National Profile on Commercially Generated Low-Level Radioactive Mixed Waste

Manuscript Completed: August 1992
Date Published: December 1992

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Prepared for

Division of Low-Level Waste Management and Decommissioning
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555
NRC FIN L1647

and

State and Regional Programs Branch
Office of Solid Waste
U.S. Environmental Protection Agency
Washington, DC 20460

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Abstract

This report details the findings and conclusions drawn from a survey undertaken as part of a joint U.S. Nuclear Regulatory Commission and U.S. Environmental Protection Agency-sponsored project entitled "National Profile on Commercially Generated Low-Level Radioactive Mixed Waste." The overall objective of the work was to compile a national profile on the volumes, characteristics, and treatability of commercially generated low-level mixed waste for 1990 by five major facility categories—academic, industrial, medical, and NRC-/Agreement State-licensed government facilities and nuclear utilities. Included in this report are descriptions of the methodology used to collect and collate the data, the procedures used to estimate the mixed waste generation rate for commercial facilities in the United States in 1990, and the identification of available treatment technologies to meet applicable EPA treatment standards (40 CFR Part 268) and, if possible, to render the hazardous component of specific mixed waste streams nonhazardous. The report also contains information on existing and potential commercial waste treatment facilities that may provide treatment for specific waste streams identified in the national survey. The report does not include any aspect of the Department of Energy's (DOE's) management of mixed waste and generally does not address wastes from remedial action activities.

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Executive Summary

This report details the findings and conclusions drawn from a survey undertaken as part of a joint U.S. Nuclear Regulatory Commission and U.S. Environmental Protection Agency-sponsored project entitled "National Profile on Commercially Generated Low-Level Radioactive Mixed Waste." The overall objective of the work was to compile a national profile on the volumes, characteristics, and treatability of commercially generated low-level mixed waste for 1990 by five major facility categories—academic, industrial, medical, and NRC-/Agreement State-licensed government facilities and nuclear utilities. Included in this report are descriptions of the methodology used to collect and collate the data, the procedures used to estimate the mixed waste generation rate for commercial facilities in the United States in 1990, and the identification of available treatment technologies to meet applicable EPA treatment standards (40 CFR Part 268) and, if possible, to render the hazardous component of specific mixed waste streams nonhazardous. The report also contains information on existing and potential commercial waste treatment facilities that may provide treatment for specific waste streams identified in the national survey. The report does not include any aspect of the Department of Energy's (DOE's) management of mixed waste and generally does not address wastes from remedial action activities.

The national survey consisted of a series of steps which included: (1) selecting a total number of facilities to be sampled, based on an expected 25% nonresponse rate and a 10% relative standard error; (2) sending out a detailed questionnaire to a number of randomly selected facilities; (3) accumulating and compiling the responses in an appropriate format and database; (4) estimating the national generation rates based on multiplying the "raw" mixed waste generation data by weighting factors to correct for the fraction of the facilities in each group that were sent questionnaires. The final sample sizes were selected to achieve a relative standard error of 10% to provide a conservative survey design and to provide a measure of protection for uncorrectable factors such as incorrect and missing data.

The survey target population (survey frame) included a total of 2,936 facilities. The random sample selected from the target population consisted of 1,323 facilities. Data from 1,016 completed mixed waste survey questionnaires, including 21 facilities that reported they were out of business (77% response rate), received by Oak Ridge National Laboratory indicate that approximately 81,000 ft³ of low-level radioactive mixed waste was generated in the United States in 1990 by those facilities surveyed. Approximately 63% of this reported volume was liquid scintillation fluids (LSF).

Using the weighting factors described previously to generate a statistically valid estimate of the 'national' profile, the survey estimates that approximately 140,000 ft³ of commercial low-level radioactive mixed waste was generated nationally in 1990 and that nearly 72% was LSF. In addition, an estimated 75,000 ft³ of commercial low-level mixed waste was in storage for various reasons as of December 31, 1990. The industrial category was estimated to be the largest generator and also the largest accumulator of mixed waste. Industrial facilities generated over 36% of the mixed waste generated in 1990 and accounted for 57% of the mixed waste in storage as of December 1, 1990. Data received from 97% of the operating nuclear utilities in the country indicated that they generated less than 10% of the estimated total 1990 generation rate for commercial mixed waste.

Although Compact/State and Hazardous Waste Stream data are presented, it should be emphasized that the profile was generated to be statistically valid only at the national level and only for the major facility categories. It is estimated that the overall accuracy of the projected

commercial mixed waste generation rates and waste in storage are well within the objective of the study that was to be, at the 95% confidence level, within a factor of 2. Estimations of commercial mixed waste generation and storage at the state or regional level may be less reliable, mainly due to fewer samples in these substrata.

The survey sets upper and lower bounds on the volume of mixed waste that is untreatable under current technologies by making the simplifying assumption that LSF, oil, organic (not halogenated), and corrosive mixed wastes are treatable. Deducting the wastes that are assumed to be treatable from the estimated national total mixed waste generation rate leaves about 18,500 ft³ of mixed waste that is untreatable. Thus, with this as an upper bound and the estimated 5,000 ft³ of reported currently untreatable mixed waste as the lower bound, the untreatable mixed waste ranges from 3.5 to 13.3% of the estimated 1990 national generation rate of 140,000 ft³. Please note, however, that the capacity to treat all of the so-called "treatable" mixed waste may not be available.

A broad spectrum of commercially generated low-level radioactive mixed waste streams are generated by the facilities surveyed including LSFs, halogenated and unhalogenated organics, wastes contaminated with toxic metals, and acidic and basic corrosives. These mixed wastes present a need for specific waste treatment services, including incineration, stabilization, chemical treatment, and recovery/reuse processes. Four commercial companies, NSSI (Houston, TX), DSSI (Kingston, TN), Quadrex (Gainesville, FL), and RAMP (Denver, CO), currently offer treatment services for mixed waste. Two other companies, SEG (Oak Ridge, TN) and Envirocare (Salt Lake City, UT), may offer mixed waste treatment services in the near future. Comparing estimated demand for commercial mixed waste treatment services (1990 generation rate plus total mixed waste in storage at the end of 1990) with available treatment capacity in specific mixed waste categories indicated that sufficient capacity seems to exist for more than 95% of all mixed waste except chlorinated fluorocarbons (CFCs), lead shielding and other waste contaminated with solid lead, and mercury-contaminated equipment and debris. The shortfall in commercial mixed waste treatment capacity amounts to about 12,000 ft³. Currently operating commercial treatment facilities may be able to handle nearly all of the commercial mixed waste generated, based on 1990 generation data, but significant additional capacity must be developed to address the total demand which consists of not only the annual generation rate but also the mixed waste in storage at the end of 1990. In addition, this comparison does not include current and future demands that the noncommercial generators (i.e., the DOE) will have for commercial mixed waste treatment services. DOE's demand for commercial mixed waste treatment may affect the availability of these services to commercial generators.

Abbreviations

ACURI	Appalachian Compact Users of Radioactive Isotopes
AEA	Atomic Energy Act of 1954, as Amended
BDAT	Best Demonstrated Available Technology
CFC	Chlorinated Fluorocarbons
Cd	Cadmium and Cadmium-containing Materials
Corr	Corrosive Materials
Cr	Chromium and Chromium-containing Materials
DOE	U.S. Department of Energy
EEI	Edison Electric Institute
EPA	U.S. Environmental Protection Agency
Hg	Mercury and Mercury-containing Materials
HSWA	Hazardous and Solid Waste Amendments of 1984
IDB	Integrated Data Base
LDR	Land Disposal Restrictions (40 CFR Part 268)
LLRW	Low-Level Radioactive Waste
LLRWPA	Low-Level Radioactive Waste Policy Amendments Act of 1985, as Amended
LSF	Liquid Scintillation Fluid
NEPA	National Environmental Policy Act of 1969
Org-Cl	Chlorinated Organics
Org-Fl	Fluorinated Organics
Org-Other	Organics Other Than Those Specifically Identified
ORNL	Oak Ridge National Laboratory
MW	Low-Level Radioactive Mixed Waste
NARM	Naturally Occurring or Accelerator-Produced Radioactive Material
NRC	U.S. Nuclear Regulatory Commission
Pb	Lead and Lead-containing Materials
RCRA	Resource Conservation and Recovery Act of 1976, as Amended
TCC	Host State Technical Coordinating Committee for Low-Level Radioactive Waste Disposal

Acknowledgments

We would like to take this opportunity to express our appreciation to individuals without whom the completion of this project would not have been possible. These included University of Tennessee Environmental Law students — Shari Tayloe, Julie Martin, Kevin Townsel, Greg Oakley, and Larry Wallace for making the hundreds of follow-up telephone calls persuading facilities to respond to the survey; ORNL Biomedical and Environmental Information Analysis staff members — Mary Francis for database construction, organization and supervision, Karen Weaver and Cynthia Seiber for data entry, Mychal Manie for computer programming, and Gerry Danford for document tracking and quality assurance checking.

In addition, we would like to acknowledge the cooperation of members of Appalachian Compact Users of Radioactive Isotopes (ACURI) and its executive secretary, John Vincenti, for agreeing to participate in the pretest of the national survey. The Edison Electric Institute (EEI) is recognized for urging its members to complete their survey forms. In addition, the following compacts and states allowed us access to unpublished information they had on mixed waste generation in their compact or state: Appalachian Compact, Massachusetts, New York, Southeastern Compact, Southwestern Compact, and Texas. The ORNL study team would especially like to acknowledge the vital input of Chad Glenn of the Nuclear Regulatory Commission and Jared Flood of the Environmental Protection Agency who initially were the primary sponsor contacts involved with this program.

NATIONAL PROFILE ON COMMERCIALLY GENERATED LOW-LEVEL RADIOACTIVE MIXED WASTE

1 Introduction

1.1 Objective of the National Profile

The objective of this U.S. Nuclear Regulatory Commission- (NRC-) and U.S. Environmental Protection Agency- (EPA-) sponsored project was to compile a national profile on the volumes, characteristics, and treatability of commercially generated low-level radioactive mixed waste. The information collected and assembled in this project may be used by NRC, EPA, and the states to make decisions regarding the management and disposal of commercially generated mixed waste. The project did not encompass mixed waste generated by the government [i.e., Department of Energy (DOE)] since that universe of mixed waste had been previously estimated by DOE. This project did not specifically attempt to address cleanup wastes from remedial action activities although information obtained from generators performing these activities was not excluded.

1.2 Definitions

For the purposes of this project, mixed waste is defined as “waste that satisfies the definition of low-level radioactive waste (LLRW) in the Low-Level Radioactive Waste Policy Amendments Act of 1985 (LLRWPAA) and contains hazardous waste that (1) is listed as hazardous waste in Subpart D of 40 CFR Part 261 or (2) causes the LLRW to exhibit any of the hazardous waste characteristics identified in Subpart C of 40 CFR Part 261.”

The LLRWPAA defines LLRW as “radioactive material that (a) is not high-level radioactive waste, spent nuclear fuel, or byproduct material as defined in section 11e. (2) of the Atomic Energy Act of 1954 (AEA) i.e., uranium or thorium mill tailings and (b) NRC classifies as LLRW consistent with existing law and in accordance with (a).”

In addition, the following were included in the definition of hazardous waste for the purposes of the National Profile:

- Oils and oil sludges. These wastes are included in the survey because they may be considered hazardous under the RCRA for the "Toxicity Characteristic" or may be listed as hazardous or may be characteristically hazardous under state law.^a
- Other wastes regulated as "hazardous wastes" solely under state law, but not under the Federal RCRA definition of hazardous waste.

Commercially generated low-level radioactive mixed waste, for the purposes of the National Profile, includes all mixed waste generated by NRC- or Agreement State-licensed facilities that would normally send any LLRW to one of the three existing LLRW disposal facilities. This definition would, therefore, include all generators of mixed waste except the DOE facilities.

Mixed waste generators include NRC- and Agreement State-licensed nuclear facilities and have been defined for this study to be nuclear utilities, medical, academic, industrial, and NRC/Agreement State-licensed government facilities. Individual generators chose the generator category that best described their mixed waste activities when completing the questionnaire. The term "nuclear utility" is equivalent to "nuclear power plant," "power plant," and "nuclear reactor facility" in this report. The "industrial" category includes facilities such as manufacturing, research and development, decontamination and waste reduction, sealed source users, waste brokers, nuclear fuel cycle other than reactors, and commercial radiopharmacies.

1.3 Work Performed

The project consisted of the following eight tasks:

1. Evaluation of existing available information on mixed waste from past surveys conducted by host states, compacts or other parties; summarizing the results; and identifying the lessons learned from past survey reports.
2. Determination of the adequacy of these existing data to estimate and project the volumes, characteristics and treatability of commercially generated mixed waste on a national level.
3. Development of a plan to collect and analyze mixed waste data and the development of a pretest questionnaire.
4. Administration of the pretest, production of the final questionnaire, and completion of the overall survey design.
5. Collection and analyses of mixed waste data.

^aEPA recently published a final decision ~~not~~ to list used oil as a hazardous waste in 57 FR 21524, May 20, 1992.

6. Compilation of a national mixed waste profile.
7. Identification of available treatment technologies to meet applicable EPA treatment standards for Land Disposal Restricted (LDR) wastes and, if possible, to eliminate the hazardous component of specific mixed waste streams.
8. Documentation of the study results in an NRC NUREG report.

1.3.1 Evaluation of Available Mixed Waste Information

Available information on the volumes, characteristics, and treatability of mixed waste were compiled and evaluated. This included:

- A literature search to identify and obtain pertinent sources of mixed waste information. Such information included mixed waste survey reports and survey forms prepared by states, compacts, or other parties. Some information was also obtained from studies in progress and from projects that are, as yet, unpublished.
- An evaluation of current and projected mixed waste inventories, the radiological and chemical characteristics of the mixed waste, and the treatability of the various types of mixed waste to meet Resource Conservation and Recovery Act (RCRA) requirements. An effort was made to distinguish between currently available treatment technologies, newly developed technologies, or technologies that may be available in the near future.
- Identification of the assumptions underlying the projections made in past surveys, such as a state's decision to include certain waste (e.g., waste oils) as hazardous waste under RCRA and how these assumptions affected the results of the study.
- An assessment of the potential that mixed waste streams or volumes that were misreported or overlooked, based on the National Profile development team's knowledge of the operations and activities within the commercial nuclear industry. This assessment addressed the potential for significant volumes of mixed waste being unaccounted for because they were reported under a designation that precludes consideration [such as waste reported as an "asset" (e.g., lead to be reused as shielding)].
- An evaluation of previous mixed waste surveys to determine their applicability to the development of a national mixed waste survey. This included contacting individuals who have conducted past surveys.

Based on the available information at the time this study was initiated (late 1990), the projected (1993-1995) national generation rate for mixed waste was estimated to be ~43,000 ft³ per year. A number of factors were determined to have an impact on the accuracy of the reported

data. These issues included the validity of voluntary surveys, whether waste oils and liquid scintillation fluids were included as mixed waste, the variation in the way individuals filled out the questionnaires, the variation in interpretations of the raw data provided by the surveyed facilities, the variations in time frames for completing the various surveys, the differences in presentation and interpretation of definitions, the different opinions on whether a particular stream is waste or an asset, the uncertainty in when a material becomes a waste, the variations in laws defining mixed waste, and the importance that individual facilities assigned to filling out the survey form accurately.

1.3.2 Evaluation of Adequacy of Existing Information

To determine if the existing data were adequate to estimate and project the volumes, characteristics, and treatability of mixed waste at the national level, the data parameters and an information configuration appropriate for a mixed waste profile were prepared. Existing data were then analyzed individually by compact and/or state to determine their ability to meet these requirements.

This evaluation indicated that the differences in the questions asked, the variation in the definitions and instructions provided, and the attention shown to completing the various questionnaires led to major difficulties in reconciling the data from the various surveys. Thus, it was recommended that a new survey reaching a wide selection of potential mixed waste generators be conducted. Because a great deal of current mixed waste data already existed, although in a wide variety of forms and in varying quality, it was also recommended that the existing data be acquired, where available, summarized, and compared with the results of a new survey.

A national mixed waste generation rate of 51,000 ft³ per year was estimated as the lower baseline for those compacts/states reporting mixed waste generation. See Sect. 4.3.2, Table 4.18 for more information on this projection.

1.3.3 Data Collection Plan

The object of Task 3 was to develop a detailed plan necessary to collect and analyze the mixed waste data for the compilation of the national mixed waste profile. Included in the plan is a statement of the task's objectives, specification of the survey design, and a description of the mixed waste database that was to be developed. The specific parameters for the data collection plan were developed as follows:

- The national mixed waste volumes were to be determined within a factor of 2 for both 1990 annual mixed waste generation rates and the total quantity of mixed waste in storage at the end of 1990.

- The factor of 2 also applied to mixed waste volumes for each of the major facility categories. The major categories consisted of nuclear utilities, medical, industrial, academic institutions, and NRC-/Agreement State-licensed government facilities.
- The radiological characteristics were to include the Low-Level Radioactive Waste (LLRW) Class (A, B, C, etc.), as defined in 10 CFR 61.55, and a listing of the major nuclides present.
- The hazardous waste characteristics were to include the EPA waste codes (D, F, K, P, or U series) and a common name descriptor.
- Information was to be acquired to determine the relationship between mixed waste stream generation and any plans the facility had for reducing or eliminating that waste stream.
- Information was to be acquired on how the various mixed waste streams are presently being treated, stored, and/or disposed of.

The study design specifications were provided by David C. Cox & Associates and are included as Appendix A. A detailed description of the data collection methods employed and the final mixed waste profile are presented later in this report.

1.3.4 Administration of the Survey Pretest

Twenty facilities belonging to the Appalachian Compact Users of Radioactive Isotopes (ACURI), the association of radioactive licensees within the Appalachian Compact, agreed to cooperate in the initial test phase of the national mixed waste survey. These 20 facilities comprised a broad mix of both large and small facilities within each of the major facility categories. Oak Ridge National Laboratory (ORNL) mailed pretest survey forms to each of the facilities on August 16, 1991, and made follow-up visits to 9 facilities. Other than the strong support that the ACURI, through its executive secretary and its board of directors, extended to the mixed waste profile effort and the individual contacts with each of the facilities, administration of the pretest followed the same methodology used for the actual survey.

Based on the data collected, the comments received during actual site visits to ACURI member facilities, and the various discussions among the mixed waste profile team members, the pretest survey questionnaire was modified to enhance its usefulness. The final survey questionnaire is included as Appendix B.

1.4 Generation of the Mixed Waste Profile

A major component of this project consisted of collecting the mixed waste data necessary to compile a national profile on mixed waste characteristics, volumes, and treatability. Detailed descriptions of the data collection methodology are presented in Sect. 3. A compilation and presentation of the national mixed waste profile including estimation procedures, profile description, major facility category and hazardous stream presentations, and a discussion of the usefulness and limitations to the profile are detailed in Sect. 4.

Another important part of this study was the identification of existing treatment capacity for specific mixed wastes reported in the survey. Various types of treatment technologies are evaluated such as incineration, compaction, solidification, vitrification, including other methods that could meet applicable EPA treatment standards and, if possible, render hazardous wastes nonhazardous. Organizations that currently have the capability to treat mixed waste and those that may have future mixed waste treatment capabilities were also reported as part of the analysis.

2 Review of Relevant Regulations Affecting the Mixed Waste Profile

Low-level radioactive mixed waste is regulated under a dual framework created by Congress. The NRC (or NRC Agreement States) and EPA (or EPA authorized states) independently regulate different components of the same waste. The AEA of 1954, as amended, the Energy Reorganization Act of 1974, as amended, and other statutes provide authority to NRC to regulate the possession and use of special nuclear material (fissile materials), source material (the raw materials of nuclear energy), and byproduct material (fission and activation products and uranium mill tailings and associated processing wastes). NRC has the primary responsibility for regulating nuclear power and nonpower reactors, academic institutions, health care facilities, commercial facilities, and Federal facilities such as Veterans Administration hospitals, the National Institutes of Health, and the National Institute of Standards and Technology that use source, special nuclear, or byproduct material. Section 274 of the AEA allows for the discontinuance of certain regulatory authority by NRC and assumption of this authority by the states. States may assume authority for licensing and regulating byproduct materials, mill tailings, source material, and small quantities (less than 350 g) of special nuclear material. An agreement between the Governor of the State and NRC allows states to assume this authority — hence the term “Agreement State.”

EPA regulates the hazardous component of low-level radioactive mixed waste under RCRA. The EPA's authority to regulate the hazardous component of mixed waste was first clarified in

“EPA Clarification of RCRA Applicability to Mixed Waste” (51 FR 24505, July 3, 1986) and was subsequently addressed in “DOE Clarification of the Definition of Byproduct Material” (52 FR 15937, May 1, 1987). The former provided EPA’s legal interpretation of the source, special nuclear, and byproduct material exclusion to the definition of solid waste found in RCRA Section 1004(27) and required authorized states to obtain authorization for mixed waste. The latter, referring only to byproduct material, indicated that only the actual radionuclides, not the entire waste stream, are considered to be byproduct material; therefore, EPA retains authority to regulate the hazardous portion of the waste stream under RCRA.

2.1 Regulation of Low-Level Radioactive Waste

Source, special nuclear, and byproduct material are subject to regulation under the AEA. NRC or NRC Agreement States generally administer the AEA for commercial and non-DOE Federal facilities while DOE regulates radioactive materials at DOE facilities. NRC is responsible for licensing and regulating nuclear facilities and materials and for conducting research in support of the licensing and regulatory process. Activities must be conducted in accordance with the National Environmental Policy Act (NEPA) of 1969, as amended. NRC responsibilities include protecting the public health and safety, protecting the environment, and safeguarding nuclear materials in the interest of national security. Agency functions are performed through: (1) standards setting and rulemaking; (2) technical reviews and studies; (3) conduct of public hearings; (4) issuance of licenses; (5) inspection, investigation, and enforcement; and (6) research (see “Regulating the Disposal of Low-Level Radioactive Waste, A Guide to the Nuclear Regulatory Commission’s 10 CFR Part 61”).

Some radioactive materials such as naturally occurring or accelerator-produced radioactive material (NARM) are not subject to regulation under the AEA and, therefore, are not subject to regulation by NRC. However, NRC does have authority for limited types of NARM, including source material (uranium and thorium) and uranium and thorium mill tailings and associated wastes. NARM waste is currently not identified as hazardous under RCRA; however, it could be because it was not specifically excluded from regulation under RCRA as were other radioactive materials. NARM regulation is primarily a state responsibility, at present, if the State chooses to exercise it.

Low-level radioactive waste is defined in the LLRWPA to mean radioactive material subject to NRC regulation that is not high-level waste, spent nuclear fuel, or byproduct mill tailings and waste, which NRC classifies as low-level radioactive waste. The NRC radioactive waste classification methodology (10 CFR Part 61) is a systems approach to control the potential

dose to people from the disposed waste. The components of the system include the site characteristics, the design and operation of the site, the institutional controls, the waste form, and intruder barriers. The quantity and type of radionuclides permitted for disposal in each class are based on combinations of these various components and on concentrations of radioactive materials that are expected to be in the wastes and that are important for disposal. Three classes are established for routine near-surface disposal: Class A, Class B, and Class C.

Low-level radioactive waste contains short-lived and long-lived radionuclides. Three important time intervals are relied on in setting the waste classification limits. One is the length of time the government will actively control access to the site (100 years). The second is the minimum stability of the waste form (300 years). The third is the expected lifetime of engineered barriers or assured burial depth (for intruder protection) and the time when total failure of the waste form is assumed to occur (500 years). Concentrations of short-lived radionuclides permitted in the waste are higher than concentrations of long-lived radionuclides, because the short-lived nuclides will significantly decay during the 100 years of assumed institutional controls. Shorter-lived nuclides will also significantly decay during the 300-year design lifetime of stabilized wastes. The limits are further set so that at the end of the 100-year institutional control period, no active site controls or maintenance are needed, and so that at the end of 500 years, no reliance on engineered features or waste form are needed for intruder protection. The limits specified for both short- and long-lived radionuclides ensure that the performance objectives will be met. Details of the concentration limits that define waste form classification as either A, B, or C are contained in 10 CFR 61.55.

Any class of radioactive waste that contains a hazardous waste as defined in RCRA is considered mixed waste. The radioactive component of commercial mixed waste is generally low-level radioactive waste and is the only area of concern for this study.

2.2 Regulation of Hazardous Waste

RCRA and HSWA set the regulatory framework for hazardous waste. Subtitle C of RCRA established the regulation of hazardous waste from generation through its ultimate disposal ("cradle-to-grave"). RCRA defines solid waste as "any garbage, refuse, sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities". Solid waste, however, does not include "source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954..." [RCRA Section 1004(27)]. As indicated above, EPA, NRC, and DOE

interpret the exception for source, special nuclear, or byproduct material as referring only to the radioactive component of the waste, and not to the entire waste mixture. Thus, AEA regulations apply only to the radioactive components and, if the waste contains RCRA hazardous waste components, the waste also becomes subject to regulation under RCRA.

HSWA amended RCRA significantly. A key element of HSWA is the LDR program which restricts the land disposal of hazardous wastes, including mixed wastes, unless a waste meets EPA treatment standards or a "no-migration" determination has been made for a specific site. The LDRs initially applied to waste listed or identified as of November 8, 1984, under RCRA. They now also cover several hazardous wastes listed after November 8, 1984, for which treatment standards have been developed. Treatment standards exist for hazardous waste that contains solvents (F001 to F005) dioxins (F020 to F023 and F026 to F028) and California list wastes (halogenated wastes, certain metal-bearing wastes, polychlorinated biphenyls, cyanide, and corrosive wastes). EPA deferred issuing treatment standards for most radioactive waste mixed with scheduled hazardous waste (i.e., all wastes listed as of November 8, 1984, which are described in the First, Second, and Third Third rules; 53 FR 31137, August 17, 1988; 54 FR 26594, June 23, 1989; and 55 FR 22520, June 1, 1990) and that are not solvents or dioxins, or California list waste until the promulgation of the last scheduled LDR rule on May 8, 1990 (the Third Third rule). After May 8, 1990, all mixed wastes falling into the above categories of waste were restricted from land disposal. However, for all mixed waste described in the First, Second, and Third Third rule, EPA granted a two-year national capacity variance based on the lack of treatability capacity. This variance (which expired on May 8, 1992) delayed the imposition of the LDR treatment requirements for land disposal of mixed waste until the expiration date. Storage of these restricted wastes is also prohibited after May 8, 1992 (with a very few exceptions) unless storage is for the sole purpose of accumulating sufficient quantities in a tank or container to facilitate proper recovery, treatment, or disposal of the waste (see 40 CFR 268.50, the storage prohibition). Under the LDR, the RCRA-regulated hazardous portion of mixed waste must meet the appropriate treatment standards for all applicable waste codes before land disposal (in the absence of a "no-migration" determination). Mixed waste for which adequate treatment capacity is not available must be stored in accordance with all RCRA storage requirements until treatment capacity becomes available (although such storage may constitute a violation of the LDR storage prohibition) or a site-specific variance from the treatment standard (40 CFR 268.44) is granted. Currently, a capacity variance is in effect for mixed waste that contains certain newly listed wastes (57 FR 37194, August 18, 1992) and debris and soil contaminated with mixed waste (57 FR 47772, October 20, 1992).

