technology, no further testing is required. However, the mixed waste must go to a Subtitle C/AEA licensed facility with LDR notifications and certifications.

c/ TCLP generally yields higher concentrations than EP for lead and arsenic in certain matrices.

d/ If the waste meets the treatment standard and passes the TCLP, it can go to an AEA licensed facility with one-time LDR notification and certification.

FIGURE TWO: TESTING REQUIREMENTS FOR ALL OTHER CHARACTERISTIC METALS[a/]



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a/ Logic tree assumes the waste also contains AEA regulated radioactive waste.

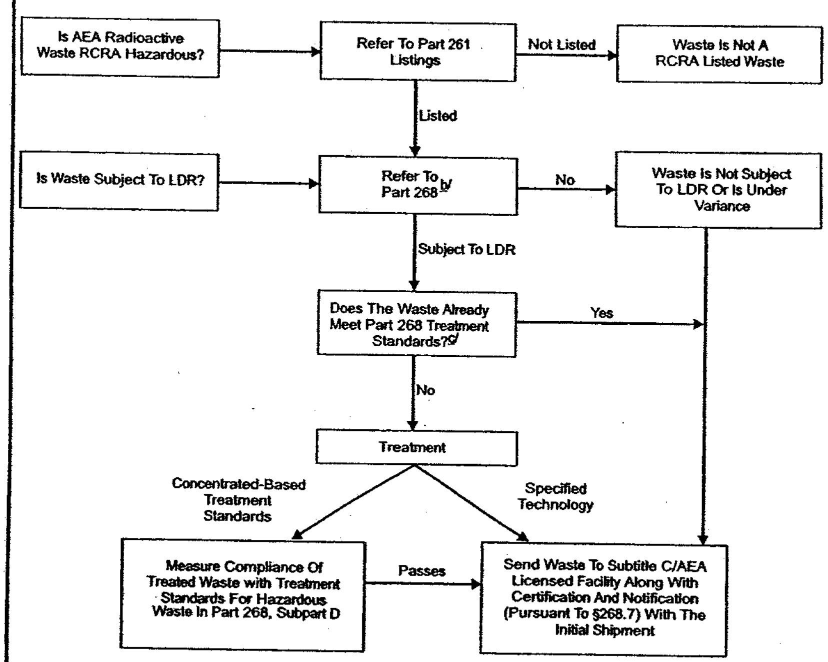
b/ This should be rare, since the two tests usually yield similar results.

c/ Wastes exhibiting the toxicity characteristic but not the EP are newly identified wastes and, therefore, are not subject to the land disposal restrictions at this time.

d/ If the treatment standard is expressed as a specified technology, no further testing is required. However, the mixed waste must go to a Subtitle C/AEA licensed facility with LDR notifications and certifications.

e/ Selenium is the one exception because it has a treatment standard slightly above the characteristic level.

FIGURE THREE: TESTING REQUIREMENTS FOR RCRA LISTED HAZARDOUS WASTES ONLY[a/]

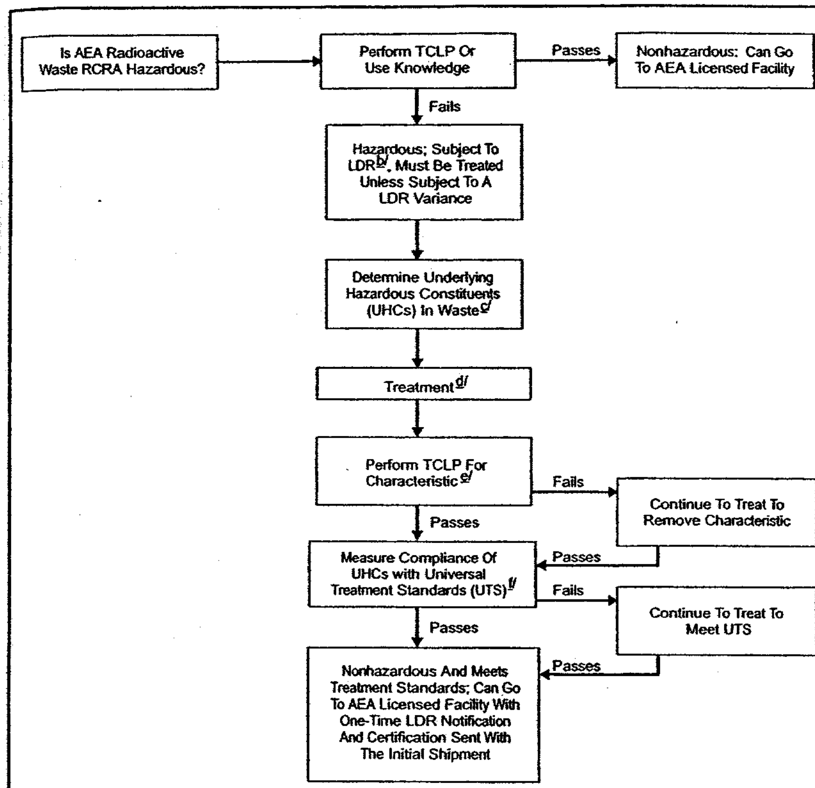


a/ Logic tree assumes the waste also contains AEA regulated radioactive waste.

b/ Refer to §268.1 to determine if LDR is applicable to waste. If so, test using TCLP or use process knowledge to determine if waste is restricted (§268.7).

c/ Test using TCLP or use process knowledge.

FIGURE FOUR: ORGANIC TOXICITY CHARACTERISTIC (TC) WASTES AND PESTICIDE WASTES[a/]



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a/ Logic tree assumes the waste also contains AEA regulated radioactive waste.

b/ Restriction applies to TC organic and pesticide wastes managed in non-CWA/non-CWA equivalent/ non-Class I SDWA systems only.

c/ Testing or knowledge of waste may be used. A UHC is any constituent listed in §268.48 Table UTS, except zinc, that can reasonable be expected to be present at the point of generation of the hazardous waste, at a concentration above the constituent-specific UTS treatment standard.

d/ If the treatment standard is expressed as a specified technology, no further testing is required. However, the mixed waste must go to a Subtitle C/AEA facility with LDR notifications and certifications.

e/ Refer to the table "Treatment Standards for Hazardous Wastes" in 40 CFR Part 268, Subpart D.

f/ Compliance should be measured based on the appropriate testing protocols (see SW-846).

Appendix A—RCRA Regulations That Require Specific EPA Test Methods

The use of an SW–846 method is mandatory for the following nine Resource Conservation and Recovery Act (RCRA) applications contained in 40 CFR Parts 260 through 270:

- Section 260.22(d)(1)(I)—Submission of data in support of petitions to exclude a waste produced at a particular facility (i.e., delisting petitions);
- Section 261.22(a)(1) and (2)—Evaluations of waste against the corrosivity characteristic;
- Section 261.24(a)—Leaching procedure for evaluation of waste against the toxicity characteristic;
- Section 261.35(b)(2)(iii)(A)—Evaluation of rinsates from wood preserving cleaning processes;
- Sections 264.190(a), 264.314(c), 265.190(a), and 265.314(d)—Evaluation of waste to determine if free liquid is a component of the waste;
- Sections 264.1034(d)(1)(iii) and 265.1034(d)(1)(iii)—Evaluation of organic emissions from process vents;
- Sections 264.1063(d)(2) and 265.1063(d)(2)—Evaluation of organic emissions from equipment leaks;
- Section 266.106(a)—Evaluation of metals from boilers and furnaces;
- Sections 266.112(b)(1) and (2)(I)—Certain analyses in support of exclusion from the definition of a hazardous waste for a residue which was derived from burning hazardous waste in boilers and industrial furnaces;
- Sections 268.7(a), 268.40(a), (b), and (f), 268.41(a), 268.43(a)—Leaching procedure for evaluation of waste to determine compliance with land disposal treatment standards;
- Sections §270.19(c)(1)(iii) and (iv), and 270.62(b)(2)(I)(C) and (D)—Analysis and approximate quantification of the hazardous constituents identified in the waste prior to conducting a trial burn in support of an application for a hazardous waste incineration permit; and
- Sections 270.22(a)(2)(ii)(B) and 270.66(c)(2)(I) and (ii)—Analysis conducted in support of a destruction and removal efficiency (DRE) trial burn waiver for boilers and industrial furnaces burning low risk wastes, and analysis and approximate quantification conducted for a trial burn in support of an application for a permit to burn hazardous waste in a boiler and industrial furnace.