2.3 State Regulations

RCRA allows for the delegation of authority of the Federal regulatory program to the states. The AEA allows for the discontinuance of certain regulatory authority by NRC and assumption of this authority by the states. NRC-granted Agreement State status and EPA-authorized RCRA state programs implement the regulatory programs. In certain cases, state regulations may include provisions more stringent than the applicable Federal regulations.

2.3.1 Low-Level Radioactive Waste in Agreement States

Twenty-nine states have signed agreements with NRC (under Subsection 274b of the AEA), enabling the various "Agreement" States to regulate the use of source, special nuclear (limited quantities), and byproduct material within their boundaries. This applies to all radioactive material except that from nuclear utilities and fuel cycle facilities (regulated by NRC) and DOE facilities (regulated by DOE). Each "Agreement" provides that the state will use its best efforts to maintain continuing compatibility with the NRC's regulatory programs. States that plan to license new disposal sites must adopt most of the provisions of 10 CFR Part 61 to maintain compatibility. All Agreement States must adopt the manifest system in 10 CFR Part 20 to cover waste generators in the state. NRC maintains a continuing relationship with each Agreement State to ensure continued compatibility; however, states are independent regulatory authorities under the agreement. In making licensing decisions, states may take local conditions such as weather or public opinion into account as long as the program remains compatible and adequate to protect the public health and safety.

2.3.2 Hazardous Wastes in Authorized States

The Federal RCRA program was developed to be implemented primarily by the states, with EPA oversight. A state must develop a program that is equivalent to, no less stringent than, and consistent with the Federal program. State programs may be more stringent than their Federal counterpart. Once authorized, the state has primary responsibility for implementation and enforcement of RCRA requirements within its boundaries. Authorized state programs operate in lieu of the Federal RCRA program, although EPA retains oversight and residual enforcement authority. EPA administers the Federal RCRA program in unauthorized states. In addition, EPA administers HSWA requirements (e.g., LDRs) in all states until they are authorized for these provisions.

A state authorized for the RCRA program may choose to define additional wastes as hazardous under its state hazardous waste program. Maryland, for example, even includes radioactive materials on its hazardous waste lists.

2.3.3 Authorization for Mixed Waste

EPA has formally clarified its position that the hazardous component of mixed waste is subject to RCRA regulation (see 51 FR 24504, July 3, 1986). In the notice, EPA called for authorized states to revise their authorized programs and incorporate the authority to regulate the hazardous components of mixed waste. States authorized for the base program (pre-HSWA) were allowed a maximum of 2 years from the promulgation of the notice to incorporate the mixed waste authority (i.e., until July 3, 1988). The July 1988 deadline was extended one year. As of September 30, 1992, authorization for mixed waste authority has been given to 31 states and 1 territory (Guam). In those states that are authorized for RCRA's base program but which have not received mixed waste authority, mixed waste is not subject to RCRA hazardous waste regulations, including the land disposal restrictions until the state is authorized for mixed waste.

At present there are 15 states (Alabama, Arizona, Delaware, Maine, Maryland, Massachusetts, Missouri, Montana, New Hampshire, New Jersey, Pennsylvania, Rhode Island, Vermont, Virginia, and West Virginia) authorized for base RCRA but not authorized for mixed waste. According to a recent EPA guidance document Federal restrictions for mixed waste disposal are not applicable in these states. In fact, mixed waste may not even be defined or regulated as hazardous waste in these states. However, it does appear that facilities in most of those states in this category treat mixed waste as if it was regulated under RCRA. In those states that are not authorized for RCRA's base program and in states authorized for mixed wastes, the RCRA land disposal restrictions are in effect.^b

3 Collection of Mixed Waste Data

3.1 Objective

The primary objective of the joint NRC- and EPA-sponsored project under Tasks 5 and 6 was to collect and analyze the data reported on the survey questionnaire (see Appendix B). The data collected supported the development of the national mixed waste profile.

^b"Guidance on the Land Disposal Restriction's Effects on Storage and Disposal of Commercial Mixed Waste," Office of Solid Waste and Emergency Response (OSWER) Directive No. 9555.00-01, September 1990.

3.2 Collection Methods

A preliminary letter (drafted and cosigned by NRC and EPA and included in Appendix B) was mailed to all the compacts and their member states, to each of the unaligned states, and also to all NRC licensees. The letter informed them of the purpose of the survey and requested their aid in helping to ensure that the compilation of the national survey would be a meaningful and credible undertaking. In addition, a number of industry groups volunteered to support and disseminate information on the survey.

Based on the study design specifications detailed in Appendix A, 1,323 facilities were randomly selected, from among 2,936 facilities with a high potential to generate mixed waste, to receive mixed waste surveys. These facilities were sent the mixed waste questionnaire in early November 1991. A formal survey monitoring procedure was established that included a survey questionnaire return tracking system and a system that allowed for follow-up call documentation.

By the end of December 1991, only 190 surveys had been returned. At that time, a series of phone calls began, by trained data collection specialists, to those facilities that had not yet returned their surveys. These calls were implemented to encourage the facilities to participate in the survey, to offer any assistance required to fill out the survey or, if necessary, to acquire any survey information over the telephone. Generally, the latter approach was used only for those facilities that indicated they generated little or no mixed waste. Initial procedures called for five telephone attempts to contact a cognizant person responsible for completing the questionnaire. In a number of cases, additional telephone contacts were attempted before a data collection specialist discontinued his or her effort to obtain a survey response from a specific facility.

By the end of April 1992, ORNL had received 995 questionnaires. An additional 21 facilities were determined to no longer be in business. Survey respondents and those facilities that were no longer in business accounted for the approximately 77% return-resolution rate (completed surveys/questionnaires sent out).

3.3 Data Collection

As questionnaires were received at ORNL, they were noted on the master list of surveyed facilities. All data were initially checked by a principal investigator for obvious errors and inconsistencies, misinterpretation of instructions, incomplete data, and clarifications. In general, all data from the survey questionnaires were included in the database. A number of exceptions to this procedure occurred when facilities inadvertently left out a waste code, description, or stream number. Obvious errors were corrected where appropriate. Responses that required clarification were followed up with a telephone call to the responding facilities. Minor inconsistencies and/or

gaps in information were not usually corrected due to the large number of questionnaires that were returned to ORNL.

One major exception to the above procedure occurred during the survey. One facility reported that it generated three waste streams with a total of over 2,000,000 ft³ of liquid mixed waste generated in 1990. Checking with this facility confirmed that these entries were valid. However, it was decided not to include these three waste streams in the database because (1) they appeared to be generated from a one-time event which is not likely to be repeated; (2) the facility has petitioned the state to have the streams delisted and, if successful, they would no longer be considered mixed waste; and (3) inclusion of these streams would invalidate the statistical interpretation of the mixed waste database and prevent its usefulness as a predictive tool for the nation as a whole. This response, however, indicates a large potential variability in the generation rate of mixed waste by specific facilities.

3.4 Data Processing

An initial data cleaning process identified and categorized the major mixed waste streams [e.g., liquid scintillation fluids (LSFs), oil, lead, etc.). Any unclassified waste streams were entered into an "unassigned" category until further classification. Daily activity reports were printed and proofread. Trend analysis was also employed as a data integrity check after the data were entered into the database. This entailed the listing of records that did not fit the norm for selected criteria. The abnormal records were then compared with the data in the original questionnaires and either confirmed or corrected. Variations of reports, using a variety of category breakouts, were made and compared to ensure congruity in the totals. "Smart" algorithms were used to seek out orphaned data records that did not match valid facility or stream identification numbers. This aided in the double-checking for data entry errors. Original questionnaires were retained for future reference.

3.5 Database Description

An analysis of the questionnaire indicated that several relational data files were necessary to include all of the available data while maintaining data integrity. The personal computer-based commercial software, FoxPro, was selected as the database program because of its versatility. The data from each questionnaire were organized into nine subfiles based on the format of the questionnaire and linked together through the use of an identification code (IDNUMBER) unique for each queried facility. This organizational structure provides for the separation of exact and

range data and enables the data to be used independently in summations and statistical calculations. Comment fields were included throughout the database for additional information that may be needed to clarify the data. The database contains the responses from 1,016 facilities that use a total file length of about 15 MB. Specific descriptions and contents of the data subfiles and definitions of the fields within the subfiles are given in Appendix C.

3.6 Data Tabulation

The reports generated were tabulated using several classification schemes. The main tabulation was based on how the facility identified itself. Other classifications used the "GROUPID" field (LSF, oil, organic, etc.) to subdivide the waste streams in the tabulations. An "Other" category was added to the Waste Stream classification to account for two types of wastes—those containing multiple types or mixtures of hazardous wastes and unique waste streams such as lead contained in a "freon" mixture. Table D.11, Appendix D, lists all the "Other" mixed wastes that were reported as being generated in 1990. Classification by compact (group of states) was also done, with the nonaligned states tallied individually.

3.7 Disposition of Original Data

Mixed Waste Survey participants were ensured of the greatest confidentiality possible. The joint letter from the sponsors (see Appendix B), NRC and EPA, indicated the data were not being collected for any enforcement purposes. ORNL was directed **NOT** to provide the identities of any of the survey respondents to NRC or EPA "unless a future development involving the protection of the public health and safety and the environment," warrants it. "Except as outlined above, data and results from the survey will only be provided to NRC, EPA or other groups or individuals, as approved in writing by the NRC Office of Nuclear Material Safety and Safeguards (NMSS) Project Manager, in an aggregated format, stripped of any specific licensee identifiers." "At the conclusion of this project, ORNL will retain all raw data that contains facility identification information (e.g., completed survey forms, follow-up call notes and records, records of interviews with specific facilities, etc.) regardless of the form of the record (e.g. hard copy, computer disk, etc.) for 7 years. Seven years after completion of this project, ORNL will destroy this information."

4 National Mixed Waste Profile

4.1 Estimation Procedures

4.1.1 Survey Design Objectives

The objective of this project was to compile a profile of national commercial mixed waste volumes to within a factor of 2 (with 95% confidence limits) for both 1990 annual mixed waste generation rates and, if possible, the total quantity of mixed waste in storage at the end of 1990. This factor of 2 also applied to mixed waste generation rates for each of the major facility categories. The categories include nuclear utilities, medical, academic, industrial facilities, and NRC/Agreement State-licensed government facilities. Based on these objectives and the necessity of limiting the survey of facilities to a manageable level, limitations were placed on the numbers and characteristics of those facilities chosen to receive the survey questionnaire.

4.1.2 Selecting the Frame

Those facilities that were deemed suitable for investigation in this study were facilities having the potential to generate low-level mixed waste. Four different strata were used to identify these facilities and are defined as follows:

- **ORNL List.** This stratum is a list of 444 facilities which was compiled by ORNL. It includes all nuclear utilities and other facilities which have been designated by ORNL as likely generators of mixed waste. Possible reasons for the inclusion of particular facilities in this stratum were their appearance on a list in a governor's certification (pursuant to the LLRWPA of 1985 as amended, certification by the governor of the intent of the state to safely manage LLRW generated within its borders) or on a compact/state survey as having generated, or having the potential to generate, mixed waste.
- **Shipper's List.** This stratum contains all 1990 shippers of LLRW (to any of the three commercial burial grounds) who do not already appear on the ORNL list.
- **NRC Potential Mixed Waste Generators with EPA Permits.** This list includes those facilities having NRC licenses and Material License Program Codes which have a high potential for generating mixed waste and have an EPA Permit to treat, store, or dispose of hazardous waste, or have an EPA identification number. The codes defined as having high potential for mixed waste generation are shown in Table 1, Appendix A.
- **NRC Potential Mixed Waste Generators without EPA Permits.** Same as above but without an EPA permit.

The likelihood that any given facility generates mixed waste depends on the actual processes and materials in use at the facility. After duplicate names were removed from the lists described above, approximately 2,936 facilities were finally estimated to be in the 4 strata. These are defined as the overall universe or entire population of interest.

Two groups of potential mixed waste generators were not included in the survey target population. The first are those that have NRC licenses and Material License Codes which were determined not to have a high potential for generating mixed waste because of the nature of the licensed activity, such as private doctor's offices. The second are those facilities in NRC Agreement States and not on the ORNL list or the shipper's list. The first group was not included in the survey target population because of a low potential for generating mixed waste and its size (only 6,000 facilities). The second group was not included because of a low potential for mixed waste generation, the lack of facility names and addresses, and for its large size (~16,000). The size of a group was, however, a secondary factor in both of these exclusions.

4.1.3 Selecting the Sample

Based on the objectives of the study as outlined previously, a sample size determination was made using the number of facilities in each of the population substrata, estimates for the means and variances of the total volume of mixed waste within each of the substrata, and the accuracy requirements of the survey. Estimates for the means and variances were based on several compact surveys completed prior to this study. The actual detailed discussion of the final sample size for each substratum is discussed in Appendix A.

Potential generators of commercial mixed waste were grouped into 17 substrata (groups), as shown in Exhibit 5 of Appendix A, based on the type of facility (nuclear utility, medical, academic, industrial facilities, or NRC/Agreement State-licensed government facilities) and whether they were on the ORNL List, the Shipper's List (excluding those on the ORNL List), or NRC licensees either with or without EPA permits. From each substratum and independently of the other strata, a simple random sample of facilities was selected. For nine of the substrata, all facilities within the substrata were selected for the sample.

As indicated in Table E.6 of Appendix E, the overall sample size was $n = 1,323$ facilities selected from an estimated overall universe of approximate size $N = 2,936$ facilities. Details on the precision requirements for determination of sample size are given in Appendixes A and E.

4.1.4 Weighting of Sample Data and Estimation of Total Volumes

Each respondent facility was assigned to only 1 of the 17 substrata as indicated in Sect. 4.1.3. The sampling weight for an individual respondent depended on the substratum in which it was originally assigned. This weighting factor was computed by dividing the estimated number of

facilities in its assigned substratum by the number of sample respondents, including the number of sample facilities that reported that they were out of business. For example, of 165 academic facilities on the Shipper's List and not on the ORNL List, 111 survey responses were received, and no facilities were found to be "out of business." Thus, the sample weight for this substratum is computed to be $165/111 = 1.4865$. The other sampling weights used are given in Table E.7 of Appendix E and range from a low of 1.026 to a high of 31.5. In other words, these numbers indicate that each response from these facilities represent anywhere from 1.03 to 31.5 other facilities in the same substratum.

The estimate of a total volume, $\hat{T}_D$, of a particular waste for any specific collection of facilities, D, in the entire universe was computed as follows. First, each sample respondent included in the specific collection of facilities (D) was identified. The reported waste volume for each sample respondent belonging to collection D was then multiplied by the appropriate sampling weight. The sum of all such products for sample respondents from D gave the estimated total volume, $\hat{T}_D$. The collection of samples, D, can be any collection desired such as all industrial, medical in state "X", etc. More details on estimation and the computation of selected standard errors (s.e.) are given in Appendix E.

4.1.5 Expected Accuracy and Precision of Survey Results

As discussed in Sect. 3.3 of Appendix A, the sample sizes for each of the 17 substrata were determined with the goal of achieving a relative standard error (r.s.e.) of 10% for the national estimate of the total volume of waste generated. While the final sample sizes selected greatly exceeded sample sizes necessary to provide estimates within the desired accuracy factor of 2 (as described in Appendix A), the selected sample sizes provide a significant factor of conservatism in the survey design and allow for nonsampling error. This nonsampling error reflects how accurately the completed questionnaire represents reality and is not related to the statistics involved in choosing the sample size or to the number returning the questionnaire. The estimated r.s.e., for sampling error only, that were realized are given below:

Category	Estimated relative standard error	
Academic	10.5%	(=3,055/28,982)
Government	22.6%	(=5,978/26,500)
Industrial	22.6%	(=11,414/50,430)
Medical	14.7%	(=2,928/19,904)
Nuclear utilities	5.2%	(=703/13,625)
<hr/>		
National	9.7%	(=13,579/139,441)

Note that each estimated r.s.e. given above is obtained from Table 4.3 by dividing the estimated s.e. by the estimated total volume generated. Four of the five r.s.e. exceeded the desired goal of 10% (only a goal used in estimating sample size); however, the r.s.e. for the estimated total commercial mixed waste generated in the country (9.7%) is almost equal to the desired goal. [Computed as the square root of the sum of the individual group variances (the square of the indicated s.e.) divided by the estimated total volume of mixed waste generated.] Based on the conservative sampling design of the survey as discussed above, the final results obtained at the national level are well within desired accuracy of a factor of 2 for both sampling and nonsampling errors.

4.1.6 Approximate 95% Confidence Intervals

Using the notation of Sect. 4.1.4, s.e. $\hat{T}_D$ is the estimated s.e. of the estimator $\hat{T}_D$. Assuming that the estimator $\hat{T}_D$ has a normal distribution, an approximate 95% confidence interval for $\hat{T}_D$ is given by:

$$\hat{T}_D \pm 1.96 [\text{s.e.}(\hat{T}_D)] .$$

Approximate 95% confidence intervals for the total volume generated in the United States and for the total generated waste for each major category are given below:

Category	Approximate 95% confidence interval
Academic	22,994 — 34,970
Government	14,775 — 38,209
Industrial	28,059 — 72,801
Medical	14,165 — 25,643
Nuclear utilities	12,247 — 15,003
National	112,818 — 166,048

From the above data, one may conclude that "we are approximately 95% confident that the actual total national volume of commercial mixed waste generated in 1990 is between 113,000 ft³ and 166,000 ft³." Similarly, it can be said that "we are approximately 95% confident that the actual total volume of commercial mixed waste generated in 1990 by academic facilities is between 23,000 ft³ and 35,000 ft³."

4.1.7 Limitations of Survey Design

As discussed in Appendix A, the sampling plan (including sample sizes) was designed to provide conservative estimates of the total volumes of mixed waste at the national level for each of the five facility categories. Reliability of the estimates at these levels are reflected in Table 4.3 and Sects. 4.1.5 and 4.1.6.

Estimates of mixed waste volumes calculated at the compact/state level are far less reliable, mainly due to fewer samples in these substrata. For this reason, estimates of mixed waste volumes and generation rates for individual states and compacts should be used with great caution.

4.2 Description of the National Commercial Mixed Waste Profile

The National Profile on Commercial Mixed Waste is a statistically based estimation of the 1990 generation rates and volumes of commercially generated mixed waste. The amounts of mixed waste generated in 1990 and in storage as of December 31, 1990, for the National Profile was estimated by examining the responses to 1,323 questionnaires (see Appendix B) which were sent to a broad spectrum of potential generators of mixed waste on November 1, 1991. The responses of 1,016 facilities (77% response rate) were entered into a 1,016 by 15 KB (a total of 15 MB) database from which the National Profile was estimated employing weighting factors described in Sect. 4.1.4.

4.2.1 Facility Categorization

Five broad categories of generators of mixed waste were established which included academic, industrial, medical, NRC/state-licensed government facilities, and nuclear utilities. These were then subdivided by size, functionality, type of business and, if applicable, type of reactor. Illustrated in Table 4.2 are the five generalized categories as they were subdivided showing the number of questionnaire responses received in each subcategory.

In addition to categorization, the questionnaire asked the respondents to indicate their EPA facility classification, if possible. A total of 616 responses were obtained to this query. Large quantity generator status (>1,000 kg/month) was indicated by 216 facilities and small quantity generator status (100 to 1,000 kg/month) was designated by 186 facilities. Also, 82 facilities reported that they were conditionally exempt small quantity generators (<100 kg/month), and 132 facilities indicated they had no EPA classification.

4.2.2 Low-Level Radioactive Waste (LLRW) Stream Descriptions

Section B of the questionnaire (see Appendix B) requested information on the amount of class A, B, or C LLRW shipped either to a broker or directly to one of the three burial sites

(Hanford, WA; Beatty, NV; Barnwell, SC). The amount of LLRW reported by the respondents is discussed in Sect. 4.3. Also requested were data on LLRW stream number, a coded number indicating the type of LLRW from a listing of 26 different potential waste streams shown in Attachment 1 of the questionnaire (Appendix B, p. 1-1 and 1-2) and a waste stream name together with the generating practice yielding the waste stream. The same information was also requested on stored waste. The responses to the LLRW stream number and name request were not provided by all facilities. Some respondents reported in detail on this information while others often neglected it entirely or were very cursory in their responses.

4.2.3 Estimated Mixed Waste Generation Rates by Facility Category

The results of the National Profile are presented in Table 4.3. Column 1 of Table 4.3 details the total mixed waste generated during 1990 by facility category as reported by the 1,016 respondents to the survey questionnaire. Note that the generation volumes reported by the academic, industrial, and NRC/Agreement State-licensed government categories were approximately equivalent and equaled 71% of the generated mixed waste reported for 1990. However, the weighted data in column 2, representing the estimated national generation rate for each category, indicate a somewhat different picture. The previous three categories are projected to have generated nearly 76% (106,000 ft³) of the total mixed waste; however, the industrial category is projected to have produced more than 36% (50,000 ft³) of the total 140,000 ft³ in the United States in 1990. The large differences between “as reported” data and projected generation rate are due to the large number of facilities in the survey frame in the industrial category coupled with a relatively small sample size within critical groups (see Sect. 4.1.4 for a discussion on weighting factors). It is interesting to note in Table 4.3 that the estimated total generation of mixed wastes by nuclear utilities is <10% (~14,000 ft³) of the total commercial mixed wastes generated in the United States.

4.2.4 Stored Mixed Wastes by Category

Amounts of mixed waste stored as of December 31, 1990, listed by category, are depicted in Table 4.4. Facilities returning the questionnaire reported 44,000 ft³ in storage as of December 31, 1990. Applying the weighting factors developed in Tasks 5 and 6 yields a national volume of 75,000 ft³.

On an “as reported” basis, nuclear utilities have the largest amount of mixed waste in storage. However, the estimated amount in storage for the industrial category, after application of weighting factors, is nearly twice the amount estimated for nuclear utilities. This is because the weighting factors for the latter category are very close to 1 since all of these facilities were contacted and the response rate was over 97% (76 of 78). Not all of the stored mixed waste

reported was untreatable. In fact, some of it was awaiting accumulation of sufficient quantities before being shipped to off-site treatment facilities (e.g., liquid scintillation wastes). **It should be noted that treatment and storage data in Tables 4.11 through 4.16 are not necessarily horizontally additive since waste in either category may have been generated prior to 1990.**

4.2.5 Mixed Waste That Currently Cannot Be Treated

Mixed waste that currently cannot be treated represents waste that may be difficult, or even impossible, to dispose of because of a lack of acceptable treatment capability or disposal capacity. Two categories, NRC/Agreement State-licensed government and nuclear utilities appear to have the largest amount of untreatable waste [69% of the reported and 59% of the projected total (about 4,800 ft³) of these wastes] as shown in Table 4.5. Chlorinated fluorocarbons (CFC), reported by nuclear utilities, account for over 23% (866 ft³) of the "reported" mixed waste designated as untreatable with present technology and about 18% (889 ft³) of the estimated wastes requiring ultimate disposal. The generation of these wastes should be decreasing rapidly as substitute materials are used and laundries serving nuclear utilities rapidly shift to aqueous-based clothes washing facilities. Not all respondents to the mixed waste questionnaire reported on their treatment options, and some of their untreatable waste may have gone directly into storage. Therefore, the estimate of 4,838 ft³ reported in Table 4.5 may be an underestimate of the total amount of untreatable mixed waste generated in 1990.

Upper and lower bounds can be set on the volume of mixed waste that currently is untreatable. Assuming that LSF, oils, organics (not halogenated), and corrosive wastes are treatable under currently available technologies and deducting them from the estimated national total mixed waste generation rate leaves ~18,500 ft³ of untreatable mixed waste. Thus, with this as an upper bound and the ~5,000 ft³ mentioned above as a lower bound, the untreatable mixed wastes range from 3.5 to 13.3% of the estimated 1990 national generation rate of about 139,000 ft³. Please note, however, that the capacity to treat all so-called "treatable" mixed waste in this report may not be available.

4.2.6 Types of Mixed Wastes Reported

In excess of 62% of the mixed wastes reported as generated during 1990 consisted of LSF wastes. After application of the statistical weighting factors (see Sect. 4.1.4), the scintillation fluid wastes were estimated at nearly 72% of the total projected generation of commercial mixed wastes in the United States. In contrast, the estimated generation rates for waste streams such as mercury-containing or cadmium-containing streams are very small as indicated in Table 4.6. Illustrated in Fig. 4.1 is a summary of the various types of waste streams reported as generated by

the five major facility categories. In addition, a mixed waste stream of appreciable size, not shown in Fig. 4.1, is a stream labeled as "Other" in Table 4.6. This waste stream, representing 7.5% of the projected mixed waste generation, has multiple hazardous components and cannot be delineated as a single waste stream. A detailed breakout of the contents of this "Other" category is contained in Table D.11 of Appendix D.

Table 4.7 is a detailed breakdown of the amounts of the various types of mixed waste in storage as of December 31, 1990. (This is the same breakdown of waste types as shown in Table 4.6.) It depicts significant quantities of cadmium-containing wastes (35% of projected waste in storage) being stored by industrial facilities and CFC-containing wastes being stored by the nuclear utilities (11% of projected waste in storage).

Table 4.8 details the amounts, by waste-stream type, of mixed wastes designated as untreatable by currently available technologies. The two major waste streams in this category are used scintillation fluids and the "Other" types of mixed wastes (21.6% and 22.9%, respectively). The scintillation fluids reported here are considered untreatable because they contain isotopes that cannot be burned either on- or off-site due to license restrictions on the available combustion units.

4.2.7 Estimated Mixed Waste Generated by Compacts and Unaligned States

In order to implement the Low-Level Radioactive Waste Policy Act of 1980, 43 states organized themselves into nine compacts primarily to consolidate their disposal efforts for LLRW. These nine compacts and their member states are listed in Table 4.9. The remaining seven states, the District of Columbia, and Puerto Rico are not aligned with other states and are, essentially, "on their own" to responsibly dispose of LLRW and mixed waste. Listed in Table 4.10 are the categorized estimated generation rates for mixed waste tabulated by compact and unaligned state (including the District of Columbia and Puerto Rico). In interpreting the data shown in this table, please review Sects. 4.1.6 and 4.1.7 regarding the statistical validity and cautions in interpreting these survey data. To aid the reader in assessing Table 4.10, the number of respondents from each compact and unaligned state is also shown. Of interest is the fact that the Appalachian Compact appears to be the largest generator of mixed waste among all the compacts and unaligned states.

4.2.8 Detailed Profile Description by Individual Category

Depicted in Tables 4.11 through 4.15 are detailed listings of estimated waste generation rates by waste type, treatment (on-site, off-site), amount destined for ultimate disposal, and amount in storage for each of the five categories. Depicted in Table 4.16 are similar data for the entire survey (not broken down into categories).

4.3 Profile Validation

4.3.1 Comparison with Manifest Data on Low-Level Radioactive Waste (LLRW)

Very accurate data exist on the shipments of LLRW to the three burial sites in the states of Washington, Nevada, and South Carolina and are based on actual manifests of shipments received at these sites. Comparisons of the LLRW shipped by the various facilities (responses to B-1 in the Questionnaire, Appendix B) with the manifested waste received at the three burial grounds provide a measure of validation concerning the completeness of the survey. The Integrated Data Base (IDB) Program at ORNL, an official DOE database on national radioactive waste, publishes annual data on shipments of LLRW to the three burial grounds. Illustrated in column one of Table 4.17 are the total 1990 LLRW shipments to the three burial grounds listed by compact (nine) and unaligned states (eight and the District of Columbia). Listed in column two of this table are the total volumes of LLRW reported as shipped off site in 1990 by the respondents to the National Profile questionnaire by compact and unaligned state. Generally, many of these shipments from individual facilities will pass through a broker who will treat, combine, or otherwise compact individual packages prior to shipment to a burial ground. Therefore, one might expect the raw totals at the originating point (as shown in column two of Table 4.17) to be somewhat higher than those listed from the manifests at the three burial sites. As indicated in the table, the total LLRW as reported by the respondents is only 1.3% less than that determined from records at the three burial sites for the IDB report. Applying the statistical weighting factors, based on number in the frame and the number of responses in the various categories, yields the projected total shipments of LLRW on a national basis. This total is ~38% greater than that reported in the IDB annual report. You will note in comparing numbers for individual compacts, that in some instances the weighted numbers for LLRW are in reasonable agreement with those listed in the IDB report (e.g., for the Southwestern and Southeast Compacts). In other instances, for example the Appalachian and Midwest Compacts, the weighted data are much higher than listed in the IDB report. **Such differences may illustrate the fact that because this survey was designed as a national survey caution must be employed in interpreting the data in ways other than those for which the survey was designed.** However, the comparison of actual and estimated low-level radioactive waste, from Table 4.17, indicates that the responses to this survey represent a fairly complete sampling of potential mixed waste generators across the United States.

4.3.2 Comparison with Existing Data on Mixed Waste Generation

Illustrated in Table 4.18 is a summary of existing mixed waste generation data gleaned from various 1990-1991 sources including Governor's Certifications compact/state low-level waste surveys and compact/state mixed waste surveys. These data are compared to unweighted and

weighted generation data as determined from the ORNL survey for the National Profile of Mixed Waste. These older data, in general, represent conditions existing during 1989. However, because of their inconsistencies, it was decided that a new national survey, having a defensible statistical basis, should be performed. The most complete data on mixed waste generation found prior to undertaking the National Survey were from the Southwest Compact; reasonable agreement is found between the 1990 projected generation rate of 16,515 ft³ and the 1989 rate of 21,156 ft³ as determined by a survey of potential mixed waste generators in that compact. Good agreement is also noted for the unaligned state of New York. However, with the exceptions of the Southwest Compact and the two unaligned states of New York and Texas, the current survey data show much higher generation rates for mixed waste than was indicated by the existing data for 1989. This may be due to inconsistencies found between previous surveys in locating and questioning of potential mixed waste generators. In addition, previous mixed waste surveys were primarily focused on the generation and shipment of LLRW rather than on mixed waste management.

5 The Treatability of Mixed Waste

The objective of Task 7 was the identification of existing treatment capability for specific mixed waste streams identified in Sect. 4.2 and Appendix D. Various types of treatment technologies such as incineration, compaction, solidification, vitrification, or other methods that could meet EPA treatment standards and, if possible, to render hazardous wastes nonhazardous were evaluated. Organizations that currently have the capability to treat low-level radioactive mixed waste, as well as the services these organizations can provide for the treatment of mixed waste, are also identified. For the purposes of the National Profile, an organization is considered to have a treatment capability for mixed waste if that organization has a process that:

1. has been technically demonstrated;
2. has the necessary permits or approvals; and
3. has sufficient approved operating capacity so as to enable a generator to anticipate treatment of his/her waste in a reasonable time frame.

Waste streams, generated nationwide as identified in Sections 4.2 and Appendix D, along with best demonstrated available technologies (BDAT) for their treatment, were examined. This section matches these treatment technologies with each waste stream and also describes treatment services available nationwide for low-level radioactive mixed wastes. A comparison is made of the

availability of treatment services with the demands indicated by mixed waste generation rates and inventories based on the national profile.

5.1 Source of Information

The categories, characteristics, and amounts of mixed waste used in Sect. 5 are based on waste volumes outlined in Sect. 4.2 and Appendix D. Volume distributions by waste category are derived from the database of information provided by a collection of 1,016 completed surveys to the questionnaire (see Appendix B). Further details about the database are contained in Appendix C.

5.2 Characteristics of Mixed Waste

Commercial low-level radioactive mixed waste in the United States consists of a variety of waste streams from a range of sources. Generators of mixed waste include facilities in the government, academic, and industrial sectors, as well as nuclear utilities and medical facilities. Mixed waste generation in the United States for 1990 is estimated at about 140,000 ft³ (see Sect. 4.2). The mixed waste generated in 1990 covered a broad spectrum of waste types. Table 5.1. shows these categories, along with the volumes generated, amounts stored, primary hazardous constituents, prevalent isotopes, and sources for mixed waste generated in the U.S. in 1990. The distributions of volume and storage by waste category are depicted in Figures 4.3 and 4.5, respectively. The waste types observed are consistent with mixed waste streams identified in other studies.¹⁻³

The LSF category is by far the largest mixed waste generation category, comprising nearly 72% of the total estimated volume. Although the largest, in terms of generated volume, the LSF category does not, in general, currently pose a significant treatability problem, nor is it expected to in the future because of the adequate amount of commercial treatment capacity that currently exists and the increasing use of substitute materials. The largest volumes of waste in storage as of December 31, 1990, are cadmium and LSF (see Fig. 4.5). Some LSF wastes undergo substantial radioactive decay in storage (e.g., waste containing ¹²⁵I, ³²P, or ³⁵S) reducing or eliminating the radiological hazard, but most LSF in storage is being accumulated for future shipment and/or treatment.

Waste categories (Table 5.1) fall into four general classes — those with organic constituents, those with hazardous metals, aqueous corrosives, and an “Other” category containing complex mixtures and those wastes for which the hazardous constituent could not be determined from available data. The organics class is broken down to include LSFs, various organohalides, and a category to include the balance of organic constituents not covered by the other categories.

Similarly, the metals class is subdivided into categories for cadmium-, chromium-, lead-, and mercury-contaminated wastes.

In addition to the large quantity of LSFs discussed previously, organic chemicals found in mixed waste include chloroform, trichloroethane, methylene chloride, waste oils, CFCs, and other chlorinated organics used in research or as pesticides. CFCs are derived from dry cleaning, refrigeration, and other industrial operations. Waste oils are derived from vacuum pumps, other equipment and maintenance operations.

Mixed waste containing metals are generated through decontamination of lead used as shielding, from batteries, paint wastes, and lead-containing research solutions. Metal-bearing wastes also result from the use of chromium as a corrosion inhibitor in nuclear power reactors, as a cleaning agent, and as a waste treatment agent for ion-exchange resins. Other sources are cadmium-containing reactor control rods and grit blast. Mercury-contaminated equipment and debris, as well as mercury from laboratory experiments, are also sources of metal-contaminated mixed waste.

Aqueous corrosive mixed wastes are generated from a wide range of industrial and laboratory operations. These are primarily acids (over 90%); however, bases also make up a small percentage of this category. "Other" sources of mixed waste include biological wastes,^c incinerator ash, filter bags, and trash (see Appendix D, Table D.11).

5.3 Mixed Waste Treatment Options

5.3.1 Land Disposal Restrictions

EPA regulations, known as the LDR, prohibit the disposal of hazardous waste (including mixed waste) unless the wastes are treated to EPA standards in 40 CFR 268 Subpart D or unless a variance or extension to an LDR effective date is granted. Hence mixed waste must be treated to the applicable treatment standard before land disposal is permitted. In general, EPA treatment standards for specific wastes are either expressed as concentration levels or treatment technologies. EPA's approach for developing treatment standards was established using BDAT. Mixed wastes are subject to the established treatment standards for the hazardous portion of the waste except for four categories of mixed waste that have a specified treatment technology as their treatment standard (radioactive lead solids, radioactive elemental mercury, radioactive hydraulic oil contaminated with mercury, and certain radioactive high-level wastes). Please note that the

^cThe definition of mixed waste does not, generally, include biological waste. However, biological waste containing mixed waste *would* be considered as mixed waste. The "biological" category in this study includes waste reported by its source as mixed waste, with a description clearly designating the biological nature of the waste.

BDAT, used to set treatment levels, does not necessarily have to be the technology used to meet a treatment standard *unless the treatment standard is expressed as a specific technology.*^d

5.3.2 Treatment Options

The treatment options evaluated for each mixed waste category are listed in Table 5.2. One or more individual treatments or sequences of treatments were identified for each waste category. Where the waste category contains two or more distinct streams, a treatment or treatment sequence is identified for each waste stream. The table also shows the hazardous constituents in each waste stream, the EPA waste code, the BDAT for treatment of the waste stream, as identified by the EPA, and the EPA treatment standard for the stream. Potential treatment schemes for each waste stream are shown under the column "Treatment Alternatives." These alternatives represent approaches that are considered as possibly feasible based on the capability of the technology to achieve the required treatment standard. The column entitled "Treatment Considerations" contains useful information pertaining to the treatment or to the waste stream. The last column, "Recommended Treatment," shows the treatment (or sequence) selected as the recommended treatment in this study. It must be stressed that, using a specific technology to meet treatment standards is mandatory when, and only when, the standard is a specified technology.

The treatment options appearing in Table 5.2 were evaluated based on information derived from several sources, including 40 CFR Part 268, and several reports.¹⁻⁵ The range of treatment options considered was compiled from these references, drawing on those technologies that have been demonstrated as meeting the EPA requirements for streams similar, as indicated by available stream property data, to those in this study (Table 5.2). For each stream, the recommended treatment was selected using the following criteria. The treatment must (1) satisfy regulatory requirements, (2) be economically feasible, and (3) be likely to become available within about a year, if not already offered commercially. It also needs to be noted that the options were evaluated on the basis of the hazardous waste and its hazardous constituents only. The radiological properties of the mixed waste stream and the present and future availability of any option to treat mixed waste may call into question the viability of the recommended treatment.

5.3.3 Selection of Recommended Treatment

Treatment, handling, and packaging requirements for the radioactive components of mixed waste depend on a knowledge of radionuclide identities and concentrations in the waste as well as the physical form of the waste, the radioactive waste class (i.e., Class A, B, or C), and the chemical form. For RCRA-regulated wastes, treatment requirements depend on a knowledge of the EPA

^dFor further information on the LDRs, please refer to OSWER Directive 9555.00-01, "Guidance on the Land Disposal Restrictions' Effects on Storage and Disposal of Commercial Mixed Waste," September 1990.

waste codes provided in 40 CFR Part 261 and the EPA treatment standards if the waste is determined to be LDR under 40 CFR Part 268.

Once classified by EPA waste code, physical form, radionuclide, and NRC waste class, the treatment for each waste can be identified. Minimum waste form and stability requirements for radioactive waste are specified in 10 CFR Part 61. Certain mixed wastes fit into special waste groups (e.g., certain high-level radioactive waste, contaminated lead solids, or mercury) with treatment standards as specified technologies.

EPA waste codes, EPA treatment standards, and concentration levels of contaminants (for wastes with treatment standards that are specified as concentration levels) were the key factors in categorizing waste streams for treatment selection. These data and information on waste forms were obtained from the survey. It must be noted that the data used in this study vary widely in the amount and quality of information available for each waste stream. In particular, individual radionuclide concentrations for wastes with multiple isotopes were usually not obtainable from the completed survey questionnaires. In addition, EPA codes were not consistently provided by the generator. Since determining EPA code or codes that apply to a waste requires considerable knowledge of RCRA regulations, it is also likely that some of the EPA codes provided are not entirely accurate or complete. For these reasons, some EPA codes have been inferred from the stream description.

The recommended treatments selected for mixed waste in this work are shown in the last column of Table 5.2. In selecting a treatment for a given waste, EPA standards were first consulted. The existence of a standard specified as a technology, such as macroencapsulation for lead shielding, leaves no option. The specified treatment technology must be selected unless a variance from a treatment standard is granted pursuant to 40 CFR 268.44. In other cases, possible treatment options for the waste were compiled from prior studies,¹⁻⁵ using alternatives previously developed for similar wastes. Final selection was made giving preference to the BDAT and current availability but also taking into account economic feasibility and likelihood of future availability.

Incineration is recommended for most of the wastes in the *organics* class, including LSFs, oils, chlorinated organics, and fluorinated organics. Incineration is the BDAT for all of the organic mixed waste in this study, except for waste oils, for which a BDAT has not been established and which is not a Federally listed hazardous waste.* However, it may be possible to

*EPA has decided not to list used oil destined for disposal as hazardous waste, considering the existing regulations and controls to be adequate to ensure that used oil does not pose a threat to public health and the environment. However, used oil may still be declared a hazardous waste if it exhibits a toxic characteristic. States have the right to impose additional controls, some of which have done so in their decision to designate used oil as a hazardous waste.

increase the percent incinerated through judicious blending with other incinerable organics. The corrosive nature of incinerator emissions from highly halogenated CFCs make incineration less feasible, since facility emission limits are likely to be exceeded. Incineration was selected for only 5%^f of CFCs. The treatment selected for the remaining 95% of CFCs is distillation, followed by chemical oxidation. The "Other organics" category consists mostly of materials for which the BDAT is incineration or deactivation (which may include incineration).

The *metals* class requires a more diverse set of treatments than the *organics* class.

Cadmium-contaminated waste may be stabilized in cement or glass. Chromium wastes, consisting mainly of chromium-contaminated solutions, can be chemically reduced, followed by precipitation, filtration, and stabilization. Neutralization of the filtrate following precipitation may be required. Three types of lead-contaminated wastes required different treatment sequences. Lead shielding that cannot be decontaminated and reused must be macroencapsulated. Lead-bearing solutions should be precipitated filtered and the precipitate stabilized. Again, neutralization of the filtrate following precipitation may be required. Lead batteries, not prevalent in the study (0.5 ft³), may require thermal recovery of the lead. The mercury category consisted of two types of streams: (1) aqueous solutions, which may be precipitated and stabilized, and (2) equipment and debris contaminated with undetermined levels of mercury, for which the treatment required^g is thermal recovery. However, based on the radiological properties of these wastes and the present and future availability of facilities that offer thermal recovery, this treatment may not be a viable option.

The selected treatment for "Aqueous Corrosives," consisting primarily (greater than 90%) of inorganic acids and bases, is neutralization. Incineration, however, is also a feasible option for aqueous streams burned in combination with high-heat-value streams.

The "Other" class is more difficult to assign treatments to, since wastes in this class have multiple or unusual contaminants. Wastes have been grouped (and numbered) within this class to the extent possible, and treatment options were identified based on the limited information available, as indicated in the "Treatment Alternatives" column. The metal-contaminated organic sludges (group 1) could be treated by distillation to recover solvents and followed by oxidation and stabilization of the residue. Incinerator ash (group 2), metal alloys (group 3), and sealed sources (group 8) are good candidates for stabilization. The aqueous, metal-bearing solutions (group 4) in

^fOnly monochloromonofluorocarbons are assumed to be acceptable for incineration.

^gThe conservative assumption that the mercury level is high for these wastes is made since the actual level is not known. For low mercury contamination levels (below 260 mg/kg Hg), the BDAT selected would be to acid leach, then oxidize, followed by dewatering. If elemental mercury is present, the treatment standard is amalgamation.

this class are more complicated than those in the metals class above, but it should be possible to treat them the same way, although with more difficulty, using precipitation, filtration, and stabilization, with possible neutralization of the filtrate. Treatment selections for groups 5-6 are not possible, given the data available.

5.4 The Demand for Treatment Services

Table 5.3 summarizes some of the results of Table 5.2, presenting estimates of the demand, in cubic feet, for treatment services by the different waste types encountered in this study. Some waste categories require more than one technology. The demand shown in Table 5.3 is defined as the sum of the 1990 annual generation rate for the waste and the amount of waste in storage at the end of 1990.^b In other words, this quantity represents the amount of capacity that would have to be provided to treat the annual waste generated and eliminate the 1990 inventory in one year. This demand figure is chosen in light of the strong regulatory incentive against storage of mixed waste.

The total demand for the different treatments is shown across the bottom row of Table 5.3, above the solid bar. Incineration, by far, is in greatest demand at 142,747 ft³ for organic and other materials. Stabilization is second highest at 42,514 ft³. Next in demand is a sequence to distill and oxidize organic sludges, in the amount of 17,486 ft³. Neutralization, macroencapsulation, and chemical reduction are next in demand, estimated at 13,847 ft³, 4,124 ft³, and 2,885 ft³, respectively. The demand for thermal recovery for mercury and lead acid batteries is estimated at 366 ft³. Lead decontamination could have a demand up to 4,124 ft³.

^bThe demand for storage has been determined using the same distribution of demand within each waste category as was obtained for generation. This assumption could result in underestimation of the demand for certain problematic wastes.

5.5 Profiles of Mixed Waste Treatment Industries

5.5.1 Overview of Existing Treatment Capability

Facilities for treatment of mixed waste have been developed at research laboratories, such as those operated by the DOE, and within the commercial sector. Examination of existing¹ (see Table 5.4) and future capability for treatment of commercial low-level radioactive mixed waste follows. DOE capabilities and facilities for treating mixed waste are not discussed in this report. In a recent Federal Register notice² regarding a case-by-case request by DOE to extend the LDR effective date for some of its mixed wastes, a discussion is provided on DOE's use of commercially available mixed waste treatment capacity. The feasibility and extent of DOE's possible use of commercial mixed waste treatment capacity is beyond the scope of this report. However, because of the large volume of mixed waste DOE generates annually, and has generated in the past, relative to commercially generated mixed waste, the possible use of commercial treatment capacity by DOE must be noted because it may impact the availability of commercial mixed waste services to the commercial mixed waste generators that is being discussed in this report.

Four commercial facilities currently treat LSF, the largest volume of mixed waste generated (Table 5.1). The Quadrex³ Corporation facility, located in Gainesville, Florida, can process up to about 4,500 drums per month or nearly 400,000 ft³ annually. Diversified Scientific Services, Inc. (DSSI), located in Kingston, Tennessee, provides incineration capacity of up to 130,000 ft³ year for LSFs and bulk organics. Another LSF treatment facility, operated by RAMP Industries and located in Denver, Colorado, provides incineration and other treatments, up to 25,000 ft³/year. NSSI/Recovery Services, Inc. (NSSI), located in Houston, Texas, accepts LSF materials and has substantial capacity (~750,000 ft³ annually) for bulking and storage prior to off-site incineration. NSSI has storage for over 33,000 ft³ of drummed wastes.

The pertinent operating license(s) and/or permit(s) should be consulted to determine the facility's treatment process or processes and the acceptable wastes. Appendix G contains portions of the radioactive materials and hazardous waste permits indicating radioactive and hazardous constituents that may be accepted for each commercial mixed waste treatment facility.

¹Vendor capacities are based on information provided by the vendors via personal communication in June 1992. This report is dependent on vendor-stated capacity estimates, which were not verified.

²"Hazardous Waste Management System: Land Disposal Restrictions (LDR); DOE Mixed Wastes Extension Application," Federal Register, Vol. 57, No. 101, Tuesday, May 26, 1992.

³Mention of specific products and/or manufacturers in this document implies neither endorsement, preference, nor disapproval by the U.S. Government or any of its agencies or contractors.

5.5.2 Quadrex

The Quadrex Corporation accepts only scintillation liquid, which is bulked by crushing to extract liquid from the vials and stored for accumulation prior to treatment off-site. The liquid, considered a hazardous waste in the state of Florida, is mainly burned off-site for energy recovery at cement kilns.

Quadrex is a TSD facility that fuel blends LSF and holds a Part B storage permit for LSF from the Florida Department of Environmental Regulation (FDER). Quadrex also has a radioactive materials license with the state of Florida which limits storage of radioactive materials to 180 d. The license includes standards for ^{14}C and tritium, allowing disposal of these isotopes as nonradioactive material, provided the activities of ^{14}C and tritium are below $0.05 \mu\text{Ci/g}$. A list of isotopes acceptable by Quadrex may be found in Appendix G. Quadrex is limited to 100 mCi/year for all isotopes other than ^{14}C and tritium in the material it processes for incineration. Because of this limit, some LSF waste with higher-than-normal activity is sent to NSSI for processing. NRC and Florida regulations allow the disposal of ^{14}C and tritium in LSF in concentrations $<0.05 \mu\text{Ci/g}$ without regard to its radioactivity (i.e., as a nonradioactive waste).

Quadrex is considering expanding the type of mixed waste it will accept for processing. The additional wastes that Quadrex is planning to treat are radioactively contaminated solvents similar to LSFs and radioactively contaminated oil. This additional treatment capability will require FDER approval of requests for amendment to Quadrex's treatment, storage, and disposal (TSD) permit.

5.5.3 RAMP

RAMP Industries processes both mixed waste and low-level radioactive waste. The mixed waste currently comprises 10 to 15% of its business. Mixed wastes accepted by RAMP include those containing only spent solvent wastes (F-series) and ignitable (D001) hazardous wastes. The F-series wastes include mostly halogenated and nonhalogenated organic solvents. Mixed wastes are bulked using a crusher/shredder to remove liquid from the vials, and stored for accumulation prior to treatment off-site. Classified as a hazardous waste in the state of Colorado, the LSF wastes are transferred locally to Chemical Waste Management, Inc., for recovery of toluene and other solvents by solvent extraction. The remaining liquid is considered nonradioactive and is transported to a permitted hazardous waste cement kiln for use as an energy recovery fuel. RAMP performs other treatment of mixed waste including compaction, neutralization, stabilization in cement, and solidification, but is limited by the hazardous waste codes of the wastes it can accept (see Appendix G).

RAMP is a TSD facility with interim status and has submitted an application for a Part B Permit to the Colorado Department of Health's (CDH) Waste Management Division. RAMP also holds a radioactive materials license, administered by the Radiation Control Division of CDH, for its radioactive waste operations.

5.5.4 NSSI/Recovery Services, Inc.

NSSI/Recovery Services, Inc. (NSSI) is a radioactive waste storage and processing facility that holds a radioactive materials license as well as a Part B Permit to store and process wastes. NSSI operates a multi-process treatment facility for radioactive and mixed waste. NSSI is currently accepting mixed waste that contains hazardous waste classified as D-series (characteristic) waste; F-, P-, and U-series (listed) waste in lab pack form; and all F-series (listed spent solvent) waste except F004 (spent non-halogenated solvents) and F006 (electroplating sludges). Wastes received by NSSI may be processed in the following ways:

- store and/or repackage wastes and accumulate them for off-site disposal,
- process and store wastes to prepare them for off-site disposal,
- process mixed waste to remove hazardous characteristics, and
- recycle wastes as fuels or as other beneficial products.

Liquid wastes received in bulk containers are tested for their compatibility and then transferred to appropriate tanks for storage and processing. Waste characteristics determine the types of processes and sequence to which they are subjected. Treatment processes allowed by their RCRA permit include chemical fixation to stabilize waste for land disposal, chemical oxidation/reduction to destroy hazardous organics, activated carbon which removes organic contaminants by adsorption onto solids, neutralization, and precipitation. Mechanical separation is used to sort lab packs. Decanting is used to separate liquids of varying densities. Solvent recovery segregates and consolidates solvents for recycling, and evaporation is used to dry sludge. LSFs and other similar organics are considered nonradioactive and are transferred off-site to a fuel broker, Gibraltar Corporation, for use as cement kiln fuel at a number of locations throughout Texas.

NSSI currently treats and stores radioactive wastes under its Radioactive Materials License administered by the Texas Department of Health. The license includes standards for ^{14}C and tritium that are similar to Florida's standards, allowing disposal of LSF containing these isotopes as nonradioactive material (i.e., as hazardous waste only) provided the activities of ^{14}C and tritium are below $0.05 \mu\text{Ci/g}$. The mixed waste that NSSI can accept are governed by the allowable

hazardous components as specified in its RCRA Part B Permit on file with the Texas Water Commission. NSSI is RCRA permitted to store and treat the hazardous wastes from an extensive list (see Appendix G) but is not allowed to dispose of mixed waste on-site. Chemical and radiological waste profiles are required by NSSI for all types of wastes it receives.

5.5.5 Diversified Scientific Services, Inc.

Diversified Scientific Services Incorporated (DSSI) has a boiler facility operating under RCRA interim status to treat mixed waste containing category F001 to F005 (spent solvents) and characteristic solvents. The facility includes a cogeneration plant, the boiler for which provides heat for steam turbines to generate electric power. Complete combustion is promoted by injection of ignitable fluid waste into the boiler by means of an atomizer, or mechanical spray device, leaving very little ash residue. Stack gases pass through a scrubber, baghouse, and High Efficiency Particulate Air (HEPA) filter to remove particulates and are monitored for radioactive particles. This waste fuel boiler has been operational since 1991 and is operating under a state interim-status-boiler permit. Other materials, such as plastic or glass scintillation vials are recycled for beneficial reuse.

The DSSI facility accepts primarily LSF and other ignitable solvents, such as halogenated organics. DSSI has a RCRA Part B Permit which allows storage of mixed waste for radioactive decay, and a radiological byproduct materials license, which limits the quantity of isotopes (see Appendix G) that may be on-site at any given time.

5.6 Potential Mixed Waste Treatment Facilities

5.6.1 Scientific Ecology Group

Scientific Ecology Group (SEG) is likely to begin accepting certain types of mixed waste in the next 2 years. Located in Oak Ridge, Tennessee, SEG provides radioactive waste management services including incineration and is submitting an application for a RCRA Part B Permit in order to process mixed waste.