Appendix B.—States and Territories with Mixed Waste Authorization [As of June 30, 1997].

State/territory	FR date	Effective date	FR cite
Colorado	10/24/86	11/7/86	51 FR 37729.
Tennessee	6/12/87	8/11/87	52 FR 22443.
S. Carolina	7/15/87	9/13/87	52 FR 26476.
Washington	9/22/87	11/23/87	52 FR 35556.
Georgia	7/28/88	9/26/88	53 FR 28383.
Nebraska	10/4/88	12/3/88	53 FR 38950.
Kentucky	10/20/88	12/19/88	53 FR 41164.
Utah	2/21/89	3/7/89	54 FR 7417.
Minnesota	4/24/89	6/23/89	54 FR 16361.
Ohio	6/28/89	6/30/89	54 FR 27170.
Guam	8/11/89	10/10/89	54 FR 32973.
N. Carolina	9/22/89	11/21/89	54 FR 38993.
Michigan	11/24/89	12/26/89	54 FR 48608.
Texas	3/1/90	3/15/90	55 FR 7318.
New York	3/6/90	5/7/90	55 FR 7896.
Idaho	3/26/90	4/9/90	55 FR 11015.
Illinois	3/1/90	4/30/90	55 FR 7320.
Arkansas	3/27/90	5/29/90	55 FR 11192.
Oregon	3/30/90	5/29/90	55 FR 11909.
Kansas	4/24/90	6/25/90	55 FR 17273.
N. Dakota	6/25/90	8/24/90	55 FR 25836.
New Mexico	7/11/90	7/25/90	55 FR 28397.
Oklahoma	9/26/90	11/27/90	55 FR 39274.
Connecticut	12/17/90	12/31/90	55 FR 51707.
Florida	12/14/90	2/12/91	55 FR 51416.
Mississippi	3/29/91	5/28/91	56 FR 13079.
S. Dakota	4/17/91	6/17/91	56 FR 15503.
Indiana	7/30/91	9/30/91	56 FR 41959.
Louisiana	8/26/91	10/26/91	56 FR 41959.
Wisconsin	4/24/92	4/24/92	57 FR 15092.
Nevada	4/29/92	6/29/92	57 FR 18083.
California	7/23/92	8/1/92	57 FR 32725.
Arizona	11/23/92	1/22/93	57 FR 54932.
Missouri	1/11/93	3/12/93	58 FR 3497.
Alabama	3/17/93	5/17/93	58 FR 14319.
Vermont	6/7/93	8/6/93	58 FR 31911.
Montana	1/19/94	3/21/94	59 FR 2752.
New Hampshire	11/14/94	1/13/95	59 FR 56397.
Wyoming	10/04/95	10/18/95	60 FR 51925.
Delaware	8/8/96	10/7/96	61 FR 41345.
Total: 39 States and 1 Territory.			

Appendix C: Testing Reference Documents

The following references provide information on approved methods for testing hazardous waste samples:

American Public Health Association, *Standard Methods for the Examination of Water and Wastewater, 17th Edition.* 1989. Available from the Water Pollution Control Federation, Washington, D.C., #S0037.

U.S. Environmental Protection Agency, *Design and Development of a Hazardous Waste Reactivity Testing Protocol.* EPA Document No. 600/2–84–057, February 1984.

U.S. Environmental Protection Agency, *Methods for Chemical Analysis of Water and Waste.* EPA–6001114–79–020. Washington, D.C., 1983.

U.S. Environmental Protection Agency, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.* SW–846. Third Edition (1986) as amended. Available from the Government Printing Office, by subscription, 955–001–00000–1, or from the National Technical Information Service, PB88–239–223. Washington, D.C., January, 1995.

U.S. Environmental Protection Agency, *The New Toxicity Characteristic Rule: Information and Tips for Generators.* Office of Solid Waste, 530/SW–90–028, April, 1990.

U.S. Environmental Protection Agency, ORD, and U.S. Department of Energy, *Characterizing Heterogenous Wastes: Methods and Recommendations.* EPA/600/R-92/033, February 1992.

U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response. ‘‘Joint EPA/NRC Guidance on the Definition and Identification of Commercial Mixed Low-Level Radioactive and Hazardous Waste,’’ Directive No. 9432–00–2, October 4, 1989.

Appendix D: List of Regulations

Environmental Protection Agency General Regulations for Hazardous Waste Management, 40 CFR Part 260.

Environmental Protection Agency Regulations for Identifying Hazardous Waste, 40 CFR Part 261.

Environmental Protection Agency Regulations for Hazardous Waste Generators, 40 CFR Part 262.

Environmental Protection Agency Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities, 40 CFR Part 264.

Environmental Protection Agency Interim Status Standards for Owners and Operators of Hazardous Waste Facilities, 40 CFR Part 265.

Environmental Protection Agency Regulations on Land Disposal Restrictions, 40 CFR Part 268.

Nuclear Regulatory Commission Regulations—Standards for Protection Against Radiation, 10 CFR Part 20.

Nuclear Regulatory Commission Regulations—Rules of General Applicability to Domestic Licensing of Byproduct Material, 10 CFR Part 30.

Nuclear Regulatory Commission Regulations—Domestic Licensing of Source Material, 10 CFR Part 40.

Nuclear Regulatory Commission Regulations—Domestic Licensing of Production and Utilization Facilities, 10 CFR Part 50.

Nuclear Regulatory Commission Regulations—Licensing Requirements for Land Disposal of Radioactive Waste, 10 CFR Part 61.

Nuclear Regulatory Commission Regulations—Domestic Licensing of Special Nuclear Material, 10 CFR Part 70.

[FR Doc. 97–30528 Filed 11–19–97; 8:45 am]

FOOTNOTES

[1] See 42 U S.C. §6903 (41), added by the Federal Facility Compliance Act of 1992 (FFCA).

[2] See revised *Guidance on the Definition and Identification of Commercial Low-Level Radioactive and Hazardous Waste and Answers to Anticipated Questions,* October 4, 1989.

[3] The RCRA base hazardous waste program is the RCRA program initially made available for final authorization and includes Federal regulations up to July 26, 1982. However, authorized States have revised their programs to keep pace with Federal program changes that have taken place after 1982 in accordance with EPA regulation.

[4] Refer to Appendix A for specific EPA regulations pertaining to (1)–(4).

[5] ALARA, codified in 10 CFR Part 20, refers to the practice of maintaining all radiation exposures, to workers and the general public, as low as is reasonably achievable.

[6] For a more detailed discussion on process knowledge, see Section 1.5 in ''Waste Analysis at Facilities That Generate, Treat, Store, and Dispose of Hazardous Wastes'' OSWER 9938.4–03, April 1994.

[7] The ''mixture'' and ''derived-from'' rules were vacated and remanded due to EPA's failure to provide adequate notice and opportunity for comment before their 1980 promulgation, in *Shell Oil* v. *EPA,* No. 80–1532 (D.C. Cir. Dec. 6, 1991). At the Court's suggestion, EPA reinstated the ''mixture'' and ''derived-from'' rules as interim final until the rules are revised through new EPA rulemaking. The ''mixture'' and ''derived from'' rules adopted by those States with authorized RCRA programs were not affected by the court case or the subsequent reinstatement by EPA. For further information, see 57 *FR* 49278, October 30, 1992, and 60 *FR* 66344, December 21, 1995.

[8] Generators who also treat their waste are subject to the requirements for treatment facilities unless they treat waste in accumulation tanks,

containers, or containment buildings, for 90 days or less in accordance with 40 CFR 262.34(a). Treatment facilities must periodically test the treated waste residue from prohibited wastes to determine whether it meets the best demonstrated available technology (BDAT) treatment standards and may not rely on materials and process knowledge to make this determination (40 CFR 268.7(b)). This testing must be conducted according to the frequency specified in the facility's waste analysis plan (refer to Section IV of this guidance for a detailed discussion of treatment, storage, and disposal facility requirements).

[9] This definition of surrogate should not be confused with the definition of surrogate for the purposes of sampling and analysis quality control in Section 1.1.8 of "*Evaluating Solid Waste—Volume IA: Laboratory Test Methods Manual Physical/Chemical Methods.*"

[10] Note that characteristic only wastes (which are neither wastewater mixtures or RCRA listed hazardous wastes when generated) may be treated so that they no longer exhibit any of the four characteristics of a hazardous waste. However, these wastes may still be subject to the requirements of 40 CFR Part 268, even if they no longer exhibit a hazardous characteristic at the point of land disposal. After treatment this waste must not exhibit any RCRA hazardous waste characteristic *and* must meet applicable treatment standards before it can be considered a non-hazardous waste (see 57 *FR* 37263, August 18, 1992, and 58 *FR* 29869, May 24, 1993).