SEG currently operates a multi-process facility for treatment of low-level radioactive waste. Wastes are sorted and segregated depending on the homogeneity of the waste shipment received. A solidification unit exists for sludges and slurries. Oil, and other wastes that are non-RCRA hazardous wastes, can be treated as LLRW (non-mixed) in Tennessee. Wastes with a halide content exceeding 5% by weight, however, cannot be incinerated at SEG since the off-gas filtration equipment cannot handle high concentrations of acid gases. The incinerator operates at 900 to 1,600 lb/h of solid waste and can simultaneously burn 30 gal/h of radioactive, nonhazardous waste oil. The SEG incinerator includes a secondary chamber with a 3-s gas residence time and a

temperature of 2,200°F to achieve a 99.9999% destruction and removal efficiency (DRE) of volatile organics.

The SEG incinerator is equipped with a baghouse and dual HEPA filters for particulate removal and a wet scrubber for acid gas removal. SEG expects to achieve a volume reduction through incineration of over 100:1 for mixed waste, similar to that currently realized with combustible radioactive waste.

SEG currently has a radioactive materials license from the Tennessee Department of Health and Environment. This license restricts possession of radioactive materials to a period of 180 d, precluding storage of mixed waste for decay as part of its treatment process. SEG has prepared and is submitting an application for a RCRA Part B Permit to allow incineration of mixed waste and hopes to have this permit within 2 years.

In the future, the facility will be capable of processing mixed waste if SEG obtains a RCRA Part B Permit. Much of the organic mixed waste could be incinerated in the SEG incinerator, which is patterned after a Studsvik unit in Sweden used for incinerating radioactive waste. SEG is developing a vitrification system that will glassify the incinerator ash into glass blocks that should be capable of passing all characteristic tests used for defining hazardous wastes.

5.6.2 Envirocare

Envirocare of Utah, Inc., operates a low-activity radioactive and mixed waste disposal (burial) facility and is planning to offer mixed waste treatment in the future. Envirocare has already received a RCRA Part B Permit from the Utah Division of Solid and Hazardous Waste, allowing the receipt, storage, and disposal of low-activity wastes which are both radioactive and hazardous at its South Clive facility. With its Part B Permit, Envirocare may store and dispose of solid-phase mixed waste (see Appendix G for specific limits).

5.7 Comparison of Treatment Capacity Versus Demand

Treatment services offered by companies in the commercial sector, along with their estimated annual treatment capacities, are shown in Table 5.4. Figure 5.2 presents the combined capacity, by treatment technology, for the four companies that currently have the capability to treat mixed waste. For the waste streams reported in the Mixed Waste Profile, the information available on hazardous constituent concentration levels, on a stream by stream basis, is limited. For this reason, comparison of hazardous constituent concentrations with specific acceptance criteria for each treatment facility cannot be made. Rather, the capacity available currently to treat each waste category is compared to the demand, with the goal of finding where capacity needs to be developed for mixed waste treatment. Figure 5.3 shows a comparison of the demands

listed in Table 5.3 with commercial treatment capacities that are currently available. Demand is defined as 1990 generation rate plus material in storage at the end of 1990. This is a conservative estimate of needed capacity because some of the waste in storage is being accumulated for treatment on-site or for shipment to off-site treatment facilities. Drawing on the data in Tables 5.3 and 5.4, the following observation can be made.

5.7.1 Availability of Incineration Capacity

a. LSF — The four industries, NSSI (capacity 750,000 ft³), Quadrex (capacity 400,000 ft³), DSSI (capacity 130,000 ft³), and RAMP (capacity 25,000 ft³), together provide 1.28 million ft³ of annual capacity to treat LSF. This amounts to nearly 13 times the amount generated annually (100,196 ft³) and can easily accommodate the stored LSF as well. Most, but not all, LSF are acceptable depending on radionuclide content.

b. Waste Oil — Waste oil destined for disposal and not exhibiting a hazardous characteristic is not considered as mixed waste by EPA and can currently be incinerated without a RCRA permit. The 5,259 ft³ generated annually could be accepted by any of the four industries offering LSF treatment, and the radioactive waste oil could also be accepted by SEG, provided the waste oil stream is tested and no listed or characteristic hazardous waste component is present.

c. Halogenated Organics — RAMP accepts organohalides, with concentration limitations, and processes them for incineration. Chlorinated organics, fluorinated organics, and low-halogen CFCs may be incinerated, based on current practice. CFCs with high halogen content, however, are not accepted for incineration. The 2,704 ft³ of incinerable organohalides (2,504 ft³ of chlorinated organics and 5% of 3,998 ft³ of chlorinated fluorocarbons) generated annually could be accepted by RAMP for incineration.

d. Other Organics — These wastes, generated at a rate of 9,697 ft³/year, are primarily D001, F003, and F005 wastes for which incineration is the selected treatment. This type of waste could be accepted by RAMP, with a capacity of 25,000 ft³/year (incineration).

e. Lead penetration sealants and oils — Penetration sealants and oils contaminated with lead, generated at a rate of 29 ft³/year, are not accepted for incineration by any of the existing commercial facilities. The demand for treatment of this waste is estimated to be small (78 ft³ or 1% of 7,782 ft³ of lead wastes).

5.7.2 Availability of Stabilization Capacity

Stabilization of solid mixed waste is provided by RAMP and NSSI. Their joint capacities of 112,000 and 5,000 ft³/year, respectively, exceed the total estimated demand (42,514 ft³/year) for stabilization. Hence, metal-contaminated solutions can be treated by these two companies, with the major capacity being provided by NSSI.

5.7.3 Availability of Neutralization Capacity

NSSI (capacity 10,000 ft³/year) and RAMP (capacity 6,000 ft³/year) provide a total capacity for neutralization of aqueous corrosives of 16,000 ft³/year, enough to accommodate the demand (13,847 ft³) for this waste class.

5.7.4 Availability of Capacity for Distillation/Oxidation of Organics

CFCs with high halogen content and metal-contaminated organic sludges present a problem for most commercial vendors. NSSI can treat such wastes by distillation to recover organics and then oxidation with stabilization of the residue. NSSI's capacity to treat organic sludges in this way is estimated at 10,000 ft³/year. This capacity would accommodate the estimated generation rate for CFCs with high halogen content (3,800 ft³/year or 95% of 3,998 ft³/year of chlorinated fluorocarbons) and CFC sludges from the *Other Hazardous Materials* category (3,500 ft³/year or 33% of 10,613 ft³/year of other hazardous materials) with some reserve capacity. However, NSSI's capacity would fall short of the demand (17,486 ft³) by about 7,500 ft³.

5.7.5 Availability of Capacity for Decontamination/Macroencapsulation of Lead

Decontamination of solid lead such as radiation shielding, provided the radioactivity is limited to the surface, is provided by NSSI. Macroencapsulation or stabilization of lead, sealed sources, and some other materials is available from NSSI, provided that waste handling does not require hot cell work based on exposure rate. The capacity of 300 lb/d for decontamination or macroencapsulation of lead (~100 ft³/year) is substantially less than the annual generation rate (1,528 ft³/year or 53% of 2,883 ft³/year of lead) and falls short of the demand (4,124 ft³) by about 4,000 ft³.

5.7.6 Availability of Capacity for Chemical Reduction of Chromium Wastes

NSSI has the capability for chemical reduction of wastes contaminated with chromic acid and chromates, with a capacity of 10,000 ft³/year. This capacity exceeds the estimated demand of 2,885 ft³/year.

5.7.7 Thermal Recovery of Mercury and Lead

No commercial services are offered for treatment of mercury-contaminated waste, generated at 49 ft³/year (or 11% of 442 ft³/year of mercury); or for lead batteries, generated at less than

1 ft³/year (from mixed waste database), for which thermal recovery is indicated as a treatment standard. These are small streams (estimated demand is 366 ft³/year) for which no commercial treatment alternatives exist. Thermal recovery is the EPA treatment standard for D008 lead characteristic hazardous waste from lead acid batteries and for D009 nonelemental mercury-contaminated materials. However, thermal recovery for these mixed wastes may not be a viable option because of their radioactive component.

5.7.8 Summary of Current Waste Treatability Capacity

The estimated demand for treatment services is summarized in Table 5.3 by waste category. These were compared with the treatment capabilities of commercial industries presented in Table 5.4. The findings of this comparison are illustrated in Fig. 5.3 and are summarized below. It should be emphasized that some of the conclusions reached here may be based on one-time generations of unique mixed waste streams; therefore, caution should be exercised in extrapolating these results to present or future treatment needs.

There appears to be adequate incineration capacity available to meet the demand for LSF, waste oil, chlorinated and fluorinated organics, and other organics, except for CFCs. Enough capacity exists to treat CFCs generated annually by distillation and oxidation, but additional capacity, estimated at 7,500 ft³, would be needed to treat CFCs generated *and* in storage at the end of 1990. Sufficient capacity exists to stabilize metal-bearing solutions, metal alloys, and sealed sources. There is adequate existing capacity available for precipitation, neutralization, and chemical reduction, but capacity is needed for decontamination and macroencapsulation of lead shielding (about 4,000 ft³) and to treat other wastes contaminated with solid lead and mercury (366 ft³) by thermal recovery.

The volume of wastes requiring added capacity to match their generation rate is estimated at about 1,600 ft³ annually. The total unmet demand is estimated at about 12,000 ft³ (storage and generation over a 1-year period).¹

It should be clearly understood that the facility capacities presented in this report represent information as provided by the companies themselves. These capacities are, to some degree, theoretical as they have never actually been demonstrated, and they do not take into account any mitigating factors that may affect actual capacity. Such factors may include the need for pretreatment or unusual physical preparation, including unanticipated chemical analyses. Also, the timing of treatment campaigns and any required downtime between campaigns may affect

¹It is important to note that estimated capacities to treat mixed waste have been provided by the vendors that offer these services. Some overestimation or underestimation may have occurred since most of the needed treatment diversity is provided by only two vendors, with the majority of the capacity provided by only one. It may be impractical for NSSI to provide all of the capacity that it has estimated.

throughput. Additional factors that may limit total capacity are the resource and manpower limitations that operating parallel processing lines may impose on those facilities providing multiple treatment options. Finally, as mentioned previously, DOE's possible use of commercial facilities may affect their availability for use by the commercial sector.

5.7.9 Estimated Future Treatment Capacity

Over the next 5 years, as many as two additional facilities could be permitted for the treatment of liquid mixed waste, including technologies other than incineration. Currently, four facilities can accept LSFs; this may increase to five if SEG receives its Part B Permit. Existing facilities have expanded the list of wastes they can accept or are in the process of doing so. Hence, the capacity for treating mixed waste appears to be increasing.

NSSI considers itself a pilot operation and is willing to develop and test new technologies. New processes to be developed at NSSI, or at other facilities, could employ one or more of the promising advanced technologies. Technologies that may have application to treatment of mixed waste include supercritical water oxidation, ultraviolet (UV) light/oxidation, wet air oxidation, and solvent extraction². New technologies such as these may be demonstrated in the near future. A detailed listing of new and emerging technologies for mixed waste treatment is provided in Appendix H.

6 Summary and Conclusions

6.1 National Profile...

The survey of potential commercial mixed waste generators in the United States consisted of a series of well-defined steps that included: (1) selecting a total number of facilities to be sampled, basing the number on an anticipated 25% nonresponse rate and a 10% desired relative standard error; (2) sending out a detailed questionnaire (Appendix B) to a number [determined in (1)] of randomly selected facilities; (3) accumulating and compiling the responses, in an appropriate format, into a database; and (4) estimating the national commercial mixed waste generation rates based on multiplying the "raw" data by weighting factors to correct for the fact that only a fraction of the facilities in each group were sent questionnaires.

The survey target population (survey frame) included a total of 2,936 facilities after duplicates were eliminated. A random sample of 1,323 facilities was selected from this target population. Data from 1,016 completed mixed waste survey questionnaires (including 21 facilities which were determined to be no longer in business, a 77% response rate) received by ORNL

indicated that ~81,000 ft³ of commercially generated low-level radioactive mixed waste was generated in the United States in 1990 by those surveyed. Approximately 63% of this reported volume was liquid scintillation fluid.

Using weighting factors to generate a statistically valid estimate of the 'national' mixed waste profile, it is estimated that ~140,000 ft³ of low-level radioactive mixed waste were generated nationally in 1990 of which nearly 72% was LSFs. In addition, an estimated 75,000 ft³ of mixed waste was in storage for various reasons as of December 31, 1990. The industrial category was estimated to be the largest generator and accumulator of mixed waste, with over 36% of the generation and nearly 57% of the storage, of the total mixed waste in the United States in 1990. Data received from 97% of the operating nuclear utilities (some may have multiple reactors) in the country indicated that they accounted for <10% of the estimated total 1990 generation rate and ~29% of the estimated mixed waste in storage.

Upper and lower bounds were set on the volume of mixed waste that is currently untreatable by making the assumption that LSF, oil, organic (not halogenated), and corrosive waste are treatable under current technologies. Deducting the wastes that are assumed to be treatable from the estimated national total mixed waste generation rate leaves ~18,500 ft³ of untreatable commercial low-level mixed waste. Thus, with this as an upper bound and the estimated ~5,000 ft³ of currently untreatable mixed waste (see Sect. 4.2.5) as the lower bound, the untreatable mixed wastes range from 3.5 to 13.3% of the estimated 1990 national generation rate of 140,000 ft³.

Although Compact/State and Hazardous Waste Stream data are presented, it should be emphasized that the profile was generated to be statistically valid only at the national level and only for the major facility categories. It is estimated that the overall accuracy of the projected mixed waste generation rates and waste in storage are well within the objective of the study which was to be, at the 95% confidence level, within a factor of 2. Estimates of mixed waste volumes calculated at the state level may be less reliable, mainly due to fewer samples in these substrata.

6.2 The Treatability of Mixed Waste

A broad spectrum of mixed wastes were generated by the facilities surveyed in the National Profile, including liquid scintillation fluids, organohalides and other organics, wastes contaminated with toxic metals, corrosives, and other hazardous materials. A considerable inventory of mixed waste existed in storage as of December 31, 1990. These mixed wastes present a need for specific treatment services, including incineration, stabilization, chemical treatment, and recovery/reuse technologies. Four companies — NSSI (Houston, TX), DSSI (Kingston, TN), Quadrex

(Gainesville, FL), and RAMP (Denver, CO) — currently offer mixed waste treatment services for a limited spectrum of mixed waste. Two others, SEG (Oak Ridge, TN) and Envirocare (Salt Lake City, UT), may offer mixed waste treatment in the near future. A comparison has been made between the available treatment capacity and expected demands due to estimated mixed waste generation in 1990 plus mixed waste in storage at the end of 1990. Based on the estimated demand for treatment services for each waste generation category, in comparison with treatment capabilities of the industries identified in this report, sufficient treatment capacity appears to exist for all mixed waste categories except chlorinated fluorocarbons, lead shielding and other waste contaminated with solid lead, and mercury-contaminated equipment and debris. Sufficient capacity to treat all mixed waste requiring macroencapsulation is also not available. The capacity shortfall amounts to ~12,000 ft³. Currently operating commercial treatment facilities may be able to handle nearly all of the commercial mixed waste generated, based on the reported 1990 generation data, but to address the total demand (computed as 1990 generation plus storage as of the end of 1990), some significant additional capacity must be developed to treat mixed waste already in storage.

Finally, it must be emphasized that the DOE generation and inventory of mixed waste and any DOE capabilities and DOE facilities for treating mixed waste (either commercial and/or DOE mixed waste) are beyond the scope of this study. Current and future demands that DOE will have for commercial mixed waste treatment services are also not covered in this study. (See 57 FR 22024, May 26, 1992, for information on DOE's efforts to contract for commercial mixed waste treatment services.) Thus any effect of DOE's current or future procurement of commercial mixed waste treatment services was not factored into the commercial low-level radioactive mixed waste treatment capacity determinations presented in this report.

A range of 5,000 to 18,500 ft³ of untreatable mixed waste was estimated from the 1990 generation and storage data resulting from the survey questionnaire results. More specifically, Table 5.3 of Sect. 5, estimates the untreatable volume of mixed waste at 11,954 ft³ after comparing treatment capacities with treatment demands in 7 waste categories. Given that some 75,000 ft³ of mixed waste was estimated to be in storage as of December 31, 1992, the question arises: Why does so much mixed waste remain untreated? Although, some of the waste may only be in storage for accumulation prior to future treatment/disposal, possible reasons for other waste not being treated, based on discussions with survey participants, include:

- Generators believe that treatment facilities may be overestimating their capabilities, capacities, and possession of required permits.

- Small mixed waste generating facilities may not be aware of the identity or capabilities of commercial facilities that can treat mixed waste.
- Mixed waste generators may be knowledgeable about the identity of treatment facilities but may have insufficient information to match their waste with the acceptance criteria of the treatment facilities.
- Generating facilities may not want to relinquish control over their waste without proper/legal assurances that may be difficult/impossible to obtain.
- Various regulations, as well as their interpretation by the individual states, make the legal landscape complex for mixed waste generators.
- Inexperience or limited experience with the management of mixed waste may cause generators to take longer to make required decisions to contact and contract with a company to treat their mixed waste.
- Waste may, indeed, be treatable to the extent noted in this report, and generating facilities are sending mixed waste to the treatment facilities, but resource (both manpower and funds) limitations make the transfer slow, costly, and sometimes institutionally difficult.

6.3 Comments

Comments and suggestions are to be directed to:

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 U.S. Environmental Protection Agency
 Washington, DC 20460
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7 References

1. "Hazardous Waste/Mixed Waste Disposal Facility-Recommended Treatments and Related Waste Management Issues," WSRC-RP-90-1143, November 1990.
2. "Final Conceptual Mixed Waste Management Plan," A report to California Department of Health Services and the states of the Southwestern Compact, by Ebasco Environmental, December 1989.

3. Kirner, N., G. Faison, and C. Owens, "Mixed Waste Management Options," DOE/LLW-134, December 1991.
4. "Final Best Demonstrated Available Technology Background Document for K031, K084, K101, K102, Characteristic Arsenic Wastes (D004), Characteristic Selenium Wastes (D010), and P and U Wastes Containing Arsenic and Selenium Listing Constituents, Volume 1," PB90-234014, May 1990.
5. "Final Best Demonstrated Available Technology Background Document for Characteristic Ignitable Wastes (D001), Characteristic Corrosive Wastes (D002), Characteristic Reactive Wastes (D003), and P and U Wastes Containing Reactive Listing Constituents, Volume 2," PB90-234022, May 1990.
6. "Regulating the Disposal of Low-Level Radioactive Waste, A Guide to the Nuclear Regulatory Commission's 10 CFR Part 61," Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, August 1989.

Table 4.1 Mixed waste survey: Operational statistics

	Facility category ¹					Total
	Academic	Government	Industrial	Medical	Nuclear utilities	
Number in sampling frame						
Known or potential generators	108	20	164	74	78	444
LLRW shipper lists	165	74	822	349		1,410
NRC license with EPA permit	73	4	166	19		262
NRC license without EPA permit	92	147	518	63		820
Subtotal	438	245	1,670	505	78	2,936
Number receiving questionnaires						
Known or potential generators	108	20	164	74	78	444
LLRW shipper lists	165	74	324	92		655
NRC license with EPA permit	73	4	24	1		102
NRC license without EPA permit	30	52	37	3		122
Subtotal	376	150	549	170	78	1,323
Number in data base						
Known or potential generators	80	17	133	53	76	359
LLRW shipper lists	111	61	250	65		487
NRC license with EPA permit	58	2	18	1		79
NRC license without EPA permit	18	40	31	2		91
Subtotal	267	120	432	121	76	1,016
Number reporting mixed waste ²						
Known or potential generators	63	11	64	37	53	228
LLRW shipper lists	72	21	78	17		188
NRC license with EPA permit	16	0	0	0		16
NRC license without EPA permit	1	15	6	1		23
Subtotal	152	47	148	55	53	455

¹As defined by Mixed Waste Profile Team prior to survey.

²Generation only.

Table 4.2 Licensee facility categories and number of survey respondents

Facility category¹	Number of respondents
Nuclear reactor facility	
Boiling Water Reactor	30
Pressurized Water Reactor	45
Research & test reactors	5
Medical (non-federal)	
Hospital	
<250 beds	7
250-750 beds	24
>750 beds	8
Unassigned hospital	12
Medical college/hospital	28
Laboratory	24
Research	37
Unassigned medical	9
Academic	
<10,000 students	121
10,000-20,000 students	54
>20,000 students	47
Unassigned academic	34
Industrial	
Manufacturing	
<50 employees	17
50-200 employees	28
>200 employees	40
Unassigned manufacturing	3
Research & development	146
Decontamination & waste reduction	14
Sealed source/gauge/instrument user	11
Waste broker/processor	6
Nuclear fuel cycle (nonreactor)	1
Commercial radiopharmacy	6
Unassigned industrial	125
Government	
Federal	
Hospital	20
Research & development	45
Military	23
Unassigned federal	13
State	21
Other government	12
TOTAL	1,016

¹As defined by respondents. Facility categories were, in some cases, different than the original assignment shown in Table 4.1.

Table 4.3 National Mixed Waste Profile
[Generation rate in 1990 (ft³/year)]

	As reported ¹	Weighted ²	Estimated standard error ³
Academic	20,420	28,982	3,055
Government	18,324	26,500	5,978
Industrial	19,055	50,430	11,414
Medical	10,151	19,904	2,928
Nuclear utilities	13,276	13,625	703
TOTAL	81,226	139,441	13,579

¹"As reported" values are shown for comparison purposes only and are not to be considered as the national mixed waste profile. "As reported" represents mixed waste reported by the 1,016 respondents to the survey questionnaire.

²"Weighted" represents the estimated mixed waste generation rate after correction of the "As reported" data for nonresponses and facilities not queried during the survey.

³"Estimated standard error" is calculated as described in Appendix E.

Table 4.4 National Mixed Waste Profile
[Amount in storage as of 12/31/90 (ft³)]¹

	As reported ²	Weighted ³
Academic	3,874	5,447
Government	1,692	2,788
Industrial	16,078	42,281
Medical	1,158	2,227
Nuclear utilities	21,403	21,984
TOTAL	44,205	74,727

¹This is not the amount requiring disposal. Some of this waste was being accumulated for treatment.

²"As reported" values are shown for comparison purposes only and are not to be considered as the national mixed waste profile. "As reported" represents mixed waste reported by the 1,016 respondents to the survey questionnaire.

³"Weighted" represents the estimated mixed waste generation rate after correction of the "As reported" data for nonresponses and facilities not queried during the survey.

Table 4.5 National Mixed Waste Profile
[Waste generated in 1990 that currently cannot be treated (ft³)]

	As reported¹	Weighted²
Academic	253	353
Government	1,183	1,455
Industrial	370	834
Medical	493	726
Nuclear utilities	1,432	1,470
TOTAL	3,731	4,838

¹"As reported" values are shown for comparison purposes only and are not to be considered as the national mixed waste profile. "As reported" represents mixed waste reported by the 1,016 respondents to the survey questionnaire.

²"Weighted" represents the estimated mixed waste generation rate after correction of the "As reported" data for nonresponses and facilities not queried during the survey.

Table 4.6 National Commercial Mixed Waste Profile
[Generation rate in 1990 (ft³/year)]

Weighted		Hazardous waste stream												
		LSF	Oil	Org-Cl	Org-Fl	CFC	Org-Other	Pb	Hg	Cr	Cd	Corr	Other ¹	Total
Academic		26,919	15	512	0	0	251	44	0	5	0	71	1,165	28,982
Government		20,315	4	1,179	0	0	3,525	200	0	100	1	1,167	9	26,500
Industry		34,089	531	494	0	319	4,091	1,365	413	643	0	1,442	7,043	50,430
Medical		18,862	0	269	0	0	676	43	25	0	0	2	27	19,904
Nuclear utilities	11		4,709	50	0	3,679	1,154	1,231	4	254	8	156	2,369	13,625
TOTAL		100,196	5,259	2,504	0	3,998	9,697	2,883	442	1,002	9	2,838	10,613	139,441

¹See Table D.11 in Appendix D for a listing of all "Other" streams reported being generated in 1990.

Table 4.7 National Commercial Mixed Waste Profile
[Amount in storage as of 12/31/90 (ft³)]¹

		Weighted												
		Hazardous waste stream												
		LSF	Oil	Org-Cl	Org-Fl	CFC	Org-Other	Pb	Hg	Cr	Cd	Corr	Other	Total
Academic		4,289	6	201	0	0	526	30	1	1	0	68	325	5,447
Government		1,598	6	21	0	0	746	247	0	100	1	0	69	2,788
Industry		5,157	1,217	215	122	393	1,163	171	2,448	1,025	26,304	1	4,065	42,281
Medical		1,622	0	4	0	0	443	0	0	0	0	1	157	2,227
Nuclear utilities		168	5,061	512	0	8,600	1,284	4,451	416	757	11	361	363	21,984
TOTAL		12,834	6,290	953	122	8,993	4,162	4,899	2,865	1,883	26,316	431	4,979	74,727

¹This is not the amount of mixed waste requiring disposal. Some of this waste was being accumulated for treatment.

Table 4.8 National Mixed Waste Profile
[Waste generated in 1990 that currently cannot be treated(ft³)]

Weighted													
Hazardous waste stream													
LSF	Oil	Org-Cl	Org-FI	CFC	Org-Other	Pb	Hg	Cr	Cd	Corr	Other	Total	
Academic	105	3	31	0	0	175	2	0	0	22	16	353	
Government	794	0	13	0	0	375	173	0	100	0	0	1,455	
Industry	2	21	90	0	1	63	148	40	0	0	469	834	
Medical	330	0	0	0	0	3	8	0	0	0	384	726	
Nuclear utilities	0	303	5	0	889	79	123	2	38	23	8	1,470	
TOTAL	1,231	327	139	0	890	695	454	42	138	45	877	4,838	

Table 4.9 State composition of the nine compacts (as of early 1992)

Compact	States
Northeast	Connecticut New Jersey
Appalachian	Pennsylvania West Virginia Maryland Delaware
Southeast	Alabama Florida Georgia Mississippi North Carolina South Carolina Tennessee Virginia
Central States	Arkansas Kansas Louisiana Nebraska Oklahoma
Midwest	Michigan ¹ Indiana Iowa Minnesota Missouri Ohio Wisconsin
Central Midwest	Illinois Kentucky
Rocky Mountain	Colorado Nevada New Mexico Wyoming ²
Southwest	Arizona California South Dakota North Dakota
Northwest	Idaho Washington Oregon Utah Alaska Hawaii Montana

¹Michigan is included as a member of the Midwest Compact for the purposes of this study.

²Wyoming is included as a member of the Rocky Mountain Compact for the purposes of this study.

Table 4.10 Mixed waste generated in 1990
Weighted (ft³)¹

	Facility category					Total
	Academic	Government	Industrial	Medical	Nuclear utilities	
Northeast Compact (79) ²	395	15	8,632	1,168	64	10,274
Appalachian Compact (136) ²	2,664	14,216	12,443	854	1,425	31,602
Southeast Compact (132) ²	4,448	4,438	7,416	4,061	2,757	23,120
Central States Compact (30) ²	493	68	25	74	238	898
Midwest Compact (166) ²	9,084	1,527	14,044	716	883	26,254
Central Midwest Compact (47) ²	2,071	2,892	1,694	2,208	2,679	11,544
Rocky Mountain Compact (11) ²	201	35	395	0 ³	0 ⁴	631
Northwest Compact (49) ²	1,160	576	137	1,271	31	3,175
Southwestern Compact (125) ²	3,729	206	3,292	4,146	5,142	16,515
Unaligned						
DC (11) ²	192	1,958	0 ³	5	0 ⁵	2,155
ME (7) ²	15	0 ³	0 ⁴	0 ⁴	115	130
MA (77) ²	2,434	27	1,225	911	72	4,669
NH (3) ²	0 ³	0 ⁴	0 ³	0 ³	0 ⁴	0 ⁴
NY (110) ²	1,419	300	1,100	1,829	164	4,812
PR (0) ²	0 ⁶	0 ⁶	0 ⁶	0 ³	0 ⁵	0 ⁴
RI (1) ²	0 ³	0 ³	0 ³	0 ⁴	0 ⁵	0 ⁴
TX (27) ²	380	242	27	2,661	27	3,337
VT (5) ²	297	0 ³	0 ⁴	0 ³	28	325
TOTAL (1,016) ²	28,982	26,500	50,430	19,904	13,625	139,441

¹Weights applied were determined on a national basis for each of the facility subcategories and are not state/compact specific.

²Numbers in () represent the number of facilities returning questionnaires within this compact/state.

³No facilities were surveyed in this particular category (e.g., no industrial facilities were surveyed in New Hampshire).

⁴At least one facility in this category within the compact/state returned a mixed waste survey questionnaire, and all facilities returning surveys in this category and within the compact/state reported generating no mixed waste.

⁵No facilities are present in this category within the compact/state (i.e., nuclear reactors in DC, PR, & RI).

⁶Facilities were surveyed in this category, but none of these facilities returned their surveys.

Table 4.11 Facility mixed waste profile - Academic¹
Weighted (ft³)

	Amount generated in 1990	Amount treated on-site in 1990	Amount treated off-site in 1990	Amount generated in 1990 that cannot be currently treated	Amount in storage as of 12/31/90
Hazardous Stream					
Organics					
Liquid scintillation fluids	26,919	193	54,745	233	4,289
Waste oil	15	14	1	3	6
Chlorinated organics	512	54	411	31	201
Fluorinated organics	0	0	0	0	0
Chlorinated fluorocarbons (CFCs)	0	0	0	0	0
Other organics	251	105	40	47	526
Metals					
Lead	44	18	1	2	30
Mercury	0	0	0	0	1
Chromium	5	0	2	0	1
Cadmium	0	0	0	0	0
Aqueous corrosives	71	63	0	22	68
Other hazardous materials	1,165	41	176	16	325
TOTAL	28,982	488	55,376	354	5,447

¹It should be noted that treatment and storage data are not necessarily additive since waste in either category may have been generated prior to 1990. Mixed waste that currently cannot be treated represents waste which may be difficult, or even impossible, to dispose of because of a lack of acceptable treatment capability or disposal capacity.

Table 4.12 Facility mixed waste profile - Government¹
Weighted (ft³)

Hazardous Stream	Amount generated in 1990	Amount treated on-site in 1990	Amount treated off-site in 1990	Amount generated in 1990 that cannot be currently treated	Amount in storage as of 12/31/90
Organics					
Liquid scintillation fluids	20,315	2,922	12,948	800	1,598
Waste oil	4	0	0	0	6
Chlorinated organics	1,179	0	0	13	21
Fluorinated organics	0	0	0	0	0
Chlorinated fluorocarbons (CFCs)	0	0	0	0	0
Other organics	3,525	5,651	107	369	746
Metals					
Lead	200	0	0	173	247
Mercury	0	0	0	0	0
Chromium	100	0	0	100	100
Cadmium	1	0	0	0	1
Aqueous corrosives	1,167	2	0	0	0
Other hazardous materials	9	0	0	0	69
TOTAL	26,500	8,575	13,055	1,455	2,788

¹It should be noted that treatment and storage data are not necessarily additive since waste in either category may have been generated prior to 1990. Mixed waste that currently cannot be treated represents waste which may be difficult, or even impossible, to dispose of because of a lack of acceptable treatment capability or disposal capacity.

Table 4.13 Facility mixed waste profile - Industrial¹
Weighted (ft³)

Hazardous Stream	Amount generated in 1990	Amount treated on-site in 1990	Amount treated off-site in 1990	Amount generated in 1990 that cannot be currently treated	Amount in storage as of 12/31/90
Organics	34,089	8,976	23,210	2	5,157
Liquid scintillation fluids	531	18	1	21	1,217
Waste oil	494	25	159	90	215
Chlorinated organics	0	0	0	0	122
Fluorinated organics	319	0	0	1	393
Chlorinated fluorocarbons (CFCs)	4,091	1,432	1,635	63	1,163
Other organics					
Metals					
Lead	1,365	0	148	148	171
Mercury	413	27	0	40	2,448
Chromium	643	0	0	0	1,025
Cadmium	0	0	0	0	26,304
Aqueous corrosives	1,442	0	0	0	1
Other hazardous materials	7,043	3,463	284	469	4,065
TOTAL	50,430	13,941	25,437	834	42,281

¹It should be noted that treatment and storage data are not necessarily additive since waste in either category may have been generated prior to 1990. Mixed waste that currently cannot be treated represents waste which may be difficult, or even impossible, to dispose of because of a lack of acceptable treatment capability or disposal capacity.

Table 4.14 Facility mixed waste profile - Medical¹
Weighted (ft³)

Hazardous Stream	Amount generated in 1990	Amount treated on-site in 1990	Amount treated off-site in 1990	Amount generated in 1990 that cannot be currently treated	Amount in storage as of 12/31/90
Organics					
Liquid scintillation fluids	18,862	932	15,143	330	1,622
Waste oil	0	0	0	0	0
Chlorinated organics	269	0	169	0	4
Fluorinated organics	0	0	0	0	0
Chlorinated fluorocarbons (CFCs)	0	0	0	0	0
Other organics	676	3	149	3	443
Metals					
Lead	43	33	9	8	0
Mercury	25	0	25	0	0
Chromium	0	0	0	0	0
Cadmium	0	0	0	0	0
Aqueous corrosives	2	1	2	0	1
Other hazardous materials	27	0	0	384	157
TOTAL	19,904	969	15,497	725	2,227

¹it should be noted that treatment and storage data are not necessarily additive since waste in either category may have been generated prior to 1990. Mixed waste that currently cannot be treated represents waste which may be difficult, or even impossible, to dispose of because of a lack of acceptable treatment capability or disposal capacity.

Table 4.15 Facility mixed waste profile - Nuclear utilities¹
Weighted (ft³)

	Amount generated in 1990	Amount treated on-site in 1990	Amount treated off-site in 1990	Amount generated in 1990 that cannot be currently treated	Amount in storage as of 12/31/90
Hazardous Stream					
Organics					
Liquid scintillation fluids	11	0	4	0	168
Waste oil	4,709	4,326	562	303	5,061
Chlorinated organics	50	0	0	5	512
Fluorinated organics	0	0	0	0	0
Chlorinated fluorocarbons (CFCs)	3,679	118	12	889	8,600
Other organics	1,154	15	7	79	1,284
Metals					
Lead	1,231	0	8	123	4,451
Mercury	4	0	0	2	416
Chromium	254	138	0	38	757
Cadmium	8	3	0	0	11
Aqueous corrosives	156	24	0	23	361
Other hazardous materials	2,369	168	2,274	8	363
TOTAL	13,625	4,792	2,867	1,470	21,984

¹It should be noted that treatment and storage data are not necessarily additive since waste in either category may have been generated prior to 1990. Mixed waste that currently cannot be treated represents waste which may be difficult, or even impossible, to dispose of because of a lack of acceptable treatment capability or disposal capacity.

Table 4.16 Facility mixed waste profile - All facilities¹
Weighted (ft³)

Hazardous Stream	Amount generated in 1990	Amount treated on-site in 1990	Amount treated off-site in 1990	Amount generated in 1990 that cannot be currently treated	Amount in storage as of 12/31/90
Organics					
Liquid scintillation fluids	100,194	13,023	106,050	1,231	12,834
Waste oil	5,259	4,358	564	327	6,290
Chlorinated organics	2,504	79	739	139	953
Fluorinated organics	0	0	0	0	122
Chlorinated fluorocarbons (CFCs)	3,998	118	12	8,909	8,993
Other organics	9,697	7,206	1,938	695	4,162
Metals					
Lead	2,883	51	166	454	4,899
Mercury	442	27	25	42	2,865
Chromium	1,002	137	2	138	1,883
Cadmium	9	3	0	0	26,316
Aqueous corrosives	2,838	90	2	45	431
Other hazardous materials	10,613	3,672	2,734	877	4,979
TOTAL	139,441	28,764	112,232	4,838	74,727

¹It should be noted that treatment and storage data are not necessarily additive since waste in either category may have been generated prior to 1990. Mixed waste that currently cannot be treated represents waste which may be difficult, or even impossible, to dispose of because of a lack of acceptable treatment capability or disposal capacity.

**Table 4.17 Compact/state generation of LLRW
(Generation and/or disposal in 1990)
(ft³)**

	LLRW disposed ¹	LLRW generated ² As reported	Weighted
Northeast Compact	87,019	78,202	140,757
Appalachian Compact	119,579	212,120	359,347
Southeast Compact	333,488	266,507	296,971
Central States Compact	58,377	35,885	37,730
Midwest Compact	123,393	202,502	263,854
Central Midwest Compact	102,981	91,862	107,609
Rocky Mountain Compact	4,484	4,835	7,014
Northwest Compact	95,918	65,373	154,653
Southwestern Compact	84,934	65,744	80,638
Unaligned			
DC	530	1,373	3,762
ME	7,840	19,393	19,904
MA	40,613	27,673	34,576
NH	177	992	1,167
NY	71,303	42,496	51,986
PR	0	0	0
RI	177	0	0
TX	9,217	9,711	13,411
VT	0	174	259
TOTAL	1,140,030	1,124,842	1,573,638

¹*Integrated Data Base for 1991: U.S. Spent Fuel and Radioactive Waste Inventories, Projections, and Characteristics*, DOE/RW-0006, Rev. 7, October 1991. Based on material provided by EG&G, Idaho to be published by the Low-Level Waste Management Program. IDB annual report data are based on actual "as received" manifest data from the three commercial burial grounds.

²National Mixed Waste Profile data are wastes shipped by LLRW generators and do not reflect any volume reduction activities by treaters or brokers prior to burial.

Table 4.18 Compact/state generation of mixed waste
[Generation rate in 1990 (ft³/year)]

	Previous estimate ¹	Mixed Waste Profile as reported	Mixed Waste Profile weighted
Northeast Compact	3,010	1,782	10,274
Appalachian Compact	1,876	18,881	31,602
Southeast Compact	5,340	18,356	23,120
Central States Compact	185	688	898
Midwest Compact	2,772	12,482	26,254
Central Midwest Compact	2,183	6,338	11,544
Rocky Mountain Compact	0	264	631
Northwest Compact	173	1,706	3,175
Southwestern Compact	21,156	12,261	16,515
Unaligned			
DC	422	677	2,155
ME	0	122	130
MA	1,636	2,995	4,669
NH	0	0	0
NY	4,535	3,075	4,812
PR	0	0	0
RI	0	0	0
TX	7,520	1,373	3,337
VT	0	227	325
TOTAL	50,808	81,227	139,441

¹National Profile on Commercially Generated Low-Level Radioactive Mixed Waste, Technical Letter Report for Task Two, March 31, 1991. Task Two Report generation data were derived from a wide variety of sources, including Governor Certifications, Compact/State Low-Level Waste Surveys, and Compact/State Mixed Waste Specific Surveys. Data quality, currentness, and match to National Mixed Waste Profile varied widely. **CAUTION** - Direct comparisons should not be made between individual compact state numbers.

Table 5.1. Mixed waste volume generation and storage in the United States for calendar year 1990 ^a			
Hazardous stream	Amount generated in 1990 (n ³)	Amount in storage as of 12/31/90 (n ³)	Hazardous constituents/source
Organics			
Liquid scintillation fluids (LSFs)	100,196	12,834	Liquid scintillation cocktails and similar radioactively contaminated organic solvents, such as toluene and xylene. Prevalent isotopes: ³ H, ¹⁴ C, ³² P, ³⁵ S, ¹²⁵ I, and ⁴⁵ Ca.
Waste oil	5,259	6,290	Various pump, maintenance, and equipment soils contaminated with radionuclides: ¹³⁷ Cs, ⁶⁰ Co, ¹³⁴ Cs, ³ H, ⁶⁵ Zn, ⁵⁴ Mn and/or ³⁶ S.
Chlorinated organics	2,504	953	Chloroform, trichloroethane, methylene chloride, pesticides, chlorinated solvents, and other organochlorides contaminated with radioactive isotopes: ¹⁴ C, ³ H, ³² P, ³⁵ S, and ¹²⁵ I.
Fluorinated organics	0	122	No generation.
Chlorinated fluorocarbons (CFCs)	3,998	8,993	Freon, halogenated solvents and filters contaminated with CFCs from dry cleaning, refrigeration, degreasing, and decontamination operations. Isotopes present: ¹³⁷ Cs, ⁶⁰ Co, and ⁵⁴ Mn.
Other organics	9,697	4,162	Miscellaneous organic solvents, reagents and other organic compounds, plus materials such as rags, wipes, etc., contaminated with these compounds, primarily from research labs. Isotopes include: ¹⁴ C, ³ H, ³² P, ³⁵ S, and ¹²⁵ I.
Metals			
Cadmium	9	26,316	Grit blast from decontamination operations and activated reactor control rods. Isotopes include: ¹³⁴ Cs, ¹³⁷ Cs, and ⁶⁰ Co. Inventory is mainly due to industrial sewer cleanup waste contaminated with ²³⁸ U.
Chromium	1,002	1,883	Chromium-contaminated solutions, including chromates or chromic acid from research, maintenance, and waste treatment (e.g., ion exchange). Isotopes include: ⁵¹ Cr and ⁶⁰ Co.
Lead	2,883	4,899	Primarily lead shielding from nuclear applications and lead-bearing solutions from research labs, some of which are corrosive. Also stack ash, penetration sealant oil, and other waste containing lead, including industrial batteries. Isotopes present: ¹²⁵ I, ³² P, ¹³⁷ Cs, and ⁶⁰ Co.
Mercury	442	2,865	Mercury and equipment/debris contaminated with mercury, mostly lab derived. Most also exhibit characteristic of corrosivity. Isotopes present: ³ H, ¹⁴ C, and ¹²⁵ I.
Aqueous corrosives	2,838	431	Inorganic and organic acids or, in some cases, bases, hazardous due to their corrosivity. Prevalent isotopes: ³ H, ³² P, ¹²⁵ I, ¹⁴ C, ³⁵ S, ⁶⁰ Co, and ¹³⁷ Cs.
Other hazardous materials	10,613	4,979	Various wastes including metal-contaminated organic sludges and aqueous solutions, incinerator ash, alloy, trash, chemicals, biological wastes, and sealed sources. Isotopes include: ³ H, ¹⁴ C, ³² P, ³⁵ S, ⁶⁰ Co, ¹³⁷ Cs, ⁶³ Ni, ¹²⁵ I, ¹³⁴ Cs, and ⁵¹ Cr.
Total	139,441	74,727	

^aAdding the values in columns 3 and 4 produces an estimate of the demand for treatment as defined in this report. That is, the demand is defined as the sum of the annual generation rate and the amount of waste in storage at the end of the year.

Table 5.2. Mixed waste treatment alternatives - available options

Hazardous waste stream	Hazardous constituents or characteristics	EPA waste code	RCRA BDAT	Treatment standard (Specified technology or minimum contaminant level)	Treatment alternatives	Treatment considerations	Recommended treatment
Organics							
Liquid scintillation fluids 100,196 ft ³	Liquid scintillation cocktails and similar contaminated organic solvents. Prevalent isotopes: ³ H, ¹⁴ C, ³² P, ³⁵ S, ¹²⁵ I, and/or ⁶⁵ Ca	F Series (38%) D Series (11%) OTHERS (1%) UNKNOWN ^b (50%)	Incineration	Standard varies with solvent ^c (e.g., Toluene=0.33 mg/L and Xylene=0.15 mg/L) (40 CFR 268.41, Table CCWE)	Incineration OR chemical oxidation OR biotreatment	Must meet TCLP or total composition treatment standards. May burn as waste or boiler fuel supplement.	Incineration
Waste oil ^e 5,259 ft ³	Pump, maintenance, and equipment oils contaminated with radionuclides: ^a ¹³⁷ Cs, ⁶⁰ Co, ¹³⁴ Cs, ²⁴¹ Am, ⁶⁵ Zn, ⁵⁴ Mn, and/or ³⁵ S	F001 (4%) D001 (<1%) F002 (<1%) D018 (<1%) UNKNOWN ^b (95%)	None	None	Incinerate OR precipitate radionuclides THEN recycle oil	High fuel value makes incineration attractive.	Incineration
Chlorinated organics 2,504 ft ³	Chloroform, trichloroethane, methylene chloride, pesticides, chlorinated solvents, and other organochlorides. Isotopes: ^a ¹⁴ C, ³ H, ³² P, ³⁵ S, and ¹²⁵ I	D022 (58%) F003 (18%) F001 (9%) F002 (9%) UNKNOWN ^b (6%)	Incineration	Standard varies with solvent ^c (e.g., chloroform=5.6 mg/L, TCE=0.41 mg/L, and Methylene chloride=0.96 mg/L) (40 CFR 268.41, Table CCWE)	Incinerate	High concentrations of halides can cause air pollution control system corrosion. Standard for chloroform (D022) has not yet been set.	Incineration
Fluorinated organics 0 ft ³	No generation	No generation	Incineration		Incinerate	See comments for chlorine.	Incineration
Chlorinated fluorocarbons (CFCs) 3,998 ft ³	Freon, halogenated solvents and filters contaminated with CFCs from dry cleaning, refrigeration, degreasing and decontamination operations. Isotopes: ^a ¹³⁷ Cs, ⁶⁰ Co, and ⁵⁴ Mn	F002 (72%) F001 (25%) OTHERS (<1%) UNKNOWN ^b (3%)	Incineration	Standard varies with solvent ^c (e.g., Trichlorotrifluoroethane=0.96 mg/L) (40 CFR 268.41, Table CCWE)	Incinerate OR distill THEN chemically oxidize	High halogen content precludes incineration for many CFC wastes, especially sludges. Chemical oxidation may require dilution of sludges.	<i>High halide content (95% of category):</i> Distillation THEN chemical oxidation <i>Low halide content (5% of category):</i> Incineration

Table 5.2. Mixed waste treatment alternatives - available options							
Hazardous waste stream	Hazardous constituents or characteristics	EPA waste code	RCRA BDAT	Treatment standard (Specified technology or minimum contaminant level)	Treatment alternatives	Treatment considerations	Recommended treatment
Organics							
Other organics 9,697 ft ³	Misc. organic solvents, reagents and other organic compounds or materials like rags, wipes, etc., contaminated with such, primarily from research labs. Isotopes: ^a ¹⁴ C, ³ H, ³² P, ³⁵ S, and ¹²⁵ I	D001 (32%) P003 (31%) P005 (21%) UNKNOWN ^b (13%) OTHERS (3%)	Deactivation Incineration	Standards vary with hazardous component ^c	Incinerate OR otherwise deactivate to remove ignitability	Incineration is effective treatment for hazardous constituents appearing in wastes in this category.	Incineration
Metals							
Cadmium 9 ft ³	Grit blast from decontamination operations and activated reactor control rods. Isotopes: ^a ¹³⁷ Cs, ¹³⁷ Cs, and ⁶⁰ Co	D006 (100%)	Stabilization OR recovery	1 mg/L (40 CFR 268.41, Table CCWE)	Thermal recovery of metal in industrial furnace OR stabilize in cement OR macroencapsulate		Stabilization in cement or glass
Chromium 1,002 ft ³	Chromium contaminated solutions, including chromates or chromic acid from research, maintenance, and waste treatment (ion-exchange) operations. Isotopes: ^a ⁵¹ Cr and ⁶⁰ Co	D007 (82%) UNKNOWN ^b (18%)	Stabilization OR chromium reduction	5 mg/L (40 CFR 268.41, Table CCWE)	Stabilize in cement OR chemically reduce chromium THEN precipitate/filter THEN stabilize in cement	Reducing agents and cement formulation depend on stream composition. Neutralization of filtrate may be required.	Aqueous solution: Chemical reduction THEN precipitation/neutralization THEN stabilization in cement or glass

Table 5.2. Mixed waste treatment alternatives - available options

Hazardous waste stream	Hazardous constituents or characteristics	EPA waste code	RCRA EDAF	Treatment standard (Specified technology or minimum contaminant level)	Treatment alternatives	Treatment considerations	Recommended treatment
Organics							
Lead 2,883 ft ³	Primarily (53%) lead shielding from nuclear applications	D008 (89%) OTHERS (1%) UNKNOWN ^a (10%)	Macroencapsulation	Lead shielding must be macroencapsulated (40 CFR 268.42, Table 3)	Decontaminate/reuse OR macroencapsulate shielding	Macroencapsulation unit must comply with NRC radiation protection requirements.	<i>Lead shielding:</i> Decontamination and reuse OR macroencapsulation
	Lead-bearing solutions (41%) from research labs, some of which are corrosive		Stabilization	5 mg/L (40 CFR 268.41, Table CCWE)	Precipitate solutions THEN stabilize OR incinerate solutions	Lead shielding may be high-level radioactive waste.	<i>Aqueous solutions:</i> Precipitation THEN stabilization in cement
	Stack ash (4%), penetration sealant and oil (1%), and other waste (1%), including industrial batteries		Deactivate/lead recovery		Drain/precipitate/filter acid solutions THEN add plates AND add filter THEN stabilize		<i>Acid batteries:</i> Recovery and stabilization
Mercury 442 ft ³	Isotopes present: ^a ¹²⁵ I, ⁵² P, ¹³⁷ Cs, and ⁶⁰ Co						
	Mercury-bearing solutions	D003 (89%) D009 (11%)	Deactivation (solutions) Mercury recovery	0.2 mg/L (40 CFR 268.41, Table CCWE)	Precipitate THEN filter solutions THEN neutralize filtrate AND stabilize filter. Roast/retort WITH recovery OR/AND amalgamate elemental Hg THEN stabilize.	Residues must meet numerical standard; hence, amalgamation may be required following recovery of Hg. Other treatment options (e.g., acid leaching) might be feasible but require a variance.	<i>Aqueous solutions:</i> Precipitate THEN filter THEN neutralize filtrate AND stabilize filter <i>High-Hg Inorganics:</i> Retort OR roast THEN amalgamate THEN stabilize
	Equipment/debris (inorganics) contaminated with Hg, most are lab-derived and exhibit corrosivity. Isotopes present: ^a ³ H, ¹⁴ C, and ¹²⁵ I			Roasting/retorting WITH recovery OR/AND amalgamation (40 CFR 268.42, Table 2)			

Table 5.2. Mixed waste treatment alternatives - available options

Hazardous waste stream	Hazardous constituents or characteristics	EPA waste code	RCRA HDAT	Treatment standard (Specified technology or minimum contaminant level)	Treatment alternatives	Treatment considerations	Recommended treatment
Organics							
Aqueous corrosives 2,838 ft ³	Inorganic and organic acids or, in some cases, bases, hazardous due to their corrosivity. Prevalent isotopes: ^a ³ H, ³² P, ¹²⁵ I, ¹⁴ C, ³⁵ S, ⁶⁰ Co, and ¹³⁷ Cs	D002 (99%) UNKNOWN ^b (1%)	Deactivation to remove corrosivity	Deactivation ^c to remove characteristic of corrosivity (i.e., 2.0 < pH < 12.5) (40 CFR 268.42, Table 2)	Acids: Recovery OR neutralization OR incineration Bases: Neutralization OR incineration	Over 90% of wastes in this category are acids, mostly inorganic.	Neutralization
Other hazardous material 10,613 ft ³	Misc. wastes including metal-contaminated (1) organic sludges (33%), (2) incinerator ash (32%), (3) Mg-Th alloys containing barium (11%), and (4) aqueous solutions (10%), (5) trash (10%), (6) various chemicals (1.3%), (7) biological ^d wastes (1.2%), (8) scaled sources (0.5%), and (9) others (1%). Prevalent isotopes: ^a ³ H, ¹⁴ C, ³² P, ³⁵ S, ⁶⁰ Co, ¹³⁷ Cs, ⁶³ Ni, ¹²⁵ I, ¹³⁴ Cs, and ⁵¹ Cr	Multiple codes apply to most streams in this category, including: D006 (35%) D008 (33%) D005 (11%) D002 (4%) D003 (2%) OTHERS (2%) UNKNOWN ^b (13%)	Various technological combinations apply: (1) Depends on solvents and metals present (2) Stabilization (3) Deactivation (4) Deactivation (5) Deactivation (6) Deactivation (7) Deactivation (8) Macro-encapsulation	(1) Standards vary with contaminant ^c (2) as above (3) 100 mg/L barium (4) Standards vary with contaminant (5) as above (6) as above (7) as above (8) as above	(1) Incinerate THEN stabilize ash OR distill THEN oxidize THEN stabilize residue (2) Stabilize ash (3) Macroencapsulate OR stabilize (4) Precipitate THEN filter THEN stabilize OR incinerate (5) Possibly incinerate (6) Possibly incinerate OR biotreat OR oxidize (7) Possibly incinerate (8) Macroencapsulate OR stabilize <i>Other technologies may apply</i>	Wastes in this category are more complicated, generally having multiple hazardous constituents and/or characteristics, or are less well categorized. Accurate matching of treatments to these wastes requires more extensive data than is available.	As applicable: (1) Distill/recover organics THEN oxidize THEN stabilize residue (2) Stabilize ash (3) Stabilize in cement (4) Precipitate THEN filter solutions THEN stabilize filter cake in cement (5) Insufficient data (6) Insufficient data (7) Insufficient data (8) Stabilize in cement

^aPrevalent isotopes are those occurring in a set of streams comprising at least 90% of the total number of streams for the current category. Isotopes are listed in order of decreasing frequency of occurrence. This information has been derived from National Profile data on streams treated in 1990, since isotope occurrence data for generation were not available by waste category.