[11] Note that hazardous and mixed waste samples analyzed for waste characteristics or composition, and samples undergoing treatability studies may be exempt from all or part of the RCRA regulations if they are managed in accordance with 40 CFR 261.4 (d), (e) or (f).

[12] EPA incorporated by reference into the RCRA regulations (58 *FR* 46040, August 31, 1993), a third edition (and its updates) of "Test Methods for the Evaluation of Solid Waste, Physical/Chemical Methods." The updates can be found in 60 *FR* 3089, January 13, 1995 (update II), 59 *FR* 458, January 4, 1994 (update IIA), 60 *FR* 17001, April 4, 1995 (update IIB), and 62 *FR* 32452, June 13, 1996 (update III). Hazardous and mixed waste

generators and management facilities should verify that the analytical method that they use to analyze hazardous waste has not been superseded in the third edition.

[13] When evaluating test protocols for explosive mixed waste, consideration should be given to the likelihood for dispersing radioactivity during detonation. Using process knowledge or a surrogate material would, in most instances, be appropriate for these wastes.

[14] Note that when using the TCLP, if any liquid fraction of the waste positively determines that hazardous constituents in the waste are above regulatory levels, then it is not necessary to analyze the remaining fractions of the waste. Extraction using the zero headspace extraction vessel (ZHE) is not required, furthermore, if the analysis of an extract obtained using a bottle extractor demonstrates that the concentration of a volatile compound exceeds the specified regulatory levels. The use of a bottle extractor, however, may not be used to demonstrate that the concentration of a volatile compound is below regulatory levels (40 CFR Part 261 Appendix II Sections 1.3 and .4).

[15] With the exception of the fourteen areas (see Appendix D) where test methods are required by hazardous waste regulation, use of EPA's *Test Methods for the Evaluation of Solid Waste* (SW–846) is not required, and should be viewed as guidance on acceptable sampling and analysis methods.

[16] An inconsistency occurs when compliance with one statute or set of regulations would necessarily cause non-compliance with the other. It may stem from a variety of considerations, including those related to occupational exposure, criticality, and other safeguards.

[17] A representative sample is defined in 40 CFR 260.10 as "a sample of a universe or whole (e.g., waste pile, lagoon, ground water) which can be expected to exhibit the average properties of the universe or whole." For further guidance see Chapter 9 of the EPA's testing guidance entitled *Test Methods for Evaluating Solid Waste* or SW–846.

[18] A prohibited waste may not be land disposed unless it meets the treatment standards established by EPA. These standards are usually based on the performance of the BDAT. A waste that is subject to an extension, such as a national capacity variance, does not need to comply with the BDAT treatment standards, but is ''restricted'' and if it is going to be disposed in a landfill or surface impoundment, it can only be disposed of in a unit that meets the minimum technology requirements (MTRs). An exception exists for interim status surface impoundments which may continue receiving newly identified and restricted wastes for four years from the date of promulgation of the listings or characteristics before being retrofitted to meet the MTRs (RCRA Section 3005(j)(6)), so long as the only hazardous wastes in the impoundment are newly identified or listed.

[19] The treatment standards for mineral processing wastes and certain additional newly listed waste streams were proposed in 61 *FR* 2338, January 25, 1996, and a second supplemental proposed rule signed April 18, 1997.

[20] Non-wastewater residues (e.g., slag) that result from high temperature metals recovery that are excluded from the definition of hazardous waste by meeting the conditions of 40 CFR 261.3(c)(2)(ii)(C), and hazardous debris that is excluded from the definition of hazardous waste in 40 CFR 261.3(f) have reduced LDR notification requirements. Specifically, these wastes, and characteristic hazardous wastes that are rendered non-hazardous, do not require a notification and certification accompanying each shipment. Instead, they may be sent to an AEA-licensed facility with a one-time notification and certification sent to the EPA Region or authorized State.

[21] Note that verification testing is a means to verify that the wastes received match the waste description on the manifest, which is required under 40 CFR 264.13 and 40 CFR 265.13(c). The main objective of corroborative testing is to provide an independent verification that a waste meets the LDR treatment standard.

[22] Land disposal facilities must maintain a copy of all LDR notices and certifications transmitted from generators and treaters (40 CFR 268.7(c)).

ACRONYMS/ABBREVIATIONS USED IN THIS GUIDANCE

AEA	Atomic Energy Act.
ALARA	As Low As Is Reasonably Achievable.
BDAT	Best Demonstrated Available Technology.
CFR	Code of Federal Regulations.
EP	Extraction Procedure (toxicity test).
EPA	Environmental Protection Agency.
FR	Federal Register.
HSWA	Hazardous and Solid Waste Amendments.
LDR	Land Disposal Restrictions.
NRC	Nuclear Regulatory Commission.
OSWER	Office of Solid Waste and Emergency Response.
RCRA	Resource Conservation and Recovery Act.
SW–846	Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods.
TC	Toxicity Characteristic.
TCLP	Toxicity Characteristic Leaching Procedure.
TSDF	Treatment, Storage or Disposal Facility.
WAP	Waste Analysis Plan.

Excerpts from U.S. Senate Report 108-105 and Bill S.1424

U.S. Senate Energy & Water Report 108-105

"Waste Analysis Requirements for the Waste Isolation Pilot Plant.—The Committee recognizes that the WIPP facility is central to the cleanup of the nuclear weapons complex and that waste should be emplaced as quickly and safely as possible—for reasons of reducing clean-up costs, public safety, and with the growing threat of radiological terrorism, for national security. Current law and regulation regarding the sampling and analysis of waste destined for WIPP produces substantial health and safety risks to workers with little if any corresponding public benefit. Both the New Mexico Environmental Evaluation Group, an independent WIPP oversight group, and the National Academy of Sciences have strongly suggested that waste destined for disposal at WIPP should not undergo hazardous waste sampling and analysis. To this end, the Committee believes that eliminating dangerous and excessive waste confirmation requirements that offer little if any benefit to the health and safety of the public will serve the national interests inherent in the safe and expeditious cleanup of the nuclear weapons complex. For these reasons, the Committee has included language in section 310 that requires that waste characterization be limited to determining that the waste is not ignitable, corrosive, or reactive. This confirmation will be performed using radiography or visual examination of a representative subpopulation of the waste. The language further directs the Secretary of Energy to seek a modification to the WIPP Hazardous Waste Facility Permit to implement the provisions of this bill by December 31, 2003. The Committee recommendation includes $1,000,000 for regulatory and technical assistance to the State of New Mexico to amend the existing WIPP Hazardous Waste Permit to comply with the provisions of the bill."

U.S. Senate Bill S.1424

Title: An original bill making appropriations for energy and water development for the fiscal year ending September 30, 2004, and for other purposes.
Sponsor: Sen Domenici, Pete V. [NM] (introduced 7/17/2003)
Cosponsors: (none)

"SEC. 310. (a) The Secretary of Energy is directed to file a permit modification to the Waste Analysis Plan (WAP) and associated provisions contained in the Hazardous Waste Facility Permit for the Waste Isolation Pilot Plant (WIPP). For purposes of determining compliance of the modifications to the WAP with the hazardous waste analysis requirements of the Solid Waste Disposal Act (42 U.S.C. 6901 et seq.), or other applicable laws waste confirmation for all waste received for storage and disposal shall be limited to (1) confirmation that the waste contains no ignitable, corrosive, or reactive waste through the use of either radiography or visual examination of a statistically representative subpopulation of the waste; and (2) review of the Waste Stream Profile Form to verify that the waste contains no ignitable, corrosive, or reactive waste and that assigned Environmental Protection Agency hazardous waste numbers are allowed for storage and disposal by the WIPP Hazardous Waste Facility Permit.

(b) Compliance with the disposal room performance standards of the WAP shall be demonstrated exclusively by monitoring airborne volatile organic compounds in underground disposal rooms in which waste has been emplaced until panel closure."

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

The findings of the Review Panel (RP) with respect to the review criteria are as follows:

Criterion 1

Is the elimination of the waste confirmation requirements mentioned in U.S. Senate Report 108-105 and Bill S. 1424 supported by the recommendations of the National Research Council (NRC) report "Improving Operations and Long-Term Safety of the Waste Isolation Pilot Plant"?