^bThe designation UNKNOWN refers to waste for which the EPA code was not provided on the survey form, and there was not sufficient information describing the waste to infer an EPA code.

^cThe different contaminants appearing in this waste category are each subject to specific standards as set forth in 40 CFR 268 Subpart D.

^dSome generators reported biological wastes in the mixed waste survey. Biological wastes do not fit the definition of mixed waste provided by NRC and the EPA, unless such waste contains mixed waste. The biological waste reported here as mixed waste is assumed to actually contain mixed waste.

^eEPA recently published a final decision not to list used oil as a hazardous waste in 57 FR 21524, May 20, 1992.

Table 5.3 Treatment demand summary (ft ³) by waste category									
Hazardous stream	1990 generation (ft ³)	Generation plus storage (ft ³)	Incinerate	Thermal recovery	Decontaminate/macroencapsulate	Stabilize (cement/vitrify)	Distill/calcine organics	Reduce chemically	Precipitate/neutralize
Organics									
Liquid scintillation fluids	100,196	113,030	113,030						
Waste oil	5,259	11,549	11,549						
Chlorinated organics	2,504	3,457	3,457						
Fluorinated organics		122	122						
Chlorinated fluorocarbons	3,998	12,991	650				12,341		
Other organics	9,697	13,859	13,859						
Metals									
Cadmium	9	26,325				26,325			
Chromium	1,002	2,885				2,885		2,885	2,885
Lead	2,883	7,782	78	2	4,124	3,578			3,191
Mercury	442	3,307		364		2,943			2,943
Aqueous corrosives	2,838	3,269							3,269
Other hazardous materials	10,613	15,952				6,783	5,145		1,559
Total volume (ft³)	139,441	214,168	142,745	366	4,124	42,514	17,486	2,885	13,847
Unrecoverable volume (ft³)		11,954	78	366	4,024	0	7,486	0	0

Table 5.4 Current and potential future commercial industries treating mixed waste

Company/location	Contact	Telephone	Permits	Permitted materials	Description	Capacity ¹	Treatment technologies ¹
DSG ² P.O. Box 863 Kingston, TN 37763	Joseph Order Jim McVey	(615) 376-0084	TN Radioactive License TN Part B Permit Cogeneration Permit Air Pollution Control Permit NESHAPS Permit	D001 and variety of F, P, and U wastes, ⁴ about 2000 isotopes (see also list in Appendix B)	Liquid scintillation materials and bulk organics	130,000 ft ³ /year	Incineration ⁵
NSR ² P.O. Box 34042 Houston, TX 77234	Bob Gallagher	(713) 641-0391	TX Radioactive License	Fully permitted (see also list in Appendix B)	Broad spectrum	750,000 ft ³ /year 112,000 ft ³ /year 10,000 ft ³ /year 10,000 ft ³ /year 300 lb/d 300 lb/d 150 gal/d (battery) Storage: 50,000 gal (tanks) 250,000 gal (drums)	LSP baling/vial shredding Stabilization Chemical oxidation/ reduction Neutralization Cleaning/decontamination Macrocapitation Neutralization/shredding/ macrocapitation
Qualex Corp. 1940 NW 67th Place Gainesville, FL 32606-1649	Bernhardt Warren	(904) 373-6066	FL Radioactive License FL Part B Permit	Liquid scintillation fluids only	Liquid scintillation materials	40,000 ft ³ /year 4,500 drums/month Storage: 3,000 gal (tank) plus 1,750 drums	LSP baling/vial shredding
RAMP Industries 1127 W 46th Avenue Denver, CO 80211	John Lucas	(303) 480-1481	CO Radioactive License CO Part B Permit	D001, F003, F005, F001, F002, and variety of D wastes D002 expected now (see also list in Appendix B)	Liquid scintillation materials, oxidizers, and miscellaneous materials	25,000 ft ³ /year 6,000 ft ³ /year 5,000 ft ³ /year 600 ft ³ /year Storage: 750 drums	LSP baling/vial shredding Neutralization Stabilization Solidification Plus others: Compaction, shredding
Envirocare 215 S State Street Suite 1160 Salt Lake City, UT 84111	Kurt Higgins	(801) 532-1330	UT Radioactive License UT Part B Permit	NARM, source, by- product, SNM ⁶ (also see list in Appendix B)	Disposal only at present; treatment to be offered in future	550 acres available for low activity- and (future-) RCRA	Disposal Possible future treatment of mixed waste

Table 5.4 Current and potential future commercial industries treating mixed waste							
Company/location	Contact	Telephone	Permits	Permitted materials	Description	Capacity ¹	Treatment technologies ¹
SEG ^{2,3} P.O. Box 2530 1560 Bear Creek Road Oak Ridge, TN 37830	Bed Arrowsmith Jim Harvey	(615) 481-0722	TN Radioactive License Other permits proposed	Radioactive materials only (also see list in Appendix B)	No mixed wastes currently	None	<i>Future capability for mixed wastes:</i> Incineration, segregation, stabilization, solidification

¹Vendor capabilities are based on information provided by the vendors and were not verified.

²The following acronyms are used: Diversified Scientific Services, Inc. (DSSI), NSSI/Recovery Services, Inc. (NSSI), and Scientific Ecology Group (SEG).

³SEG cannot treat mixed wastes at the present time. They are applying for the necessary Tennessee Part B permits for simple treatment (segregation, stabilization, solidification, etc.) and for incineration of mixed waste.

⁴Tennessee lists scintillation liquids as EPA D001 wastes, other states list them as F003 and F005 wastes.

⁵DSSI burns wastes as fuels in a cogeneration boiler.

⁶NARM refers to naturally occurring or accelerator-produced radioactive material. The terms source, by-product, and SNM refer to source, by-product, and special nuclear materials as defined in 10 CFR 40.

Industries Generating Mixed Waste	Used Liquid Scintillation Cocktails	Organic Chemicals	Lead Wastes	Mercury Wastes	Chromium & Cadmium Wastes	CFC Wastes	Aqueous Corrosive Liquids	Waste Oil
Academic Institutions	•	•	•		•		•	•
Government Institutions	•	•	•		•		•	•
Industry	•	•	•	•	•	•	•	•
Medical Institutions	•	•	•	•			•	
Nuclear Power Plants	•	•	•	•	•	•	•	•

Fig. 4.1. Types of mixed waste streams.

Total: 139,441 ft³

Fig. 4.2. Mixed waste generation in 1990 by facility category (weighted).

Total: 139,441 ft³

Fig. 4.3. Mixed waste generation in 1990 by hazardous waste stream (weighted).

Total: 74,727 ft³

Fig. 4.4. Mixed waste in storage as of 12/31/90 by facility category (weighted).

Total: 74,727 ft³

Fig. 4.5. Mixed waste in storage as of 12/31/90 by hazardous waste stream (weighted).

Total: 39,245 ft³

Fig 5.1. Mixed waste generation in 1990 by hazardous waste stream (weighted) without liquid scintillation fluids.

Treatment Technologies Offered (Annual Capacity)

Capacities based on estimates provided by vendors.

Fig. 5.2 Commercial treatment capacity by vendor and treatment technology.

Treatment Technologies

Fig. 5.3 Treatability of mixed waste - availability of services versus demand.

APPENDIX A

STUDY DESIGN SPECIFICATIONS

**NATIONAL PROFILE OF MIXED WASTE GENERATORS
SURVEY DESIGN DOCUMENT**

October 2, 1991

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**U.S. Nuclear Regulatory Commission
Decommissioning and Regulatory Issues Branch
Division of Low-Level Waste Management and Decommissioning**

**Under Contract No. 68-D0-0099, Task 1-8
Exposure Evaluation Division
Office of Toxic Substances**

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1. Introduction

This document presents the statistical design of a national survey of commercially generated mixed waste. The objective of the survey is to compile a profile, both at the national level and by certain broad classes of establishments, of the volumes, characteristics and treatability of commercially generated and stored mixed waste. Because of the technical nature of the definition of mixed waste, the reader is directed to the "Technical Letter Report for Task Three" developed by Oak Ridge National Laboratory (ORNL) for a full definition. In brief, mixed waste is material which is both Low-Level Radioactive Waste (LLRW) under the Atomic Energy Act and its amendments and a hazardous waste under the Resource Conservation and Recovery Act (RCRA).

The key goals of this document are:

- to characterize the target population;
- to write down the specifics of a sampling plan;
- to describe the details of the data collection plan;
- to describe plans for dealing with survey and sampling errors; and
- to lay the foundation for the estimation process which will follow the data collection process.

The sections which follow will address each of the goals in turn.

2. Characterization of the Target Population

The unit of investigation for this study is defined as an establishment in the United States which has a potential to generate mixed waste. Since an establishment could have mixed waste on its site only if it was licensed by either the NRC or one of the Agreement States to produce, handle or dispose of radioactive waste, we can certainly restrict the target population to such establishments. It is reasonable to suggest also that we further limit the target population to establishments which also have permits or interim status under RCRA. We do not actually employ this limitation because it is possible that an establishment generates mixed waste, for example the emission of a hazardous substance from a piece of equipment on the premises, but is not required to have a permit under RCRA.

Many of the establishments having licenses from the NRC or an Agreement State could not, by the nature of their business, be generators of mixed waste. For example, from the NRC list of approximately 8,000 establishments, only about 1,750 could reasonably generate mixed waste. This group was determined by including only those establishments on the list which have a

Material License Program Code which is, according to the judgment of cognizant technical personnel, associated with an establishment that could possibly generate mixed waste. The Material License Program Codes contain information about the details of the type of radioactive material which the NRC licensee can handle. These codes are included as one of the data items in the data base of NRC licensees which was provided by the NRC. Table 1 contains the specific Material License Program Codes which were included in the definition of the population.

Although an analogous data file to that used for NRC licensed states will not be obtained for the Agreement States, the definition for the target population remains "all establishments on either the NRC or Agreement States lists which, because of the nature of their business, have a chance of generating, either by design or by accident, any mixed waste." We will describe this population as the "potential generators of mixed waste."

Within the population of potential generators of mixed waste, there will be wide variation regarding the likelihood of generating mixed waste. In particular, utilities which are operating nuclear power plants are very likely candidates to generate such wastes because of the volumes of LLRW which are generated on such sites. Therefore it is beneficial to break down the full set of establishments into smaller groups from which to select the sample. Since estimating the volume of mixed waste is the primary goal of the survey, groups which have greater potential to generate substantial volumes will be more likely to be included in the survey. The approach to this segmentation of the sample will be discussed in the next section under "Stratification" of the sample.

3. Sampling Plan

This section will discuss several components of the design of the survey. They include:

- stratification;
- sample size determination;
- sampling frame; and
- sampling procedure.

3.1 Stratification

There are two basic reasons for stratification. The first is to fulfill the requirement for producing estimates within subgroups called estimation cells of the population at a predetermined level of accuracy. This requirement is present in the Mixed Waste Survey as it is required to make accurate estimates for each of the following five types of establishments:

- Utilities
- Medical facilities
- Academic institutions

TABLE 1. Material License Program Codes Included

<u>CODE</u>	<u>DESCRIPTION</u>
01100	Academic Type A Broad
01110	Academic Type B Broad
01120	Academic Type C Broad
02110	Medical Institution Broad
02410	In-Vitro Testing Laboratories
02500	Nuclear Pharmacies
02511	Medical Product Distribution - 32.72
02512	Medical Product Distribution - 32.73
02513	Medical Product Distribution - 32.74
03110	Well Logging Byproduct / SNM Tracer & Sealed Sources
03112	Well Logging Byproduct Only - Tracers Only
03113	Field Flooding Studies
03211	Man and Dist Type Broad A
03212	Man and Dist Type Broad B
03213	Man and Dist Type Broad C
03214	Man and Dist Other
03218	Nuclear Laundry
03220	Leak Test Service Only
03221	Inst Cal Ser Only - Source < 100 Curies
03222	Inst Cal Ser Only - Source > 100 Curies
03223	Leak Test and Inst Cal Ser Only - Source < 100 Curies
03224	Leak Test and Inst Cal Ser Only - Source > 100 Curies
03225	Other Services
03231	Waste Disposal (Burial)
03232	Waste Disposal Service Prepackaged Only
03233	Waste Disposal Service Incineration
03234	Waste Disposal Service Processing and/or Repackaging
03610	R and D Type Broad A
03611	R and D Type Broad B
03612	R and D Type Broad C
03613	R and D Broad - Multisite - Multiregional
03620	R and D Other
11100	Mills
11200	Source Material Other < 150 Kilograms
11220	Source Material Military Munitions Testing
11300	Source Material Other > 150 Kilograms
11400	Uranium Hexafluoride Production Plants
11500	Solutions Testing
11700	Rare Earth Extraction and Processing
11800	Source Material
21130	Hot Cell Operations
21210	Uranium Fuel Processing Plants
21240	Uranium Fuel R&D and Pilot Plants
21310	Critical Mass Material - Universities
21320	Critical Mass Material - Other Than Universities
22110	SNM Plutonium - Unsealed < Critical Mass
22111	SNM U-235 and/or U-233 Unsealed < Critical Mass
22150	SNM Plutonium-Sealed Sources < A Critical Mass
22151	SNM U-235 and/or U-233 Sealed Sources < A Critical Mass
22162	Pacemaker Byproduct and/or SNM Man and Dist
23100	Fresh Fuel At Reactor Sites
25100	Transport-Private Carriage

- Industrial establishments
- Government facilities.

This list requires some clarifications. First, the group defined as "Utilities" includes only those establishments which are nuclear power plants. Other utilities would fall under the more general industrial category. Medical facilities include hospitals, medical laboratories, medical school hospitals and doctors' offices. Government hospitals, such as Veterans Administration hospitals, are classified as Medical establishments rather than being included in the Government category. Academic institutions include all levels of such institutions, but also some academically affiliated research facilities. The Industrial category includes all other private companies and institutions, including research and development institutions.

The second reason to introduce stratification into a survey design is to optimize the accuracy of the estimates ultimately produced. This is accomplished by selecting subgroups within the population which are similar with respect to their characteristics and with respect to the quantities being estimated. We refer to these subgroups as substrata. One example of such a group of establishments is a list which was developed by Oak Ridge National Laboratory (ORNL) from an earlier stage of this study which contains "likely" generators of mixed waste. This list contains many major generators of mixed waste including all utilities holding NRC licenses. Because establishments on this list are considered to represent a large portion of all mixed waste generated in the country, the list will be included in the survey in its entirety as a separate substratum.

Another example of a critical substratum of establishments is the set of all shippers of LLRW who do not already appear on the ORNL list. Because this group of establishments already ships LLRW, they are considered to be much more likely to be generators of mixed waste than other groups in the population. Experts consulted regarding this group also suggested that the amount of mixed waste generated by these establishments will vary widely. This can be interpreted to mean that the standard deviation, a statistical measure of the variability of a set of numbers, for this substratum will be larger than other groups.

Sampling practice dictates that survey resources should be concentrated in those segments of the population in which the variability of the key estimates (total volume of mixed waste in this case) is the highest. Following that practice will accomplish two important goals. First it will result in overall estimates of the total mixed waste which are more accurate. Second it will use the financial resources of the survey project in the most cost effective manner by concentrating the survey among establishments which are most likely to provide the NRC and EPA with useful information.

Exhibit 1 incorporates the two types of stratification discussed above to reveal a breakdown of the population of interest into the primary estimation cells (shown as rows in Exhibit 1) and,

	ORNL List	Shipper's List Excluding ORNL List	Other Potential Mixed Waste Generators				Total
			NRC		Agreement States		
			With EPA Permits	Without EPA Permits	With EPA Permits	Without EPA Permits	
Utilities	67	—	—	—	—		67
Medical	53	369	19	87	40*	170*	738*
Academic	77	207	79	136	160*	270*	929*
Industrial	105	922	167	549	330*	1,100*	3,173*
Government	16	83	5	156	10*	310*	580*
TOTAL	318	1,581	270	928	540*	1,850*	5,487*

* denotes estimate

Exhibit 1. Breakdown of the number of establishments in the population of interest.

within that, by substrata (shown as columns in Exhibit) which are introduced to increase efficiency of estimates. The substratification cells defined in that exhibit are the following:

- **Oak Ridge National Laboratory (ORNL) List.** This substratum is a list of 318 names which was compiled by ORNL. They include all nuclear power plants and other waste generators who, for one reason or another, have been designated likely generators of MW. The list contains both NRC and Agreement State licensees.
- **Shippers List Excluding the ORNL list.** This substratum contains all shippers of LLRW who do not already appear on the ORNL list. Outside of the ORNL list, this group is considered to be the next most likely group to generate mixed waste. This list contains both NRC and Agreement State licensees.
- **Other NRC Potential Mixed Waste Generators.** This substratum is defined in two steps. It starts with the group of establishments having NRC licenses and Material License Program Codes which are considered to be "potential" generators of mixed waste (using the codes in Table 1). The group is further broken down into those with and without EPA Permits to treat, store, dispose or generate hazardous waste.
- **Other Agreement State Potential Mixed Waste Generators.** This substratum is analogous to the NRC category above.

Although there is no list which categorizes these establishments by material license codes (like the NRC list), they are defined as part of the population for completeness. All numbers shown in Exhibit 1 which have an asterisk beside them are estimates and not exact counts as are the other columns in the Exhibit. They were obtained by doubling the numbers shown in the columns marked "NRC" and rounding off to the nearest factor of 10. This method of estimation was used because the total number of Agreement State licensees is approximately 16,000 as compared to 8,000 licensees for the NRC. Thus a factor of 2 was considered reasonable.

The estimates for Other Agreement States Potential Mixed Waste Generators is included in Exhibit 1 to provide a complete picture of the target population. However, after some discussion with NRC technical personnel and the other participants in this research project, it was decided not to include this group in the sampling frame for the survey. Preliminary investigation revealed that information on establishments in Agreement States, in a form analogous to that obtained for NRC establishments, does exist. Further, that information is usually in machine readable form, though with different data formats and having different sets of data fields available. However, to obtain this information it would have required submitting a request, in writing, to each of the 28 Agreement States and allowing approximately 45 days for their responses. It was a management decision, supported by technical input from the project team, that the cost of obtaining and processing this information far outweighed the expected benefit that would accrue from having it.

The latter conclusion was reached based upon the opinion of experts in the nuclear industry that most of the volume of mixed waste would be concentrated in the more easily available lists. It was also suggested that the "Other NRC Potential Mixed Waste Generators," i.e., those not on the ORNL or Shipper's lists, would be similar to the "Other Agreement State Potential Mixed Waste Generators." Therefore, the experts' opinion about the relative importance of the group not available on the ORNL and Shippers lists could be tested with the group of NRC establishments which are included in the sample. If there turns out to be a substantial component of MW found to be generated in the NRC group which is outside of both the ORNL and Shippers Lists, then a model can be built to accommodate that portion of the population on the Agreement State side.

Since no sampling will be done from the two segments of the target population shown in Exhibit 1 under "Other Potential Mixed Waste Generators, Agreement States," they will be excluded from the formal survey process. Therefore these two segments will not be shown in subsequent exhibits. Similarly, the formulation and use of the model, mentioned in the previous paragraph, is considered to be outside the scope of the survey and is not considered further in this design document.

3.2 Sample Size

A sample size determination is made using several key facts about the population and the study goals. Those include the number of units (establishments with potential for generating mixed waste) which are in each of the population strata, estimates for the means and variances of the total volume of mixed waste within each stratum, and the accuracy requirements of the survey.

For the purposes of the sample size estimation, one must formulate a reasonable target for control of sampling error. In surveys, this quantity is often expressed using the concept of relative standard error of the estimate, which is defined as the standard error of the estimate produced by the survey divided by that estimate, and for this survey we based our estimates on a target relative standard error of 10%.

It is useful to explain this concept with an example. If, after collecting the data for this survey, a standard error of 10,000 cubic feet of mixed waste is obtained as associated with an estimate of the total mixed waste generated nationally of 100,000 cubic feet, the relative standard error would be 10%. This figure must be carefully interpreted. Usually, researchers measure the "error" in an estimate by quoting probabilistically based intervals around the estimate which are called confidence intervals. A 95% confidence interval about the above example estimate would be approximately two standard errors, or 20,000 cubic feet of mixed waste.

All error requirements quoted in this document will be stated in terms of relative standard errors. However, they must be transformed into target confidence intervals to be consistent with the stated error requirements of the survey. The overall accuracy requirement set by the sponsors of this project is to be within a factor of two of the actual volume of mixed waste both nationally and within each of the five estimation cells. This requirement results in an asymmetric interval about each estimate which is half the estimate on the lower side and twice the estimate on the upper side. As described above, the relative standard error of 10% of the estimate results in a 95% confidence interval of roughly twice that size or 20% of the estimate. This component of error is that which is due to sampling error (the error introduced because a sample was taken rather than a census). The stated overall accuracy requirement on the lower and upper sides, therefore, leaves room for what is termed "non-sampling" errors. Although one can quantify the size of the sampling error, there is no similar way to quantify the size of the non-sampling error. It is a matter of subjective judgement that the level of the non-sampling error can be contained within the bounds just defined. As will be discussed below, it is generally accepted that sample sizes be defined using methods which quantify sampling error, and that non-sampling error be minimized by using established practices for questionnaire design and testing, and careful attention to all details of survey operations.

	Subgroup Mean	Subgroup Standard Deviation
Utilities	76	140
Medical	78	85
Academic	107	402
Industrial	15	34
Government	15'	34'

' denotes estimate

Exhibit 2. Estimates of Population Means and Standard Deviations in cubic feet.

Consider first the table of means and standard deviations which is shown as Exhibit 2. The two columns of this exhibit contain the means and standard deviations obtained from a small "subgroup" of six States. This information was included in an earlier Technical Letter Report produced by the Oak Ridge National Laboratory for this project. Although the volumes of mixed waste included in this subgroup represent different surveys with different selection criteria, they are the best data we have from which to make mean and standard deviation estimates for the total volume. These numbers are used as a basis for the sample size calculations which are described below. Since the six-State data did not have information about Government establishments, the mean and standard deviation for that group were estimated as being similar to the Industrial sector.

The means and standard deviations for the substrata are assumed to be constant multipliers of the figures shown in Exhibit 2. They differ from the base figures because experts in this field indicate that these groups have very different likelihoods of generating mixed waste. The multipliers of the base mean and standard deviation figures in Exhibit 2 used in producing sample size estimates are the following:

ORNL List	1.00
Shipper's Lists	1.10
Other NRC with EPA Permit	0.40
Other NRC without EPA Permit	0.20.

For example, the estimated means and standard deviations for the Academic substratum are tabulated in Exhibit 3. When the estimates for the mean generated mixed waste for all estimation cells by substrata are combined, a estimate for total mixed waste generated within the sampling frame of the survey is 103,275 cubic feet. A very crude estimate of 100,000 cubic feet of mixed waste was provided by experts in the nuclear industry. Since these figures are roughly consistent, the basic assumptions for the means and

Substratum	Mean	Standard Deviation
ORNL List	107	402
Shippers List	117.7	442.2
Other NRC with EPA Permit	42.8	160.8
Other NRC without EPA Permits	21.4	80.4

Exhibit 3. Mean and standard deviation estimates for mixed waste generated (in units of cubic feet) for the Academic Sector.

standard deviations are considered to be validated.

Using the means and standard deviations just described, we employed Neyman allocation methods to compute a sample size for each of the estimation cells separately. Each estimation cell was handled separately because the error requirements are defined to hold independently for each of these cells. It is clear that meeting the error requirements separately for each of the estimation cells, will ensure the same or better accuracy for estimates related to the combined population.

For completeness, the details of the sample size calculation for the medical estimation cell will be provided here. The sample size calculations for the other estimation cells are similar. Consider the table shown as Exhibit 4. The first four columns in the table correspond to each of the substrata, excluding the "Other Agreement State Potential Generators," within this estimation cell. The rows of the table contain the key information required to perform the sample size computation. The first row contains the total number of establishments in each of the substrata, denoted N_h to indicate population size in substratum h . The second row shows estimates for the mean mixed waste in the substrata derived from Exhibit 2. The next row is derived by multiplying the values in the prior two rows, to produce estimates for the total mixed waste in each substratum, T_h . These estimates are clearly very crude. If the amounts of mixed waste by substratum were known accurately, there would be no need to do a survey. However, for the purposes of sample size estimation and allocation, such estimates are needed. The next row contains an estimate for the standard deviation of the mixed waste in each substratum derived from Exhibit 2 using the adjustment factors for substrata and illustrated in Exhibit 3.

These numbers are combined using standard formulas to produce preliminary estimates of the total sample size required for each estimation cell. Since, the ORNL group had been designated a certainty sector early in this discussion, they are not included in the sample size calculation. This explains the need for the last column of the table. This column contains sums over those columns

	ORNL List*	Shipper's List Excluding ORNL List	Other Potential Mixed Waste Generators		Total	Total for Noncertainty Strata
			NRC			
			With EPA Permit	Without EPA Permit		
Number of Establishments (N _n)	53	369	19	87	528	475
Estimated Mean Mixed Waste in ft ³	78	85.8	31.2	15.6		
Estimated Total Mixed Waste in ft ³ (T _n)	4,134	31,660.2	592.8	1,357.2	37,744.2	33,610.2
Estimated Standard Deviation in ft ³ (S _n)	85	93.5	34	17		
SAMPLE SIZE	53	73	1	3	130	77

* denotes certainty substratum

Exhibit 4. Example of sample size calculation for the Medical estimation cell.

which are not certainty sectors.

The formula used to determine total sample size for the non-certainty cells is the following¹:

$$n = \frac{(\sum N_h S_h)^2}{V + \sum N_h S_h^2}$$

where V is the estimate for the variance of the total mixed waste for this estimation cell. In this equation, the sum is taken over only those columns in the table which are not certainty sectors, and is found in Exhibit 4 in the very last column of the Exhibit.

¹Cochran, W. G., Sampling Techniques, Third Edition, John Wiley and Sons, New York, 1977 (equation 5.50 on page 106).

V is determined using a target relative standard error of 10%. As discussed above, the relative standard error is a commonly used quantity for expressing errors in survey estimates. A 95% confidence interval would be approximately plus or minus 20% of the estimate. V is computed as follows:

$$V = (0.10 \times \sum T_h)^2.$$

This latter sum is taken over all columns including the certainty substratum. This is because the accuracy requirement is for the entire estimation cell and not just a subset of it.

The last step of the sample size computation process is to allocate the sample size just computed for the estimation cell as a whole to the individual strata. The certainty sectors are determined already, so the allocation is to the remaining strata. The formula used to allocate, following the Neyman allocation method, is the following:

$$n_h = n \left(\frac{N_h s_h}{\sum N_h s_h} \right).$$

The sum in this equation is over only the non-certainty sectors.

Exhibit 5 contains the results of the preliminary sample size calculation for all of the estimation cells combined. These estimates are preliminary because they are not yet adjusted for expected nonresponse and other constraints that will be discussed below. As Exhibit 5 demonstrates, Neyman allocation tends to concentrate the sample in those segments of the population in which the estimated volume of mixed waste is the highest and, at the same time, the variability in that volume is also the highest.

	ORNL List	Shipper's List Excluding ORNL List	Other Potential Mixed Waste Generators		TOTAL
			NRC		
			With EPA Permit	Without EPA permit	
Utilities	67	-	-	-	67
Medical	53	73	1	3	130
Academic	77	180	25	22	304
Industrial	105	273	18	30	426
Government	16	78	2	27	123
TOTAL	318	604	46	82	1,050

Exhibit 5. Preliminary sample size allocation.

Exhibit 6 contains estimates of the sample sizes for the survey revised to take into consideration the impact of nonresponse on the ultimate set of completed interviews. Nonresponse has two effects. One is that it lowers the number of available cases to be used for estimation, thus lowering the accuracy of the estimates. Second, since those who participate essentially select themselves for participation or not, there could be a subtle bias in the estimates representing the difference between those who choose to respond to the survey versus those who choose not to respond. Since we expect a 75% response rate, the numbers in Exhibit 6 were obtained from Exhibit 5, by multiplying each estimate from non-certainty cells by 1.333, the nonresponse adjustment factor (NRAF). This sample size adjustment can compensate for the fact that the number of cases who respond would be too low, but it cannot compensate for nonresponse bias. We must assume here that the group of responders are similar to the non-responders with respect to volumes of mixed waste generated, so that a nonresponse adjustment is possible. Also, we work to control the impact of non-sampling bias by careful survey operation. This will be discussed further below.

Exhibit 7 contains the final sample size estimates for the survey. These numbers are obtained from Exhibit 6 using the natural constraint that the sample size cannot exceed the total number of establishments in the population from Exhibit 1. This constraint affected the Academic row for the Shipper's column where the NRAF adjusted number of 240 cases was limited to 207. When the remaining 33 cases were allocated to the other two NRC columns, the number of cases in the Academic group having EPA permits was so close to the population total of 79, it was decided to select all such cases for the sample. This increased the sample for that estimation cell from 379 in Exhibit 6 to 407 in Exhibit 7.

	ORNL List	Shipper's List Excluding ORNL List	Other Potential Mixed Waste Generators		TOTAL
			NRC		
			With EPA Permit	Without EPA permit	
Utilities	67	-	-	-	67
Medical	53	97	1	5	155
Academic	77	240	33	29	379
Industrial	105	364	24	40	533
Government	16	104	3	36	159
TOTAL	318	805	61	109	1,293

Exhibit 6. Sample size allocation including adjustment for nonresponse.

Modifications were also made in the Government estimation cell. The NRC adjusted number appearing in Exhibit 6 of 104 cases for the Shipper's column exceeded the total of 83 cases available. Therefore, all 83 cases were included for sampling in that group, and the 21 other cases were allocated proportionately to the two NRC columns. These combined modifications resulted in a total sample of 1,321 cases, allocated to the various estimation cells and substrata as shown in Exhibit 7.

3.3 Sample size sensitivity

The sample size computations described in the prior section rely upon many assumptions and preliminary estimates. Should these assumptions be shown to be inaccurate, through the experience of the actual survey, the survey accuracy could be different than projected. The sample size estimates presented here were made using information supplied and reviewed by experts in the nuclear industry. The information was considered to be the best available short of actually doing the survey.

Exhibit 8 shows how sample size estimates change as the assumed relative standard errors (RSEs) change. The Exhibit contains sample size allocations for each of the five estimation cells and the total population. Two different assumptions for the RSE, 15% and 20%, are shown. As was mentioned earlier, all of the estimates contained in Exhibits 3 through 7 were obtained assuming a 10% RSE for the survey estimates. Within each of the two alternative accuracy assumptions in Exhibit 8, sample sizes are given for both the base sample estimate (analogous to Exhibit 5) and the final allocation which incorporates the adjustment for non-

	ORNL List	Shipper's List Excluding ORNL List	Other Potential Mixed Waste Generators		TOTAL
			NRC		
			With EPA Permit	Without EPA permit	
Utilities	67*	-	-	-	67
Medical	53*	97	1	4	155
Academic	77*	207*	79*	44	407
Industrial	105*	364	24	40	533
Government	16*	83*	5*	55	159
TOTAL	318	751	109	143	1,321

* denotes a certainty cell (all population units are sampled)

Exhibit 7. Final sample size allocation.

	15% Rel Std Error		20% Rel Std Error	
	Base Sample Size	Adjusted Sample Size	Base Sample Size	Adjusted Sample Size
Utilities	67	67	67	67
Medical	92	105	75	82
Academic	248	304	205	248
Industrial	270	325	205	238
Government	96	123	75	94
TOTAL	773	924	627	729

Exhibit 8. Sample size estimates associated with alternative assumptions for target relative standard errors of estimates.

response (analogous to Exhibit 7). It is clear from Exhibit 8 that sample sizes are effected dramatically by the assumption regarding RSE. The final non-response adjusted sample size estimate from Exhibit 7 is 1,321 as compared to 924 for 15% RSE and 729 for 20% RSE.

The project team decided to use a 10% RSE assumption for this survey for several reasons. First of all, that assumption is conservative. Since any number of the other assumptions made to produce the sample size estimates could be flawed, for example the means and standard deviations shown in Exhibit 2 or the assumed response rate, it is prudent to opt for a larger sample size. Second, an RSE of 10% yields a 95% confidence interval on the survey estimates of plus or minus 20% of those estimates. Since the non-sampling error is controlled only by careful design of the questionnaire and operation of the data collection process, there was a desire to allow sufficient room for non-sampling error to still stay within the management requirement of estimating total mixed waste to within a factor of two. A third reason for this assumption is that it was the judgement of those on the project team that sufficient financial resources were available to solicit the full 1,321 questionnaires, including the provision to do adequate follow-up of respondents.

Exhibit 8 is included in this report to fully document the discussions of the project team in setting the survey design assumptions for the project.

3.4 Sampling frame

The sampling frame is intended to be a complete physical list of the entire target population for this study. In practice, obtaining such lists, either in computer readable form or in a hard copy list, is often difficult; and this particular survey is not an exception to this rule. The definition of the target population is all "potential generators of mixed waste." The word potential was added to the definition to exclude establishments which, because of the nature of their operations, could not generate mixed waste. Work was done with the NRC list to exclude such establishments using Material License Program Codes.

The set of lists that were available for use as all or part of the sampling frame include the following:

- **The Oak Ridge List of Likely MW Generators (the ORNL List).** This list currently shows 318 establishments including all nuclear power plants. The list was formulated during the preliminary work done by ORNL on this project and was augmented slightly during the frame construction phase. It represents a group of establishments which are very likely to generate mixed waste. Since obtaining estimates for total MW generated is the main goal of this survey, this list will be included in the survey in its entirety. The list may be eventually augmented with names from two other compacts to which requests for such information was made. If the names become available at some future date, they will be matched against other substrata and added to the ORNL segment of the population and sampled with certainty.
- **The Shipper's Lists.** These are actually three separate lists of establishments which ship LLRW to one the three sites licensed to handle such waste, one each in the states of South Carolina, Washington, and Nevada. Computer readable lists for sites shipping to South Carolina and Washington were obtained from State authorities. A hard copy list of 31 establishments was obtained from Nevada State authorities and typed manually into a computer file. The three lists were merged and matched via computer to obtain one shipper's list.
- **The NRC Licensee Data Base.** This list contains a complete accounting of all NRC Licensees, and as such is the most complete source for the population of mixed waste generators for NRC states. However, since it is believed that most of the roughly 8,000 licensees would not be potential mixed waste generators, the other lists mentioned above were matched against the NRC list so that a more efficient sampling scheme could be implemented. Also, there is information on the NRC data base (namely, the Material License Program Code) which allowed the 8,000 cases on that file to be reduced to 1,748 potential mixed waste generators. As mentioned earlier, Table 1 of this document contains the complete list of Codes included in

the population. From this point forward, reference to the NRC list will mean the list of 1,748 potential generators.

- **The Agreement State Licensees.** As discussed above, it was not considered cost-effective to obtain and process lists of Agreement State licensees. Therefore, they are not included in the sampling frame for this survey except as they appear on either the ORNL or Shippers lists.
- **Hazardous Waste Data Management System (HWDMS) and Resource Conservation and Recovery Information System (RCRIS).** These data bases contain information about establishments which have permits to treat, store or dispose of hazardous waste under RCRA as well as generators of hazardous waste. The HWDMS is an older data base which is being replaced by RCRIS. At the time frame development was done, only eight states were available in the RCRIS format, the remainder being obtained from HWDMS. In either case, information relating to name, address, phone number, etc. was available. These files were available in computer readable form and, counting generators, included some 300,000 establishments.

In accordance with the sampling stratification described above, the following approach to creating a sampling frame for this survey was implemented. First, all NRC establishments on the ORNL list and the Shipper's Lists were matched against the NRC data base. Agreement State establishments on the ORNL list were crossed with those on the Shipper's Lists. All cases were, therefore, put into one the following unique groups:

- (1) the ORNL list;
- (2) the Shipper's Lists (excluding any cases on the ORNL list); and
- (3) the potential generators on the NRC list which are not on either the shipper's lists or the ORNL list.

More details on the methodology for building the sampling frame will be given in the next section.

3.5 Sampling procedure

Central to the sampling procedure is that each case included in the survey be selected with known probability. Such a sample is called a "probability sample." Without a probability sample, it is not possible to produce estimates of total volumes or other estimates from the survey which can be properly weighted and summed so as to represent the entire population of interest. Therefore, operational activities relating to the sample selection endeavored to preserve the probabilities of selection.

First, the sampling frame was created. As described above, each establishment (unit of sample selection for the survey) was

matched against the other lists to ensure that it appeared in one and only one sector.

The matching and merging proceeded as follows. The first step in this process was to put all files into a consistent computer format, identifying key fields which were in common (name, address, city, state, zip code, and contact person). Next, the three shipper's lists (in two stages) were matched to produce one large shipper's list. This combined shippers list was, then, matched against the ORNL list. When matches were discovered, the two records were collapsed into one record (retaining all information from both sources including which file the record was on). The next phase of the matching used the NRC list (suitably limited to 1,748 establishments as discussed earlier in this document). The cases which did not match to either the ORNL or (combined) shipper's list were assumed to belong to the "Other NRC Potential Mixed Waste Generators" segment of the population. The final matching step compared the NRC group with a combined version of the EPA HWDMS and RCRIS files to place each establishment in the substratum to which it belonged.

All matching was done by name. As this method of matching is not foolproof, it is expected that some duplicates still remain on the frame. The name matching algorithm worked as follows. Two files at a time were matched (as discussed in the previous paragraph). Both files were sorted by state and zip code. Any two records with the same state and zip code which had the first 5 letters of their name in common were shown as a "potential" match. This method produced many more "potential" matches than "actual" matches. The list of "potential" matches was reviewed visually to identify the actual matches. As all statistical work was done using the PC/SAS statistical package, the combining of records was done using a full screen data base editor included in that package.

It should also be mentioned that the allocation of cases in the frame to the five estimation groups (utilities, medical, academic, industrial and Government) could not be done by computer, since no codes indicating which group establishments were in was available on the data bases. Therefore it had to be done by hand using the names on the files. The allocation of establishments was done using the definitions described earlier in this document and reviewed by a second individual at David Cox & Associates. They were, then, sent for review to the technical staff at ORNL. ORNL's comments were incorporated in the final allocation of establishments to estimation cells.

The second major component of sample selection is to select a simple random sample within each of the strata according to the sample size numbers shown in Exhibit 7. In this case the method used was to assign each case in the sampling frame a random number, using the pseudo-random number generator included with the PC/SAS system. Within each of the sampling cells, the cases were sorted by random number and the initial number of cases (matching the number to be sampled from Exhibit 7) was selected as being in the

sample. This is equivalent to selecting a simple random sample within each sampling cell.

4. Data collection methodology

This data collection methodology selected for use in this survey is a mailed out survey with telephone follow-up. The survey forms will be mailed out and respondents will be allowed approximately four weeks to respond before a telephone follow-up will be made.

The follow-up call will consist of two parts. The first part will be a reminder to fill out the survey form. The second part will be an offer either to collect the information over the phone at the time of the call or to schedule a call in the future to collect the information by phone. Should those who promise to send the questionnaire in by mail not fulfill this promise within four weeks of the first call, a second call will be made to collect the data or schedule the collection by phone. Such a protocol has been shown to achieve a response rate that approaches 75% of the cases selected.

5. Assessing and controlling errors

One of the most critical aspects to designing a survey is preparation for errors. The two main categories of error which creep into surveys (whether censuses or samples) are sampling and non-sampling errors. The former refers to the error in estimates which occurs because not all of the cases in the population were used in making the estimate. This is the type of error which can be handled the easiest. Statistical methodology has been developed to the point where such errors are easily quantifiable and estimates of the impact of such errors can be made. In particular for this survey, based upon assumptions of the type used in the section on sample size computation, a sufficient number of sample units has been selected to yield a relative standard error of each estimate of total mixed waste within each estimation cell of 10% of the estimate for the total in that cell. This error requirement corresponds to a 95% confidence interval equal to plus or minus 20% of those estimates.

The other type of error, non-sampling error, is much more difficult to estimate or control. It includes:

1. Nonresponse bias.
2. Frame bias.
3. Response bias (lying, misunderstanding, answering a different question).

The first of these, non-response bias, was discussed briefly above. This type of error exists because not all of the cases selected initially are willing to participate in the survey. The usual approach to handling this error is to carefully arrange the survey

instrument and plan the operations of the survey to minimize the existence of this type of problem; however, additional cases have been included in this sample to accommodate a response rate of 75%. If the survey experiences a response rate lower than 75%, the number of cases in the resulting survey database may be fewer than is required to produce the planned level of accuracy.

A second very important way to improve response relates to how the respondent is contacted and whether he can be convinced that it is in the establishment's best interest to respond. Therefore, trade organizations and other industry groups that could have an influence on response have been contacted to provide supporting letters to be either mailed separately to the sampled establishments or included as an attachment to the main mailout.

Frame bias may result when the sampling frame does not match the target population exactly. The problem in this survey would be when cases which are potential generators of mixed waste are excluded from the frame. In that event, estimates for volumes generated could be either over- or under-estimated. Other frame problems include errors in the information on the lists (e.g., wrong address in a mail survey), duplicate entries on the file, definition of a unit on the frame not matching the definition in the target population (e.g., different uses of the term, "establishment"). The procedures described above for creating the frame were intended to produce the best sampling frame that could be obtained; however, if there are still frame duplicates, it is expected that those which are included in the sample will be found during data collection and noted at that time. During the data analysis step, those for which duplicates were found will be incorporated in an adjustment of the sample weights.

The issue of response bias relates to whether the respondents correctly answer the questions intended. There was some concern that the respondents may not be fully cognizant of the definition of mixed waste and could claim that they do not generate mixed waste (a situation that could exclude them from the survey) when in fact they do.

The impact of response bias is best mitigated by very careful design of the survey instrument. Much care has been taken to ensure that all of the key data items will be included in the survey and that subjective responses are minimized. Also, a survey pretest of approximately 20 establishments which are affiliated with the Appalachian Compact Users of Radioactive Isotopes (ACURI) is in process at this writing. All information relating to the survey instrument obtained from the pretest will be incorporated in the final survey instrument.

6. Estimation

Estimates of total mixed waste generated and other quantities collected in the survey will be produced for each estimation cell. All survey estimators will be weighted using data recording the

probability of selection which will be attached to each respondent's data record at the time of the creation of the sample. If there were no frame problems, nonresponses, or other incomplete responses during the data collection process, the weights that would be used at the analysis phase would be equal to the reciprocal of the probability of selection. However, since the majority of surveys experience some of the problems mentioned, we expect that weight adjustments, mainly for nonresponse, duplicates, and out of scope cases, will be required. Estimates of totals (for example the total mixed waste generated) will take the following form:

$$\hat{Y} = \sum_{i,j,k} Y_{i,j,k} * WGT_{i,j,k} * NRAF_{i,j}$$

where $y_{i,j,k}$ is the response of the kth establishment in the jth stratum (jth column in Exhibit 1) of estimation cell i (the ith row in Exhibit 1). WGT is the initial sampling weight associated with the establishment, and the NRAF (to be explicitly defined below) is the stratum's unit non-response adjustment factor.

The WGT for each stratum is defined as the reciprocal of the probability of selection. This number is the quotient of corresponding cells in Exhibit 1 to those in Exhibit 7 (the population number divided by the sample number). For example, for the Medical estimation cell and the Shippers substratum, the total number of cases in the population (from Exhibit 1) is 369. The sample for that cell (from Exhibit 7) is 97. Therefore, the probability of selection is $97/369 = 0.26287$ and the corresponding initial weight, WGT, is $1/0.26287 = 3.8041$.

The NRAF is computed as follows:

$$NRAF_{i,j} = \frac{\sum_{viable} WGT_{i,j,k}}{\sum_{usable} WGT_{i,j,k}}$$

where the term "viable" in the formula indicates that the sum should include all units (k) in stratum j and estimation cell i which are in scope for the survey. This would only exclude establishments which were found at the time of data collection to be duplicates, out of business, or otherwise outside of the scope of the survey. The term "usable" refers to all establishments (k) in stratum j and estimation cell i which completed the survey.

Estimates of means or proportions can also be obtained from the survey using standard formulas. A mean would be computed as

follows:

$$\bar{Y} = \frac{\sum_{i,j,k} y_{i,j,k} * WGT_{i,j,k} * NRAF_{i,j}}{\sum_{i,j,k} WGT_{i,j,k} * NRAF_{i,j}}.$$

The proportion of establishments having some characteristic can be computed using the same formula as the mean where the value $y_{i,j,k}$ is interpreted as a 1 or 0 depending on whether the characteristic is present or not.

The final comment regarding estimation relates to estimation of sampling errors. It is generally accepted as good practice in sample surveys to compute sampling errors related to estimates produced. It is planned that such errors will be computed for at least the major estimates of the survey. These include the total volume of mixed waste generated and stored nationally and by major type of establishment. For this survey it is planned to select one of the following three commonly used methods to compute sampling errors:

- balanced half sample replication;
- jackknife; or
- Taylor series approximation.

As a detailed discussion of these methods is beyond the scope of this design document, we provide a reference to the book by Wolter.¹

¹Wolter, K. M. (1985). *Introduction to Variance Estimation*, Springer-Verlag, New York.

APPENDIX B

SURVEY PACKAGE - NATIONAL PROFILE ON MIXED WASTE (INCLUDING MIXED WASTE QUESTIONNAIRE)

OAK RIDGE NATIONAL LABORATORY

OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.
FOR THE U.S. DEPARTMENT OF ENERGY

POST OFFICE BOX 2008
OAK RIDGE, TENNESSEE 37831

November 1, 1991

Recipients of the National Profile on Mixed Waste Questionnaire

As described in the following notice, Oak Ridge National Laboratory (ORNL) is participating in a project to develop a national profile on the volumes, characteristics, and treatability of commercially generated low-level radioactive mixed waste. This project is being sponsored by the U.S. Nuclear Regulatory Commission (NRC) and the U.S. Environmental Protection Agency (EPA). ORNL is requesting your participation in the development of this profile, by completing the attached questionnaire, as your facility may possibly generate mixed waste. We recognize that a number of facilities that are being asked to participate in this survey may also have participated in recent State or regional surveys. ORNL evaluated many of these surveys as part of our development of the national profile. ORNL determined that while they contain much useful information, results of previous surveys are not adequate to develop a national profile because of differing survey objectives, survey methods, and time frames.

It is important for questionnaire recipients to realize that the data from this profile will be useful to States as they plan and develop low-level radioactive waste disposal capacity as mandated in the Low-Level Radioactive Waste Policy Amendments Act of 1985. This information is not being collected for enforcement purposes by NRC or EPA. In order to make the information available to States in a timely manner, ORNL is requesting that you complete and return the survey form no later than December 2, 1991. Please complete and return the applicable portion of the survey form regardless of whether or not you generate mixed waste.

A self-addressed postcard has been included in the survey package. Your return of this card will indicate that you have received the survey package and have designated an individual to complete the questionnaire. This individual will also serve as a point of contact for any questions ORNL may have about your answers.

We appreciate your support in this important national project. If you have any questions, please feel free to telephone collect:

John Mrochek	(615) 574-6840
Jerry Klein	(615) 576-6823
Andy Francis	(615) 576-8456

Sincerely,

Jerry A. Klein, Ph.D.
Manager, Nuclear Waste Studies
and Applications

Enclosures

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

AUG 7 1991

TO NRC LICENSEES, RCRA STATE PROGRAM DIRECTORS, AND OTHER INTERESTED PARTIES

SUBJECT: ANNOUNCING PLANS FOR MIXED WASTE SURVEY

The purpose of this notice is to inform you of an upcoming survey and to request your support in making this effort a success. The U.S. Nuclear Regulatory Commission (NRC) and the U.S. Environmental Protection Agency (EPA) are conducting a voluntary survey to collect information to develop a national profile on the volumes, characteristics, and treatability of commercially generated mixed waste. Mixed waste is waste that contains a radioactive component subject to the Atomic Energy Act (AEA) and a hazardous component subject to the Resource Conservation and Recovery Act (RCRA). The Office of Management and Budget has approved the agencies' plan to survey some 1200 respondents. Since this survey will be limited to approximately 1200 respondents, not every licensee who receives this letter will receive a survey questionnaire. We hope to be in a position to begin the actual survey by September 1991. The results of the survey will be published in the Spring of 1992.

This project was undertaken by the two agencies at the request of the Host State Technical Coordinating Committee (TCC). In May 1990, a letter was sent to NRC Chairman Kenneth M. Carr and EPA Administrator William K. Reilly, by the TCC, requesting the development of a national profile on the volumes and characteristics of commercially generated mixed waste. The stated intent of the national profile should be "... to provide needed information to States and compact officials, private developers, and Federal agencies to assist in the planning and development of treatment and disposal facilities for mixed waste." As a result of this letter and consultations between NRC, EPA, and the Department of Energy (DOE), a contract was awarded to Oak Ridge National Laboratory (ORNL), to initiate work on this study.

This study began with an evaluation of past State, compact, and industry survey data to determine if these data are adequate for compiling a national mixed waste profile. At the conclusion of this initial phase, ORNL found that there was much useful existing information, but that the many different survey objectives and survey methods used, as well as the different timeframes involved in earlier surveys, argue against sole reliance on the existing data. ORNL recommended that a new survey be undertaken, and the two agencies adopted this recommendation.

The survey results are expected to help meet the current information needs of NRC, EPA, States and compact officials, and private developers. This information is expected to: (1) provide States and compacts with information to assist in planning and developing adequate disposal capacity for low-level radioactive waste, including mixed waste, as mandated by the Low-Level Radioactive Waste Policy Amendments Act; (2) provide private developers with a clearer idea of the characteristics and volumes of mixed waste and the technical capability and capacity needed to treat this waste; and (3) provide a reliable national data base on the volumes, characteristics, and treatability of commercial mixed waste. This data may also serve as a basis for possible Federal actions to effectively manage and regulate the treatment and disposal of mixed waste.

The agencies' intent in conducting this survey is to collect accurate and complete information on mixed waste for the reasons outlined above. The data are not being collected for any enforcement purpose. Survey responses will be submitted to and retained by ORNL. Survey results will be provided to NRC and EPA, stripped of any facility identification. Also, any survey results published by NRC or EPA would not identify individual facilities.

States, compact officials, and generators of low-level radioactive waste are asked to support and cooperate with this survey to help ensure that compilation of a national profile will be a meaningful and credible undertaking. The agencies' goal is to achieve at least a 75-percent response rate for this survey. Agreement State cooperation and support are especially needed to ensure that the survey provides a truly national profile. Therefore, NRC and EPA are particularly seeking the aid of Agreement State officials to facilitate making contact with Agreement State licensees. Because of the time-sensitive nature of the project, and our need to compile a national data base, we plan to make direct contact with Agreement State licensees in distributing the survey questionnaire. If this should pose a problem with any Agreement States, please contact Mr. Vandy Miller, Assistant Director for State Agreements Programs, NRC, on 301-492-0326. Any questions about the survey itself should be directed to Chad Glenn, NRC, on 301-492-0567, or Richard LaShier, EPA, on 202-382-2228.

Robert M. Bernero, Director
Office of Nuclear Material Safety
and Safeguards
U.S. Nuclear Regulatory Commission

Sylvia K. Lowrance, Director
Office of Solid Waste
U.S. Environmental Protection Agency

**UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555**

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QUESTIONNAIRE:

NATIONAL PROFILE ON MIXED WASTE

by
Oak Ridge National Laboratory

NOTICE-Public reporting burden for this collection of information is estimated to average 2 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Information and Records Management Branch (MNBB-7714) U. S. Nuclear Regulatory Commission, Washington, DC 20555; and to the Office of Information and Regulatory Affairs, Office of Management and Budget, Paperwork Reduction Project, #3150-0161, Washington, DC 20503.

QUESTIONNAIRE:
NATIONAL PROFILE ON MIXED WASTE

by
Chemical Technology Division
Oak Ridge National Laboratory

Prepared for the
U.S. Nuclear Regulatory Commission
and
U.S. Environmental Protection Agency

Prepared by the
OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37831
managed by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
under contract No. DE-AC05-84-OR21400

QUESTIONNAIRE INSTRUCTIONS

Definitions:

WASTE - For purposes of this study, waste is defined as a material not able to be recycled which must be treated, stored, disposed on-site, or shipped offsite for disposal/storage. This definition is meant to include waste oils or other materials which may be designated as "alternate fuels" and subsequently burned onsite or offsite.

LOW-LEVEL- RADIOACTIVE

WASTE - Low-level-radioactive waste (LLRW) is radioactive waste that (a) is not high-level radioactive waste, spent nuclear fuel, or byproduct material as defined in section 11e. (2) of the Atomic Energy Act (i.e. uranium or thorium mill tailings) and (b) the NRC classifies as LLRW consistent with existing law and in accordance with (a).

SOLID

WASTE - The Resource Conservation and Recovery Act (RCRA) defines solid waste as "any garbage, refuse, sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities," but does not include "source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954...." [RCRA Section 1004(27)]. EPA, NRC, and DOE interpret the exception for source, special nuclear, or byproduct material as referring only to the radionuclide component, and not to the entire waste mixture. [Low-Level Mixed Waste A RCRA Perspective for NRC Licensees, EPA/530-SW-90-057].