Finding 1 of the RP

The NRC committee was formed to respond to specific issues identified by the U.S. Department of Energy (DOE) and was disbanded in 2001. Consequently, the RP had no other choice but to rely exclusively upon the text of the NRC (2001) report.

The DOE has been exploring the waste characterization requirements necessary to satisfy the U.S. Environmental Protection Agency (EPA) and the requirements necessary to satisfy the New Mexico Environment Department (NMED). The EPA regulates the long-term repository containment of radionuclides. The following characterization requirements are needed to comply with EPA regulations:

1. Acceptable Knowledge (AK) and Non-Destructive Assay requirements listed in Appendix A of *Contact-Handled Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant*; and

2. Radiography results for ferrous and non-ferrous metals; cellulose; rubber; plastics; and liquids.

The NMED focuses on the containment of materials regulated by Resource Conservation and Recovery Act (RCRA). Characterization requirements of NMED are as follows:

1. AK
2. Headspace gas
3. Solids sampling and analysis

4. Real-Time Radiography/Visual Examination (RTR/VE)
5. Compliance with Waste Acceptance Criteria as described in the Attachments B to the WIPP Hazardous Waste Facility Permit (HWFP)

Characterization requirements in compliance with transportation regulations are:

1. AK
2. RTR/VE
3. Headspace gas flammables analysis
4. Payload container surface dose measurements
5. Fissile material quantity measurements for payload containers
6. Radionuclide description for at least 95% of the activity in each shipment

In complying with transportation regulations, DOE determines when characterization activities beyond the initial AK would need to be used. For some wastes, AK contains sufficient information to comply with transportation regulations.

The U.S. Senate Bill S. 1424 states that waste confirmation for all waste received for storage and disposal shall be limited to:

1. confirmation that the waste contains no ignitable, corrosive, or reactive waste through the use of either radiography or visual examination of a statistically representative sub-population of the waste; and

2. review of the Waste Stream Profile Form to verify that the waste contains no ignitable, corrosive, or reactive waste and that assigned Environmental Protection Agency hazardous waste numbers are allowed for storage and disposal by the WIPP Hazardous Waste Facility Permit.

Reference is made to the 2001 NRC Report under the heading "Waste Characterization and Packaging Requirements",

Pages 77-78:

"__Finding:__ The committee found inadequate legal or safety bases for some of the National TRU Program requirements and specifications.

That is, some waste characterization specifications have no basis in law, the safe conduct of operations to emplace waste in WIPP, or long-term performance requirements [...]. The National TRU Program waste characterization procedures involve significant resources (e.g., expenditures of several billion dollars) and potential for exposure of workers to radiation and other hazards. Insofar as some of this waste characterization may be unnecessary, such characterization is inconsistent with economic efficiency and the ALARA principle that guides radiation protection practices [...]. The committee regards the 30+ years of waste emplacement operations and related worker safety issues at WIPP as posing no significant needs for waste characterization information, because no use of characterization data is made in any handling, shipping, or emplacement operations."

Page 78:

"***Recommendation:*** *DOE should eliminate self-imposed waste characterization requirements that lack a legal or safety basis. One way to justify a reduction in waste characterization requirements is through implementation of joint U.S. Nuclear Regulatory Commission (USNRC)-U.S. Environmental Protection Agency (EPA) guidance (62 Federal Register 62079;[...]), which appears to the committee to provide appropriate guidelines for implementation and integration of Resource Conservation and Recovery Act (RCRA) requirements for mixed TRU waste. Implementation of this regulatory guidance could significantly reduce the testing protocols and associated radiation exposure of personnel. Another way to justify a reduction is to identify the origins of all waste characterization requirements and to eliminate those requirements that lack a technical or safety basis. Such reductions may require modifications to existing permits granted by external regulating authorities such as the EPA and New Mexico Environment Department."*

Pages 78-80:

"***Rationale:*** *.... The committee sought to identify the connection between the National TRU Program procedures and the various regulatory, legal, and technical requirements that the procedures* *should be devised to meet. The committee views these requirements in a hierarchy, at the top of which are legal and safety requirements, with regulatory specifications at the next tier, procedures proposed by DOE to meet regulatory requirements at the third tier, and the DOE protocols for these procedures at the fourth tier.*

"The approach used by the committee was to focus on six primary National TRU Program procedures representative of high-level requirements that drive operational activities in waste characterization and repackaging [...]:

1. *determination that the TRU waste is of defense origin;*
2. *sampling and analysis of homogeneous waste;*
3. *headspace gas sampling and analysis;*
4. *radioassay of the plutonium content;*
5. *real-time radiography; and*
6. *visual examination.*

".... A review of these six procedures revealed that one may be interpreted too strictly by DOE and three are without a technical or legal foundation:

"Procedure 1: Determination that the TRU waste is of defense origin. WIPP is limited to defense-related waste as stipulated in the Land Withdrawal Act, with defense activities defined in the Nuclear Waste Policy Act of 1982. The committee notes that this definition includes the words 'in whole or in part', which can be interpreted to include mixtures of defense and nondefense waste, although DOE does not appear to take advantage of this (see DOE, 1997a; Nordhaus, 1996). That is, waste such as plutonium-238 (^{238}Pu)-contaminated scrap from a facility used for both defense and nondefense missions at Los Alamos National Laboratory would appear to qualify as defense waste under the definition, without the need for waste segregation restrictions.

"Procedure 2: Sampling and analysis of homogeneous waste. DOE has written, There is no regulatory requirement to conduct homogeneous waste sampling and analysis, however, in an effort to meet the

intent of 40 CFR 264.13, WIPP has imposed additional characterization requirements on the waste generators (Nelson, 1999[...], p. 2). No operational decisions are made based on these data; that is, the results of the sampling and analysis do not affect how waste is handled, so it is not clear what justifies the additional radiation exposure risk and cost of this procedure. In the committee's view, this sampling and analysis applied only to homogeneous waste is unnecessary: If acceptable knowledge documentation [...] provides sufficient characterization information for heterogeneous waste, the committee can identify no technical reason why acceptable knowledge should not also be adequate for homogeneous waste.

"Procedure 3: Headspace gas sampling and analysis. DOE informed the committee that there is no regulatory requirement to conduct headspace gas sampling and analysis, however, in an effort to meet the intent of 40 CFR 264.13, WIPP has imposed additional characterization requirements on the waste generators (Nelson, 1999[...], p. 3). The headspace gas sampling and analysis was developed as a means of checking on conformance with USNRC and the U.S. Department of Transportation (DOT) requirements [...]; however, these requirements can be met by other means [...].

"Procedure 6: Visual examination. Visual examination is done on a fraction of the waste containers to confirm the real-time radiography and acceptable knowledge waste characterization information (Nelson, 1999[...], p. 5). However, there is no requirement for verification of real-time radiography results. An alternative way to confirm these results without operator exposure would be to use standardized test drums. The visual examination confirmation is a self-imposed procedure that yields no benefit but results in increased risk of exposure and cost."

Furthermore the NRC (2001) suggested that a DOE study (1999) confirms that sampling and analysis of homogeneous waste (which frequently requires drilling into a radioactive waste container using a large drill to obtain a core sample), headspace gas sampling and analysis (which requires workers to establish a pathway into a radioactive waste container to attach a sample line, frequently done with a large needle), and visual examination (which requires workers to open a radioactive waste container and physically sort through its contents), are based on terms negotiated in a permit and not on a required regulation or legal mandate.

Page 80:

"....The committee sees no utility in the information that these procedures provide. Any speculative benefits of acquiring this information must be weighed against the risks and costs. The committee's judgment is that the collection of these data from superfluous procedures increases, rather than decreases, the risk and safety of the overall TRU waste operations." [The RP notes that the second term 'safety' in the quoted phrase conveys the opposite meaning from the first term 'risk'. Upon reading the complete text of the cited report, the RP concludes that the cited phrase should be read 'to reduce risk' rather than 'reduce risk and safety.']

"These superfluous characterization and intrusive procedures also represent a conflict with the ALARA principle. The issue of how to handle conflict between regulatory requirements for waste characterization information and ALARA is beyond the scope of the committee's statement of task. At issue, however, is whether the present TRU waste management program results in significantly more worker radiation exposure than is justified to satisfy safety and nonnegotiabie regulatory requirements."

Based on the careful evaluation of the NRC (2001) report, the RP concludes that the elimination of the waste confirmation requirements mentioned in U.S. Senate Report 108-105 and Bill S. 1424 is supported by the NRC.

Criterion 2

Is the elimination of the waste confirmation requirements mentioned in U.S. Senate Report 108-105 and Bill S. 1424 supported by various statements and other publications of the New Mexico Environmental Evaluation Group?

Finding 2 of the RP

As the Senate language was based on the statements and other publications of Environmental Evaluation Group (EEG), the RP had to rely upon the existing materials prepared by the EEG.

Responding to a question of the NRC (EEG 2003, page 2, #5): "What WIPP waste characterization requirements, if any, has DOE imposed that go beyond EPA, NMED, and transportation requirements?", the EEG response was:

"*None that the EEG is aware of. The DOE established a unique system for waste characterization in order to satisfy the various requirements for opening the WIPP facility and allowing TRU wastes from across the country to be disposed of in New Mexico. These were worked out over several years through various methods with the various agencies and the DOE Generator/Storage Sites, involving give-and-take on both sides. During these negotiations, the DOE wished to deviate from the usual hazardous waste processes for a disposal facility. These deviations were apparently because of the DOE's limited knowledge about the TRU waste, the introduction of RCRA requirements to the DOE holdings, the complications caused by the presence of radionuclides, a desire to have the waste analyzed by those most familiar with them (the generator/storage sites), the uniqueness of the WIPP as a geological repository rather than a landfill, and other considerations. Thus, it is less a condition of whether or not the DOE has imposed requirements that go beyond those of the regulatory agencies than it of whether or not the DOE is going beyond the agreements established with the agencies.*"

Silva (2002b, page 1) provided EEG's views to a committee of NRC by stating:

"*These previous EEG statements reflect our basic criteria regarding waste characterization:*
1. 'We believe overall waste characterization requirements are excessive .... However, any proposed relaxation needs to be evaluated in sufficient detail to convince regulators, EEG, and stakeholders that the modification is justified' ...."

2. "In our October 4, 2001 Statement to the NAS Committee on the Characterization of Remote-Handled Transuranic Wastes for the Waste Isolation Pilot Plant we said, 'The conclusions from EEG-72 were that for routine operations the radiological risk was on the order of 10,000 times the hazardous waste risks, all from Volatile Organic Compounds (VOCs).... The fact that radiological risks are much greater than hazardous waste risks needs to be kept in mind by DOE, regulatory agencies, peer review groups, this Committee, and oversight agencies when addressing possible changes to waste characterization requirements'."

3. "The relaxation of audit requirements and QA/QC is not an appropriate way to reduce the waste characterization burden. These requirements should maintain the current level of stringency. The appropriate way to reduce the waste characterization burden is to eliminate unnecessary requirements, not to reduce the degree of compliance."

Silva (2002b, page 8) has also stated that:

"We see no technical reason why it is necessary to analyze for metals and chemicals at all. [...] Our reasons are: (1) the quantity of these materials to be emplaced in the repository was not important enough to DOE to estimate in the HWFP Application nor for the New Mexico Environment Department to request, (2) the data are not to be used for any regulatory control under the HWFP, and (3) evaluations in EEG-72 concluded that human exposures to hazardous metals and chemicals would only occur from the same type of operational and human intrusion accidents that released radioactive materials. In EEG-72, the calculated radionuclide risk would be $\geq 5x10^5$ times the hazardous metals risk.

"Despite the above statement, we do recognize an advantage of toxic metals sampling; the possible detection of prohibited items, such as PCB concentrations greater than 50 parts per million." [The RP does not understand this statement as it appears inconsistent with the above paragraph.]

"Our concerns about VOC or SVOC sampling are the same as for headspace gas sampling (that room based concentration limit and

transportation requirements be met in some manner). The Committee may wish to explore the need for VOC and SVOC sampling_in order to provide additional information on homogenous wastes."

In May 2002, based on the results of an EEG Report (Channell and Neill 1999), Silva (May 2002a, page 5) stated that:

"With respect to waste characterization for non-radiological constituents such as VOCs, the EEG's analyses indicate that the non-radiological risks are substantively less than the radiological risks[...]. The analyses suggest that these constituents do not require the same level of sampling characterization. Furthermore, it has been suggested that additional waste characterization of the non-radiological constituents may increase radiological risks to workers. The EEG recommends that the DOE analyze the efficacy of AK for RH TRU in the absence of confirmatory testing. However, until the data are generated and evaluated, the DOE should not deviate from the characterization process used for CH TRU. The DOE also needs to address the documents identified by the EEG which raise questions about AK at the generator/storage sites."

Furthermore, Channell and Walker (2000 page 60) of EEG concluded that:

"Even if VOC emissions are much higher than expected, the Confirmatory VOC Monitoring Plan at WIPP would detect concentrations that are three orders of magnitude below allowable Permit limits. Any hazardous emissions from pre-Permit wastes would likely be reported and acted on long before Permit limits were reached."

It appears that EEG agrees that the current characterization requirements are excessive. It appears that EEG also agrees that monitoring VOCs in underground disposal rooms is sufficient. The RP was unable to identify more details on views of EEG regarding the elimination of the waste confirmation requirements mentioned in U.S. Senate Report 108-105 and Bill S. 1424.

Criterion 3

Based on the information presented to the Review Panel, is the permit modification listed under Section 310 of U.S. Senate Bill S. 1424 technically defensible?

Finding 3 of the RP

In assessing the need for various characterization tests, the RP first evaluated the regulatory requirements. Regulations promulgated in implementing requirements of RCRA provide guidance on compliance with RCRA. Briefly, each generator is required to perform specific tasks as follows:

1. If the process used by the waste generator does not use or produce any of the classes covered under RCRA, then the waste is not covered under RCRA. Many organizations use the process knowledge to demonstrate exception from RCRA.

2. The generator performs specific tests as provided in the regulations, and can demonstrate a lack of presence of listed waste or passage of specific characteristic wastes.

3. The generator has also the option to request a delisting of the waste even if the process knowledge or the tests indicate coverage under RCRA. The delisting process is intended to remove those waste streams that pose insignificant risks from unnecessary and costly compliance with RCRA requirements.

4. If the process knowledge or various tests demonstrate that the waste is legally covered under RCRA and the waste is not delisted, the generator must treat the waste prior to its disposal. This latter requirement is referred to as Land Disposal Restrictions (LDR) and is intended to ensure the long-term safety of Disposal facilities permitted under RCRA.

For transuranic (TRU) waste, WIPP Managers have chosen to accept the fact that TRU waste includes RCRA constituents. As stated above, the consequence of such a decision is compliance with the requirements of LDR. However, the Waste Isolation Pilot Plant/Land Withdrawal Act exempts the WIPP from the coverage of LDR. Consequently, it appears that the WIPP managers would have to comply only with those RCRA requirements that are unrelated to LDR. These include those tests that would be required for the safety of operations. The safety-related requirements are those that are also covered by the transportation requirements—notably corrosivity, reactivity, and ignitability/flammability.

Acceptable knowledge can be one way in which compliance with the legal requirements is confirmed. EPA provides guidance in this regard. In particular, EPA (1994) provides guidance regarding waste analysis at facilities that generate, treat, store, and dispose of hazardous waste. Although EPA views representative sampling and laboratory analysis as the preferred method, acceptable knowledge is considered to be a viable alternative to meet waste analysis requirements. EPA (1994, page 1-11) indicates that:

"... generators and TSDFs also can meet waste analysis requirements by applying acceptable knowledge. Acceptable knowledge can be used to meet all or part of the waste analysis requirements."

Moreover, on pages 1-13 to 1-14 of EPA (1994) it is stated that:

"... there are situations where it may be appropriate to apply acceptable knowledge, including:
• Hazardous constituents in wastes from specific processes are well documented, such as with the F-listed and K-listed wastes.
• Wastes are discarded unused commercial chemical products, reagents or chemicals of known physical, and chemical constituents. Several of these fall into the P-listed and U-listed categories...
• Health and safety risks to personnel would not justify sampling and analysis (e.g., radioactive mixed waste).
• Physical nature of the waste does not lend itself to taking a laboratory sample."

The RP finds itself in agreement with the NRC (2001, page 77) that:

"... some waste characterization specifications have no basis in law, the safe conduct of operations to emplace waste in WIPP, or long-term performance requirements."

The NRC (2001, page 80) identifies three tests as having no legal foundation and

"*... sees no utility in the information that these procedures provide. Any speculative benefits of acquiring this information must be weighed against the risks and costs. The committee's judgment is that the collection of these data from superfluous procedures increases, rather than decreases, the risk and safety of the overall TRU waste operations.*" [The RP notes that the second term 'safety' in the quoted phrase conveys the opposite meaning from the first term 'risk'. Upon reading the complete text of the cited report, the RP concludes that the cited phrase should be read 'to reduce risk' rather than 'reduce risk and safety.']

In addition to NRC (2001) report, the RP evaluated a more recent relevant NRC (2002) report. The latter report adopts the conclusions of the NRC (2001) report, and provides the following recommendation (NRC 2002, page 49):

"The committee acknowledges that DOE must consider many non-technical factors in composing its characterization plan. However, DOE should propose only characterization activities that have a technical, health and safety, or regulatory basis."

As no evidence was provided that the views of the EEG—as presented in its statements and reports—had been subjected to independent peer review, the RP used the EEG information cautiously.

DOE has already agreed with the NRC recommendation to eliminate self-imposed waste characterization requirements that lack a legal or safety basis (NRC 2001, page 113). DOE has developed and begun the implementation of a strategy to systematically improve the Waste Analysis Plan by reducing the frequency of waste characterization and implementing methods that make characterization simpler, less expensive—and above all—safer. On August 8, 2000, the New Mexico Environment Department approved two packages of Class 2 modifications to the WIPP's Hazardous Waste Facility Permit that include:

1. The "miscertification rate" of TRU waste was revised to apply to the waste summary category group instead of each waste stream. This could result in a ten-fold reduction in the number of drums that must be opened for VE.

2. The solids sampling requirements for analysis of VOCs have been revised to allow use of one subsample instead of three subsamples. This could avoid a cost of approximately ten million dollars that the Idaho National Engineering and Environmental Laboratory would have had to spend in re-analyzing the samples.

3. The number of headspace gas samples required has been reduced for two types of waste streams to a statistically-selected number of drums, instead of 100% sampling. The two types of waste streams now eligible for statistical headspace gas sampling are: wastes that have been thermally processed; and homogeneous wastes with "acceptable knowledge" that demonstrate no volatile organic compounds have been present in the waste.

Approval of these modifications could result in significant cost savings associated with waste characterization and will reduce radiation exposures to workers.

Additionally, several modifications have been prepared and submitted that specifically address safety issues associated with TRU waste handling and disposal. One such modification, submitted in October 2000, will allow generators to remove from consideration for VE any containers that pose a safety concern. For example, if a generator determines that opening a container with a high fissile gram content is a safety hazard, that container can be ruled ineligible for VE and another container selected.

Based on the information presented to the Review Panel, the permit modification listed under Section 310 of U.S. Senate Bill S. 1424 is technically defensible. There is no reason to perform waste confirmation tests that:

1. provide insignificant health and safety benefits to the U.S. population; and
2. pose serious radiological and occupational health and safety risks for the workers performing these tests.

RECOMMENDATION

The RP recommends that the Mayor of Carlsbad make available this report to the U.S. Senate Committee for Energy and Water.

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Biographical Summaries

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, NV.

Melvin W. Carter is currently an International Radiation Protection Consultant and Neely Professor Emeritus at Georgia Institute of Technology in Atlanta, GA. His fields of interest include: pollutant pathways in the environment and their kinetics; policy formulation in environmental protection and radiological protection; and procedures and methods for environmental surveillance. His other fields of interest are: the management of radioactive wastes; radiological engineering evaluations for criteria and standards; and the transportation of radioactive materials. He has provided consulting services to a large number of national and international organizations. He served as the Director of the Office of Interdisciplinary Programs at Georgia Tech, which included the Bioengineering Center and Environmental Resources Center. He was also Professor of Nuclear Engineering and Health Physics at Georgia Tech. He developed and taught graduate and undergraduate courses, which included: Nuclear Technology and the Environment; Radiation Protection in Nuclear Facilities; and Introduction to Bioengineering. He also taught Radiological Health Physics Practices. He was the Director of the National Environmental Research Center of the U.S. Environmental Protection Agency in Las Vegas, NV and the Southeastern Radiological Health Laboratory of the U.S. Public Health Service in Montgomery, AL. He performed research on radioactive water decontamination and waste disposal, and participated in investigative work on the accumulation of radioactivity in bottom sediments of the Clinch and Tennessee rivers. Melvin Carter is a member of the National Academy of Engineering, and has served on a number of committees, boards, and panels of the National Research Council. He is past President of the Health Physics Society, and past President of the International Radiation Protection Association. He served as Chair or a member of a number of scientific committees, and has been a member of the Board of Directors of the National Council on Radiation Protection and Measurements. He served as a presidential appointee as one of the nine-member Nuclear Waste Technical Review Board. He was inducted into Georgia Tech's Engineering Hall of Fame. Melvin Carter has published over 100 works, including several books. Melvin Carter received a B.S. degree in Civil Engineering, as well as a M.S. degree in Public Health Engineering from Georgia tech, and a Ph.D. in Radiological and Environmental Engineering, with a minor in Chemistry, from the University of Florida in Gainesville, FL.

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 American Society of Mechanical Engineers 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 American Society of Mechanical Engineers 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. degree from the Polytechnic Institute of Brooklyn.

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; U.S. Department of Energy (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 Colorado and has done Graduate, Technical, and Management course work at Pennsylvania State University. He is a registered Professional Engineer in Ohio.

Michael C. (M.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. M.C. Kirkland managed several environmental and construction projects that employed many soil investigative techniques including significant work with cone penetrometers. Additionally, he provided consulting services to a large environmental remediation services company regarding Dense Non-Aqueous Phase Liquid locating and removal techniques. During his tenure at the SRS, M.C. 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. M.C. 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. M.C. Kirkland holds a B.S. in Mechanical Engineering from the University of South Carolina. He is registered as a Professional Engineer in South Carolina.

Betty R. Love is currently Executive Vice President of the Institute for Regulatory Science. In that capacity, she is responsible for the management of day-to-day operations of the Institute, and for administration of several projects. She is the Administrative Manager of a large-scale peer review program in collaboration with the American Society of Mechanical Engineers for a number of organizations including the U.S. Department of Energy. Her current research activities center around the development and implementation of a systematic approach to stakeholder participation, notably in scientific meetings. Previously, Betty Love was Director, Department of Training and Information within the 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; has edited a number of compendia; and is the primary author of *Manual for Public and Stakeholder Participation*. Betty Love received a B.S. degree in Business Administration from Virginia State University in Petersburg, VA, and an M.S. degree in Developmental Clinical Psychology from Antioch College in Yellow Springs, OH.

Robert E. Luna is currently a private consultant involved in the packaging and transportation of a wide variety of radioactive materials at national and international levels. His current interests range from risk assessment related to packaging and transportation of radioactive materials, to nuclear weapon accident phenomenology. Previously, he was Senior Manager for the Waste Legacy Program Development Office at Sandia National Laboratory. In that capacity, he was responsible for business development for the mining industry; Department of Defense environmental cleanup needs; U.S. Nuclear Regulatory Commission transportation technology; and application of environmental remediation technology to various U.S. Department of Energy sites. In addition, he was involved in the study of nuclear weapon safety, transportation risk assessment, and cask sabotage source terms. Prior to that position, he managed a number of programs dealing with environmental characterization and monitoring technology, and while at Sandia National

Laboratory, he was involved in the development of the Environmental Impact Statement for the Pantex Plant in Amarillo, TX. For nearly 20 years, Robert Luna was involved with increasing responsibility in various aspects of radioactive and hazardous material package design and transportation, including: package design and testing; structural and thermal analysis; material development; and information management. He led the development of RADTRAN risk assessment code; managed the development of regulatory guide NUREG 0170; and led national efforts related to the risk assessment of packaging and transportation of high level waste/spent nuclear fuel at Sandia. Robert Luna represented the U.S. Department of Energy at the International Atomic Energy Agency in the development of the document regulations for the transportation of radioactive materials and related topics. He managed and contributed to experiments which defined sabotage threat and the potential impact of the sabotage of spent nuclear fuel transportation casks, including: threat evaluation, source-term development, and damage evaluation. He was involved in the development of generation, transport, and the fate of aerosols resulting from nuclear weapons accidents, including mishaps during the stages of assembly, disassembly, deployment, and storage. Robert Luna is a Fellow of the American Society of Mechanical Engineers; a member of the American Nuclear Society; and a member of ANSI N14 Management Committee for Nuclear Material Packaging. He is on the Editorial Board of the *International Journal of Radioactive Material Transportation.* He was past Chair of the Bernalillo County Air Quality Control Board. He received the Department of Energy Award of Excellence for "Significant Contributions to the Nuclear Weapons Program in Plutonium Safety Issues". He is the author or coauthor of more than 100 publications. Robert Luna holds a B.S. degree in Mechanical Engineering from Rutgers University; an M.S. degree in Mechanical Engineering and a Ph.D. in Aerospace and Mechanical Sciences from Princeton University; and Master of Management degree from the Anderson Schools of Management, University of New Mexico. He is a registered Professional Engineer in New Mexico.

Peter Maggiore is currently Principal Scientist with Portage Environmental, in San Antonio, TX. There, he is a corporate resource regarding regulatory analysis, environmental compliance, and scientific matters. In addition, Peter Maggiore has responsibilities in the areas of quality assurance/quality control and business development. Prior to his current position, he served as Cabinet Secretary of the New Mexico Environment Department, reporting to the governor regarding all environmental matters. In his capacity as Secretary of Environment Department, he was responsible for drafting legislation, preparing regulations; enforcing regulations, and otherwise overseeing environmental protection in New Mexico. In addition, on numerous occasions he provided expert testimony at New Mexico and U.S. legislative and other hearings; and interacted with officials of the U.S. Environmental Protection Agency and other federal environmental officials. During his tenure, New Mexico Environment Department, he signed the RCRA B permit for the Waste Isolation Pilot Plant and was responsible for the enactment five major environmental laws. Prior to his appointment as Secretary, Peter Maggiore served at leading positions at the Environment Department. In addition he has extensive industrial experience. His academic experience includes appointments at the University of New Mexico and the University of Maine. He is a member of the National Water Well Association; New Mexico Hazardous Waste Management Society; New Mexico Geological Society; Albuquerque Geological Society; American Institute of Professional Geologists; and the Environmental Council of States. Peter Maggiore received a B.S. degree in Geology from the State University of New York at Stony Brook; and an M.S. degree in Geology from the University of New Mexico.

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. He is a fellow at 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.

John E. Moore is currently a Hydrogeologist at the Office of Water of the U.S. Environmental Protection Agency in Denver, CO. He is also an Adjunct Professor at Metro State College in Denver, CO, and a consulting hydrologist. His recent activities have included serving as a technical advisor, and planning geologic and hydrogeologic projects nationally and internationally. Prior to his current positions, he was Senior Hydrogeologist at Environmental Strategies Corporation, where he performed site investigations for property transfer, and aquifer remediation. He was a Technical Advisor at the U.S. Environmental Protection Agency in Washington, DC, where he conducted field investigations and prepared data for congressional hearings on the extent of groundwater contamination at U.S. Department of Energy facilities and military sites. Earlier, he was Deputy Assistant Chief Hydrologist at the U.S. Geological Survey in Reston, VA. While there, he was responsible for the Water Resources Division's publication program, and presented technical short courses to U.S. Geological Survey district and regional offices. Earlier in his career, he was head of the Southwest Florida U.S. Geological Survey Office; Ground Water Specialist and head of hydrologic studies at the U.S. Geological Survey regional office in Denver, CO; and an assistant in hydrogeologic studies at the Nevada Test Site. John Moore is past President of the International Association of Hydrogeologists and of the American Institute of Hydrology. He is a Fellow of the Geological Society of America, and a member of the American Geophysical Union. He is an honorary Life Member of the International Association of Hydrogeologists, where he is also Chair of the Education and Training Commission. John Moore is on the Editorial Board of *Environmental Geology and Hydrology and Hydrogeology*. He is author or coauthor of over 70 publications. He received a B.A. degree in Geology from Ohio Wesleyan University in Delaware, OH, and an M.S. degree and a Ph.D. in Geology from the University of Illinois, Urbana, IL. He is a registered Professional Geologist in the state of Wyoming, and is certified as a Professional Hydrogeologist by the American Institute of Hydrology.

Goetz K. Oertel's career in engineering, physics, chemistry, astronomy, and technical program management spans more than 40 years. He consults for industrial, academic, and governmental organizations in North and South America. As President and CEO of the Association of Universities for Research Astronomy, a nonprofit corporation, he engineered the initiation and completion of two 8-m aperture optical telescopes, and oversaw the Space Telescope Science Institute from before launch, through repair of the "Hubble flaw", to its successful operation. He initiated the conceptional phase of the Next Generation Space Telescope that will succeed Hubble as well as the Advanced Solar Telescope, and he oversaw the completion of ambitious ground-based astronomy facilities. He held technical and management positions in the U.S. Department of Energy, including Director of Defense Waste Management; Acting Manager of the Savannah River Operations Office; Deputy Manager of Albuquerque Operations Office; and Deputy Assistant Secretary for Safety, Health, and Quality Assurance. He had primary responsibility for the congressionally-mandated Defense Waste Management Plan, and for managing the related technology development, operations, and projects. He led the initiation of the Defense Waste Processing Facility, and saw it and the Waste Isolation Pilot Plant through technical, managerial, stakeholder, and political challenges. He was National Aeronautics and Space Administration Space Science Chief and Program Manager, and Aerospace Engineer at Langley. He was a Fellow in the White House with the President's Science Advisor and the Office of Management and Budget's Space and Energy branch. He chaired the Westinghouse West Valley Corporation Technical Advisory Group for high-level nuclear waste vitrification and management before, during, and after that project's successful vitrification campaign. He is a member of the American Physical Society, Sigma Xi, and other professional organizations. He is a Fellow of the American Association for the Advancement of Science. He is Chair or member of boards and committees of the National Research Council; George Mason University; the American Society of Mechanical Engineers; International University Exchange; and Westinghouse West Valley Corporation. He is a founding member of the Editorial Board for "Data Science", the new international on-line journal of Codata. He published numerous peer-reviewed papers and was awarded two patents. Trained as electrical engineer and physicist, he received a Vordiplom in Physics and Chemistry from the University of Kiel while on German industrial and governmental scholarships, and a Ph.D. in Physics from University of Maryland at College Park under a Fulbright scholarship.

Harold W. Olsen is a Research Professor in the Division of Engineering and the Department of Geology and Geological Engineering at the Colorado School of Mines. He is also a Scientist Emeritus of the U.S. Geological Survey. His experience includes research regarding geological and environmental hazards, including landslides; subsidence; expansive soils; and subsurface contamination. This research involves interrelationships between the geologic characteristics of unconsolidated earth materials and their geomechanical and hydrologic properties. It also includes the development and application of new experimental capabilities for geotechnical measurements on undisturbed core samples that provide experimental control on the chemistry and degree of saturation of soil pore fluids, and on arbitrary stress and strain paths. Recently Harold Olsen has been working on a National Aeronautics and Space

Administration contract through the University of Colorado entitled *Identification and Mapping of Expansive Clay Soils in the Western U.S. Using Field Spectrometry and AVIRIS Data*; and a National Science Foundation grant entitled *The Importance of Osmosis in the Volumetric Behavior of Earth Materials.* Formerly, he was a Research Civil Engineer at the U.S. Geological Survey Engineering Geology Branch and Earthquake and Landslide Hazards Branch. His projects included the investigation of physicochemical and physical phenomena that can increase the vulnerability of ground to failure with time, and that can be used to strengthen and stabilize weak or failed ground. These phenomena include chemical causes of groundwater movement, and chemical and saturation effects on the permeability, compressibility, and strength of argillaceous materials. Harold Olsen conducted reviews of geotechnical aspects of Preliminary Safety Analysis Reports concerning proposed nuclear reactor sites for the Atomic Energy Commission. He also has worked as a Geotechnical Consultant in U.S. Geological Survey Technical Assistance Programs in Peru, Indonesia, and Bangladesh. He is an expert on soil properties and behavior, and the application of geotechnical data to studies of terrestrial and marine environments. Harold Olsen has been Editor-In-Chief of the American Society of Civil Engineers' Journal *Geotechnical and Geoenvironmental Engineering,* and a member of the American Society of Civil Engineers' Geo-Institute Awards Committee. His current professional society activities include membership in the: American Society of Civil Engineers' Geo-Institute Technical Publications Committee; American Society of Civil Engineers' Committee on Engineering Geology; American Society for Testing and Materials Committee D-18 on Soil and Rock for Engineering Purposes; and Highway Research Board Committee A2L03 on the Physicochemical Properties of Soils. He has authored or coauthored over 100 papers, reports, and conference contributions. Harold W. Olsen received S.B., S.M., and Sc.D. degrees in Civil Engineering from the Massachusetts Institute of Technology in Cambridge, MA. He is a certified Professional Hydrologist (Groundwater).

Wren Prather-Stroud is Manager of Western Operations of the Institute for Regulatory Science (RSI). In that capacity, she manages the day-to-day operation of the RSI office in Carlsbad, NM, and interacts with RSI clients in various western states—notably New Mexico and

Nevada. Her current activities include assisting in the development of the RSI stakeholder participation approach; stakeholder information workshops; and other activities related to public participation in technical aspects of societal decisions. Previous to her current position, Wren Prather-Stroud was employed at Westinghouse where she was responsible for the preparation of various reports; feature articles for the U.S. Department of Energy (DOE) and DOE contractor publications; interaction with DOE contractors; and special writing assignments. For example, she prepared responses to eight recommendations included in a report of the National Research Council. Wren Prather-Stroud was also involved in the study of shipping TRU waste to the Waste Isolation Pilot Plant by rail, and chaired the WIPP Rail Working Group. Wren Prather-Stroud is an accomplished Master sculptor working with bronze and clay, and her sculptures are featured in numerous public and private locations in New Mexico and other states. She received a Bachelor of Arts degree in English from the University of Denver, with a minor in Advertising & Public Relations.

Fritz A. Seiler is currently President of Sigma Five Consulting—a company devoted to the application of computer technology to solve environmental problems. He has over 30 years experience in research involving physics and risk assessment, with a broad background in nuclear physics, health physics, toxicology, uncertainty analysis, and risk management. He was a faculty member at the University of Basel, Switzerland where he conducted research in nuclear physics, including: experimental and theoretical studies reactions between light nuclei (fusion reaction) and studies on neutron interactions; neutron activation analysis; prompt gamma measurements; and similar topics. In addition, he accepted an appointment as Staff Officer for Nuclear-Biological-Chemical (NBC) Warfare Defense on the Swiss Army Command. In this capacity, he assessed and minimized NBC risks to military and civilian populations. Subsequently, he assumed an additional appointment as Commanding Officer of the Swiss Army's 37 radiation laboratories coordinating sampling; data collection; risk evaluation; and risk management. Subsequent to immigration to the United States, Fritz Seiler joined the Lovelace Inhalation Toxicology Research Institute. In that capacity, he was involved in risk assessment of chemical and radiological agents, cost-risk-benefit analysis emphasizing economics, and uncertainty analysis. He was also involved in the study of nuclear radiation dosimetry;

environmental dispersion; chemical and radiological materials transport; and new sampling methods. He performed a wide variety of measurements, data evaluation, and statistics, as well as theoretical modeling and systems simulation. Later, he joined IT corporation and continued and expanded his previous activities. For a one year period, Dr. Seiler was a Vice President with the Institute for Regulatory Science—a not-for-profit organization involved with the application of best available science, including peer review to societal decisions. Dr. Seiler is Fellow of the American Physical Society and has been designated Distinguished Technical Associate of IT Corporation. He is a member of the Society of Risk Analysis; the Health Physics Society; the American Nuclear Society, (Member of NCRP Liaison Committee); and the American National Standards Institute. He has published more than 120 scientific papers in the areas of physics, risk assessment, and risk management. Fritz Seiler received a Baccalaureate in Economics from the Basel School of Economics, and a Ph.D. in Physics from the University of Basel, Switzerland.

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.

Bruce M. Thomson is a Professor in the Department of Civil Engineering at the University of New Mexico. His interests cover a wide area of environmental systems, including: disposal of hazardous materials in arid ecosystems; treatment of radioactive wastewater; development of barriers for containment of contaminated sites; and in-situ immobilization of inorganic contaminants. He has been an instructor and Graduate Fellow at Rice University's Department of Environmental Science and Engineering; Environmental Engineer for the U.S. Environmental Protection Agency; and Visiting Professor at the Tyndall Air Force Base Headquarters Engineering and Services Center. He has taught courses in waste management, and has supervised graduate students in the areas of hazardous and radioactive waste management, and environmental restoration. Bruce Thomson is a member of: the American Chemical Society; the Water Pollution Control Federation; the Association of Groundwater Scientists and Engineers; the Association of Environmental Engineering Professors; and the American Society of Civil Engineers. He has been appointed to several committees, including: the National Research Council's Subcommittee on Mixed Waste Forms; the New Mexico State Underground Storage Tank Committee; and the New Mexico Mining Commission. He is author or coauthor of over 100 papers—including those in peer-reviewed journals—reports, and other publications. He is a coeditor of a book on the disposal of hazardous materials in desert ecosystems. Bruce Thomson received a B.S. degree in Civil Engineering from the University of California; and M.S. and Ph.D. degrees in Environmental Science and Engineering from Rice University. He is a registered Professional Engineer in New Mexico.

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); Chair of the ASME Peer Review Committee; 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 in Urbana, IL.

Roger P. Whitfield is a consultant in the areas of strategic planning, business development, environmental program planning, environmental and safety reviews, and procurement assistance. He was Deputy Assistant Secretary for Environmental Restoration in the U.S. Department of Energy's Office of Environmental Management. In that capacity he was responsible for remediation of sites used in the U.S. Department of Energy's nuclear weapons program; the Uranium Mill Tailings Program; the Formerly Utilized Sites Program; and the decontamination and dismantlement of the facilities. He also served as Project Manager; Director of the Environmental Division; and Assistant Manager for Health, Safety and Environment at the U.S. Department of Energy's Savannah River Site. At the National Aeronautics and Space Administration he was Program Manager for the design and test center located at the launch center; systems checkout engineer at Kennedy Space Center; project engineer; and performed design, fabrication, testing, and quality assurance of rocket engines. During Roger Whitfield's tenure as Deputy Assistant Secretary he received the Presidential Rank Award and the Federal Environmental Engineer of the Year Award. Also, during this period he was awarded the University of Alabama Mechanical Engineering Department Distinguished Fellow Award and the Engineering

Department Distinguished Fellow Award. He has published numerous papers in trade journals. He received a BSME degree from the University of Alabama in Tuscaloosa, AL, along with the Machinery Magazine Design Award and an MBA degree from Florida State University in Tallahassee, FL.

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.

Acronyms

AEA	Atomic Energy Act
AK	Acceptable Knowledge
ALARA	As Low As Reasonably Achievable
ASME	American Society of Mechanical Engineers
BAS	Best Available Science
BDAT	Best Demonstrated Available Technology
CAR	Commission on Assessment and Reviews
CCA	Compliance Certification Application
CFR	Code of Federal Regulations
CH	Contact-Handled
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EEG	Environmental Evaluation Group
EP	Extraction Procedure
EPA	U.S. Environmental Protection Agency
FR	Federal Register
FTIRS	Fourier Transform Infrared System
GC	Gas Chromathography
HPLC	High Pressure Liquid Chromatography
HSWA	Hazardous and Solid Waste Amendments
HWFP	Hazardous Waste Facility Permit
INEEL	Idaho National Engineering and Environmental Laboratory
LDR	Land Disposal Restrictions
MS	Mass Spectrometry
NAS	U.S. National Academy of Sciences
NDA	Non-Destructive Assay
NMED	New Mexico Environmen~~tal~~ Department
NRC	National Research Council
NUREG	Nuclear Regulatory Guidelines
OSWER	Office of Solid Waste and Emergency Response
PA	Performance Assessment
PAN	Passive/Active Neutron
PCB	Polychlorinated Biphenyl
PREPP	Process Experimental Pilot Plant
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
RH	Remote-Handled

RP	Review Panel
RSI	Institute for Regulatory Science
RTR	Real-Time Radiography
SGS	Segmented Gamma Scans
SPC	Statistical Process Control
SVOC	semi-volatile organic compound
SW–846	Test Methods for Evaluating Solid Wastes, Physical/ Chemical Methods
SWB	Standard Waste Box
TC	Toxicity Characteristic
TCLP	Toxicity Characteristic Leaching Procedure
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
WIPP/LWA	Waste Isolation Pilot Plant/Land Withdrawal Act
WSPF	Waste Stream Profile Form