HAZARDOUS

WASTE - A hazardous waste is defined in RCRA as "...a solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may..." pose a "substantial present or potential hazard to human health or the environment when improperly...managed." [RCRA Section 1004(5)]. A solid waste is a hazardous waste if it is a "listed" waste or exhibits a hazardous characteristic as outlined in 40 CFR Part 261 Subpart D or C. RCRA-authorized states may declare other materials as hazardous.

MIXED

WASTE - For purposes of this project, mixed waste (MW) is defined as "waste that satisfies the definition of LLRW in the LLRW Policy Amendments Act of 1985 (LLRWPA) and contains hazardous waste that (1) is listed as hazardous waste in Subpart D of 40 CFR Part 261 or (2) causes the LLRW to exhibit any of the hazardous waste characteristics identified in Subpart C of 40 CFR Part 261". In addition, the following are included in the definition of hazardous wastes for the purpose of this study: Oils and sludges, and other wastes classified as hazardous by a RCRA-authorized state.

A. General Information

- Facility Information - Name is the facility name as shown on the NRC/Agreement State license or the name as shown on official facility stationary.
- Facility Category - Please select the **single**, best match to your facility's category. If the choice is between two possibilities, select the one most representative of your mixed waste.
- Standard Industrial Classification (SIC) Number - Bureau of Commerce publication
- NRC/Agreement State license number - Self explanatory.
- EPA identification number - Self explanatory. Please note that the size of facility referred to under EPA facility classification is in terms of **total hazardous waste** generated including mixed waste.
- Name and title...- Self explanatory.

B. Low-Level Radioactive Waste (LLRW) - Please enter the total, "as-shipped" volume (in cubic feet) of LLRW shipped either to a broker or to a disposal site during 1990 in each of the three radioactive waste classifications and the **Total** volume of LLRW shipped.

Attachment 1 contains a list of 25 potential LLRW streams which, in the case of Biological, Waste Oils, Lead-, Paint-, and Mercury-Containing Wastes are further sub-categorized. If none of these categories fit your waste stream, the last one (No. 226) can be used together with your own description of the stream. A sub-categorized waste stream should be reported as a 4-digit number with the last digit representing the subcategory; all others should be reported as their 3-digit numbers. However, the Waste Stream Numbers which are not sub-categorized may be augmented with a 4th digit to indicate the presence of a hazardous "characteristic" in that waste according to the following rule: 1 - indicating flammable; 2 - indicating reactive; 3 - indicating corrosive; and 4 - indicating toxic (e.g., 2163 would indicate a corrosive mineral extraction waste).

Note that Question B-2 requests information on **generated LLRW** and Question B-3 requests information on **stored LLRW**. Use the defining 3- or 4-digit numbers from Attachment 1 for both questions. Please use the selected waste stream numbers throughout the remainder of the questionnaire for those same generated or stored waste streams. Use the single, most descriptive **name** for that waste stream as shown in Attachment 1 (this is the only place where it should appear in the Questionnaire). Use your best judgement in describing the **Generating Practice** which results in the indicated generated or stored waste; some examples are listed in Questions B-2 and B-3.

Some respondents may immediately categorize a waste as a **mixed waste** without ever classifying it as a LLRW; in such a case, the respondent may wish to bypass Questions B-2, B-3, and Section C, starting immediately with Section D. However, please do

enter a descriptive stream number from Attachment 1. If additional pages are required to complete the requested information, please reproduce additional copies of the needed pages from this Questionnaire.

C. Hazardous Waste (HW)

Section C is designed to lead you through the regulations to determine if any of your generated or stored LLRW wastes contain a hazardous material which would cause the waste to be a **mixed waste**. Those facilities located in RCRA-authorized states should review the applicable state regulations for definitions of other hazardous materials declared by their state authorities. Follow the procedure (outlined in Figure C-1) for each **generated** (B-2) and **stored** (B-3) LLRW to identify the generated or stored mixed wastes.

D. Mixed Waste (MW)

Complete the information requested for **Generated Mixed Waste** in Questions D-1, D-2, and D-3. Detailed instructions are included with each question.

E. Stored Mixed Waste

Complete the information requested for **Stored Mixed Waste** in Questions E-1 and E-2. Detailed instructions are included with each question.

F. Mixed Waste Minimization

Please describe, in narrative style, the methods your facility is employing to minimize the generation of mixed waste.

Please remember that the intent of this survey is to gather **complete** and **accurate** information on mixed waste management and is not intended for enforcement purposes. The data reported by you will be used to assist Federal and State regulatory agencies, compact officials, and private developers in making important decisions on mixed waste management and disposal practices for many years. Your cooperation in this survey is greatly appreciated.

Please complete the Questionnaire as accurately as possible within four weeks after receipt and return it in the enclosed envelope to:

OAK RIDGE NATIONAL LABORATORY
ATTN: Dr. J. A. Klein
Nuclear Waste Studies and Applications
P. O. Box 2008, MS-6495
105 Mitchell Road
Oak Ridge, TN 37831-6495

IF YOU HAVE ANY QUESTIONS ABOUT COMPLETING THIS QUESTIONNAIRE, please call **collect** (615)574-6823, (615)574-6840 or (615)576-8456; M-F, 8:00 AM to 4:30 PM, EST.

MIXED WASTE QUESTIONNAIRE

A. General Information

● Facility Information
Name: _____

Address: _____

● Facility Category

Check ONE category which best describes your facility:

1. Nuclear Reactor Facility

Boiling Water Reactor (BWR): _____

Pressurized Water Reactor (PWR): _____

Research & Test Reactors: _____

2. Medical (non-Federal)

Hospital

<250 beds: _____

250 to 750 beds: _____

>750 beds: _____

Medical college/hospital:

Laboratory: _____

Research: _____

3. Academic

<10,000 students: _____

10,000 - 20,000 students: _____

>20,000 students: _____

● Standard Industrial Classification (SIC) Number (if known) _____

4. Industrial

Manufacturing:

<50 employees on site: _____

50 to 200 employees on site: _____

>200 employees on site: _____

Research and Development:

Decontamination facility & waste

reduction: _____

Sealed source/gauge/instrument user:

Waste broker/processor: _____

Nuclear fuel cycle other

than power reactors: _____

Commercial radiopharmacy: _____

5. Government

Federal

Hospital: _____

Research & Development: _____

Military: _____

State: _____

Other (describe): _____

● NRC/Agreement State license number: _____

● EPA identification number: _____

EPA facility classification

Large quantity generator (>1000 Kg/month): _____

Small quantity generator (100-1000 Kg/month): _____

Conditionally exempt small quantity generator

(<100Kg/month): _____

No EPA classification: _____

● Name and title of person completing form and telephone number:

Name: _____

Title: _____

Tel. No.: () _____

B. Low-Level Radioactive Waste (LLRW)

B-1. Enter total volume of LLRW (as defined in the Low-Level Radioactive Waste Policy Amendments Act of 1985) shipped for disposal during 1990 in cubic feet (one 55-gal drum is equivalent to 7.5 ft³ and one 30-gal drum is equivalent to 4.0 ft³), either to a waste broker or directly to a commercial disposal site and list the waste classification (A, B, or C as described in 10 CFR 61.55):

Class A _____ (ft³)

Class B _____ (ft³)

Class C _____ (ft³)

TOTAL LLRW SHIPPED _____ (ft³)

B-2. List your LLRW streams, generated during 1990, by number and the name of the waste (as defined in Attachment 1). Also list practices at your facility that generate this LLRW [e.g. laboratory counting procedures, waste from research or manufacturing, spent reagents, cleaning of laboratory equipment, cleaning of contaminated components, decontamination of lead shielding, lead contamination during process, backflush of resin filters and changeouts, equipment/tool decontamination, laundering garment waste, pump seal oil, etc.-].

B-2 (cont'd).

LLRW STREAM NO. AND NAME

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

LLRW GENERATING PRACTICE

B-3. List your LLRW, stored as of 12/31/90, by number and the name of the waste (as defined in Attachment 1). Under the column headed **LLRW Storage Information**, please indicate the purpose such as Storage (on- or off-site) for Decay, Storage for Accumulation (lowered cost for larger number of drums shipped off-site), Permanent On-Site Storage, Storage for Generator Treatment (volume reduction, incineration, etc.).

STORED LLRW NO. AND NAME

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

LLRW STORAGE INFORMATION

C. Hazardous Waste (HW)

Hazardous waste is a waste containing components subject to the requirements of the Resource Conservation and Recovery Act (RCRA) of 1976 and its amendments. Mixed waste is a waste with both a hazardous component subject to RCRA and a radioactive component subject to the requirements of the Atomic Energy Act of 1954. You already have determined which of your wastes are radioactive in Section B above. This part of the questionnaire will assist you in determining whether your radioactive wastes also are hazardous (and are, therefore, **mixed wastes**).

Hazardous waste may be solid, semi-liquid, liquid, or gaseous. Your waste is hazardous if (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: ignitability, corrosivity, reactivity, or toxicity.

The following four questions proceed through the HW determination process step-by-step; figure C-1 provides an overview of the 4-question process. Proceed through the process for each LLRW stream listed in B-2 and for each stored LLRW listed in B-3. A positive answer to C-2, C-3, or C-4 designates the waste as being hazardous and thus a mixed waste.

Figure C-1. The process of determining whether or not a waste is RCRA hazardous.

C-1. Is your waste excluded from the definition of hazardous waste?

EXCLUDED MATERIALS (40 CFR 261.4)

Some materials are excluded from the definition of solid waste (and, therefore, cannot be a RCRA hazardous waste):

- Domestic sewage;
- Industrial wastewater discharges regulated under Section 402 of the Clean Water Act;
- Irrigation return flows;
- Source, special nuclear or byproduct material as defined by the Atomic Energy Act¹;
- Materials subjected to in-situ mining techniques which are not removed from the ground as part of the extraction process;
- Pulping liquors that are reclaimed in a pulping liquor recovery furnace and then reused in the pulping process (unless accumulated speculatively);
- Spent sulfuric acid used to produce virgin sulfuric acid (unless accumulated speculatively); and
- Secondary materials that are reclaimed and returned to the original process or processes in which they were generated where they are reused in the production process.

Some solid wastes are excluded from the definition of hazardous waste:

- Household waste;
- Solid waste from agricultural crops and livestock returned to the soils as fertilizer;
- Mining overburden returned to the mine site;
- Ash, slag, and fine gas emission control waste generated primarily from the combustion of fossil fuel;
- Wastes from the exploration, development, or production of crude oil, natural gas, or geothermal energy;
- Chromium wastes from leather tanning and finishing industries, and from titanium oxide production;
- Solid waste from the extraction, beneficiation, and processing of ores and minerals;
- Cement kiln dust waste; and
- Arsenical-treated wood wastes.

Certain hazardous wastes used for treatability studies are exempt from regulation under Subtitle C provided they meet specific conditions (see 40 CFR 261.4 for details).

¹For the purposes of determining the applicability of RCRA, "by-product material refers to the actual radionuclides dispersed or suspended in any radioactive waste substance (except special nuclear material) yielded in, or made radioactive by exposure to, the radiation incident to the process of producing or utilizing special nuclear material." This clarification applies only to 42 U.S.C. 2011(c)(1) by-product material. According to this clarification, only the actual radionuclides, not the entire waste stream, are considered by-product material; and thus, RCRA has authority to regulate the hazardous portion of the waste stream.

_____ YES Your waste is not hazardous. Proceed to C-5.

_____ NO Proceed to Question C-2.

C-2 Is your waste specifically "listed" as a RCRA hazardous waste?

LISTED WASTES (40 CFR Part 261 Subpart D)

EPA details all listed hazardous wastes in the following three sections of 40 CFR 261 Subpart D: §261.31 for hazardous waste from non-specific sources; §261.32 for hazardous waste from specific sources; and §261.33 for discarded commercial chemical products, off-specification species, container residues, and spill residues (see Attachment 2, Tables C-1, C-2, C-3, and C-4).

NONSPECIFIC SOURCE LISTED WASTES ("F" WASTES)

There are several broad categories of "F" wastes:

F001 - F005 Spent halogenated and non-halogenated solvents (Note, these listings apply only to solvents that are in fact used for their solubilizing properties, but not to materials used, for example, as carriers. In addition, mixtures or blends of solvents are covered by the listings only if one of the listed solvents comprises at least 10% of the mixture or blend [by volume] before use.)

F006 - F009 Electroplating wastes

F010 - F012 Metal heat treating wastes

F020 - F023 Dioxin wastes

F026 - F028 Dioxin wastes

F019, F024, F025, and F039 Miscellaneous wastes

See Attachment 2, Table C-1, which is organized numerically by the assigned RCRA waste code number.

SPECIFIC SOURCE LISTED WASTES ("K" WASTES)

"K" wastes are organized in the following categories:

Wood preservation	Explosives	Primary lead	Secondary lead
Inorganic pigments	Petroleum refining	Primary zinc	Veterinary pharmaceuticals
Organic pigments	Iron and steel	Primary aluminum	Ink formulation
Inorganic chemicals	Primary copper	Ferroalloys	Coking
Pesticides			

See Attachment 2, Table C-2 which is organized numerically by waste code number.

DISCARDED COMMERCIAL CHEMICAL PRODUCTS, OFF-SPECIFICATION SPECIES, CONTAINER RESIDUES, AND SPILL RESIDUES (EITHER "T" OR "U" WASTES)

Note "T" and "U" lists apply only to chemical substances manufactured or formulated for commercial or manufacturing use, which consist of the commercially pure grade of the chemical, any technical grades of the chemical that are produced or marketed, and all formulations in which the chemical is the sole active ingredient. The lists do not apply to process wastes which contain the listed substances.

See Attachment 2, Tables C-3 and C-4, which are organized numerically by waste code number.

C-2 (cont'd)

_____ YES Your waste is hazardous (begin Section D of the questionnaire).

_____ NO Proceed to Question C-3.

C-3. Is your waste mixed with a "listed" hazardous waste or derived from a "listed" hazardous waste?

MIXTURE AND DERIVED-FROM RULES (40 CFR 261.3)

Mixture Rule

Any solid waste mixed with one or more listed hazardous waste is hazardous. This rule applies regardless of what percentage of the waste mixture is composed of listed hazardous waste (Note that certain so-called "key wastes" such as solvent- and transformer-oil-contaminated rags, may be hazardous wastes via the mixture rule). The following are exceptions to this rule:

- Wastewater subject to regulation by the Clean Water Act mixed with low concentrations of a listed waste (unless the resultant mixture exhibits one of the characteristics);
- Mixtures of nonhazardous wastes and listed wastes that were listed for exhibiting a characteristic (if the resultant mixture does not exhibit any of the characteristics);
- Mixtures of nonhazardous wastes and characteristic hazardous wastes that no longer exhibit any of the characteristics;
- Certain concentrations of spent solvents and laboratory wastewater that are discharged in low concentrations and do not pose a threat to human health or the environment; and
- De minimis losses of discarded commercial chemical products or intermediaries used as raw materials in manufacturing or produced as byproducts.

Derived-From Rule

Any solid waste generated from the management of a listed hazardous waste (including any sludge, spill residue, ash, emission control dust, or leachate, but not including precipitation run-off) is a hazardous waste.

_____ YES Your waste is hazardous (begin Section D of the Questionnaire).

_____ NO Proceed to Question C-4.

C-4. Does your waste exhibit any of the four RCRA "characteristics"?

HAZARDOUS CHARACTERISTICS (40 CFR Part 261 Subpart C)

- I. Ignitability** -- A waste is ignitable and is classified as D001 if it meets any of the following criteria:
- (1) It is a liquid (except for aqueous solutions containing less than 24 percent alcohol by volume) and has a flash point less than 140° F;
 - (2) it is not a liquid and is capable, under standard temperature and pressure, of causing fire through friction, absorption of moisture or spontaneous chemical changes, and when ignited, burns so vigorously and persistently that it creates a hazard;
 - (3) it is an ignitable compressed gas, as defined by the Department of Transportation (DOT); or
 - (4) it is an oxidizer, as defined by DOT.
- II. Corrosivity** -- A waste is corrosive and is classified as D002 if it meets either of the following criteria:
- (1) It is aqueous and has a pH less than or equal to 2 or greater than or equal to 12.5, as determined by a pH meter; or
 - (2) it is a liquid and corrodes steel at a rate greater than 0.25 inches per year at specified conditions.
- III. Reactivity** -- A waste is reactive and is classified as D003 if it meets any of the following criteria:
- (1) It is normally unstable and readily undergoes violent change without detonating;
 - (2) it reacts violently with water;
 - (3) it forms potentially explosive mixtures with water;
 - (4) when mixed with water, it generates dangerous quantities of toxic fumes, gases, or vapors;
 - (5) in the case of cyanide- or sulfide-bearing wastes, it generates dangerous quantities of toxic fumes, gases, or vapors when exposed to pH conditions between 2 and 12.5;
 - (6) it detonates or explodes when subjected to a strong initiating force or heated under confinement;
 - (7) it readily detonates or decomposes explosively at standard temperature and pressure; or
 - (8) it is defined by DOT as a forbidden explosive, Class A explosive, or Class B explosive.
- IV. Toxicity** -- A waste exhibits the characteristic of toxicity if, using the Toxicity Characteristic Leaching Procedure (TCLP) as described in 40 CFR Part 261 Appendix II (SW-846, Method 1311), a representative sample of a liquid or the extract of a solid waste contains any of the following constituents at a level equal to or greater than the given value (all values are in mg/L).

EPA Haz.No.	mg/L	EPA Haz.No.	mg/L	EPA Haz.No.	mg/L
D004 Arsenic	5.0	D027 1,4-Dichlorobenzene	7.5	D035 Methyl ethyl ketone	200.0
D005 Barium	100.0	D028 1,2-Dichloroethane	0.5	D036 Nitrobenzene	2.0
D018 Benzene	0.5	D029 1,1-Dichloroethylene	0.7	D037 Pentachlorophenol	100.0
D006 Cadmium	1.0	D030 2,4-Dinitrotoluene	0.1	D038 Pyridine	5.0
D019 Carbon tetrachloride	0.5	D012 Endrin	0.02	D010 Selenium	1.0
D020 Chloroform	0.03	D031 Heptachlor (and epoxide)	0.008	D011 Silver	5.0
D021 Chlorobenzene	100.0	D032 Hexachlorobenzene	0.1	D009 Tetrachloroethylene	0.7
D022 Chloroform	6.0	D033 Hexachloro-1,3-butadiene	0.5	D015 Toxaphene	0.5
D007 Chromium	5.0	D034 Hexachloroethane	3.0	D040 Trichloroethylene	0.5
D023 o-Cresol	200.0	D008 Lead	5.0	D041 2,4,5-Trichlorophenol	400.0
D024 m-Cresol	200.0	D013 Lindane	0.4	D042 2,4,6-Trichlorophenol	2.0
D025 p-Cresol	200.0	D009 Mercury	0.2	D017 2,4,5-TP (Silver)	1.0
D016 2,4-D	10.0	D014 Methoxychlor	10.0	D043 Vinyl Chloride	0.2

C-4 (cont'd) _____ YES Your waste is hazardous (begin Section D of this Questionnaire).
 _____ NO Your waste is not hazardous (proceed to C-5).

C-5. You have completed Section B of this Questionnaire and defined your LLRW streams and your stored LLRW. You have also completed Section C, which has aided you in determining if any of your LLRW streams or stored wastes also contain hazardous waste; having arrived at this point, you have determined that none of your LLRW contains hazardous waste and thus, you have completed this questionnaire. Please return the Questionnaire to the Oak Ridge National Laboratory in the enclosed envelope. Thank you for your participation in this national survey on the volumes, characteristics, and treatability of commercially generated low-level radioactive mixed waste.

D. Mixed Waste (MW)

D-1. In order for a waste to be regarded as a mixed waste, it must contain radioactive waste and a hazardous waste. The hazardous components of mixed waste typically are organic solvents, metallic lead, mercury, chromate, cadmium wastes, halogenated cleaning/degreasing wastes, aqueous corrosive liquids, or waste oils. For purposes of this study, waste oils and other waste materials which may be designated as "alternate fuels" and burned onsite, are included and should be reported. For each LLRW stream in B-2, identified as containing a hazardous waste in C-2, C-3, or C-4, indicate the physical form (aqueous, bulk liquid, adsorbed liquid, uncompact/compacted solid) and the basis for that judgement. Here, one of two responses is requested; a response of T is indicative of Tested for hazardous constituent levels exceeding those listed in question C-4 by the TCLP, for its corrosivity by pH measurement (pH less than or equal to 2 or greater than or equal to 12.5), or for its ignitability by measurement of its flash point (less than 60°C/140°F). The second Basis response is PK, indicating generator reliance on process knowledge to identify a waste as containing a "listed" waste or to determine that the waste would fail a "characteristic" test (Question C-4). Under Hazardous Component, the Name, EPA Hazard Waste No. (from Attachment 2, Tables C-1, C-2, C-3, C-4 or Question C-4), and the Source or origin of the component is requested; some typical names and EPA Hazard Nos. are toluene-F005, xylene-F003, lead-D008, cadmium-D006, chlorofluorocarbons, trichloroethylene, tetrachloroethylene (all three are F001), chromate-D007, etc. Those chemicals which are state-regulated will be indicated by the absence of a EPA Hazard Code No. Total Volume Generated During 1990 requests the total annual volume (in cubic feet) of the waste stream "As Generated" not "as shipped".

<u>WASTE STREAM NO.</u>	<u>PHYSICAL FORM</u>	<u>BASIS (T or PK)</u>	<u>HAZARDOUS COMPONENT</u>		<u>TOTAL VOLUME GENERATED DURING 1990 (ft³/yr)</u>
			<u>NAME AND EPA HAZ. NO.</u>	<u>SOURCE</u>	
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

WASTE STREAM NO.	PHYSICAL FORM	BASIS (T or PK)	HAZARDOUS COMPONENT		TOTAL VOLUME GENERATED DURING 1990 (ft ³ /yr)
			NAME AND EPA HAZ. NO.	SOURCE	
1	LIQUID	W	CHLORINE	151-20-3	100
2	SOLID	W	CHLORINE	151-20-3	50
3	SOLID	W	CHLORINE	151-20-3	25
4	SOLID	W	CHLORINE	151-20-3	10
5	SOLID	W	CHLORINE	151-20-3	5
6	SOLID	W	CHLORINE	151-20-3	2
7	SOLID	W	CHLORINE	151-20-3	1
8	SOLID	W	CHLORINE	151-20-3	0.5
9	SOLID	W	CHLORINE	151-20-3	0.2
10	SOLID	W	CHLORINE	151-20-3	0.1
11	SOLID	W	CHLORINE	151-20-3	0.05
12	SOLID	W	CHLORINE	151-20-3	0.02
13	SOLID	W	CHLORINE	151-20-3	0.01
14	SOLID	W	CHLORINE	151-20-3	0.005
15	SOLID	W	CHLORINE	151-20-3	0.002
16	SOLID	W	CHLORINE	151-20-3	0.001
17	SOLID	W	CHLORINE	151-20-3	0.0005
18	SOLID	W	CHLORINE	151-20-3	0.0002
19	SOLID	W	CHLORINE	151-20-3	0.0001
20	SOLID	W	CHLORINE	151-20-3	0.00005
21	SOLID	W	CHLORINE	151-20-3	0.00002
22	SOLID	W	CHLORINE	151-20-3	0.00001
23	SOLID	W	CHLORINE	151-20-3	0.000005
24	SOLID	W	CHLORINE	151-20-3	0.000002
25	SOLID	W	CHLORINE	151-20-3	0.000001
26	SOLID	W	CHLORINE	151-20-3	0.0000005
27	SOLID	W	CHLORINE	151-20-3	0.0000002
28	SOLID	W	CHLORINE	151-20-3	0.0000001
29	SOLID	W	CHLORINE	151-20-3	0.00000005
30	SOLID	W	CHLORINE	151-20-3	0.00000002
31	SOLID	W	CHLORINE	151-20-3	0.00000001
32	SOLID	W	CHLORINE	151-20-3	0.000000005
33	SOLID	W	CHLORINE	151-20-3	0.000000002
34	SOLID	W	CHLORINE	151-20-3	0.000000001
35	SOLID	W	CHLORINE	151-20-3	0.0000000005
36	SOLID	W	CHLORINE	151-20-3	0.0000000002
37	SOLID	W	CHLORINE	151-20-3	0.0000000001
38	SOLID	W	CHLORINE	151-20-3	0.00000000005
39	SOLID	W	CHLORINE	151-20-3	0.00000000002
40	SOLID	W	CHLORINE	151-20-3	0.00000000001
41	SOLID	W	CHLORINE	151-20-3	0.000000000005
42	SOLID	W	CHLORINE	151-20-3	0.000000000002
43	SOLID	W	CHLORINE	151-20-3	0.000000000001
44	SOLID	W	CHLORINE	151-20-3	0.0000000000005
45	SOLID	W	CHLORINE	151-20-3	0.0000000000002
46	SOLID	W	CHLORINE	151-20-3	0.0000000000001
47	SOLID	W	CHLORINE	151-20-3	0.00000000000005
48	SOLID	W	CHLORINE	151-20-3	0.00000000000002
49	SOLID	W	CHLORINE	151-20-3	0.00000000000001
50	SOLID	W	CHLORINE	151-20-3	0.000000000000005
51	SOLID	W	CHLORINE	151-20-3	0.000000000000002
52	SOLID	W	CHLORINE	151-20-3	0.000000000000001
53	SOLID	W	CHLORINE	151-20-3	0.0000000000000005
54	SOLID	W	CHLORINE	151-20-3	0.0000000000000002
55	SOLID	W	CHLORINE	151-20-3	0.0000000000000001
56	SOLID	W	CHLORINE	151-20-3	0.00000000000000005
57	SOLID	W	CHLORINE	151-20-3	0.00000000000000002
58	SOLID	W	CHLORINE	15	

[illegible]

D-3. For each mixed waste shown as being treated in D-2, indicate the effect of your current treatment practices. Under **After Treatment**, indicate the new **Volume** (depending on treatment, it may either increase or decrease), the new cumulative **Radioactivity** (if no change use previously listed value), and the effect of the treatment on the **Hazardous Component** in the waste (e.g. neutralization of a corrosive waste to eliminate a hazardous "characteristic", removal of a "listed" hazardous component, or immobilization to eliminate the toxic characteristic). The last column requests the **Volume** of mixed waste remaining after all current treatment techniques have been exhausted and is the waste which, under current conditions, cannot be disposed of.

[illegible]

E. Stored Mixed Waste

E-1. We understand the sensitivity on disclosing volume data for stored MW because of the time limitations on such storage after its declaration. However, an ultimate use for the data of this survey is planning for the treatment and ultimate disposal of this type of waste. We reiterate the fact that the data from your facility will not be associated with the name of your facility in any compiled results provided to NRC or EPA.

In order for a waste to be regarded as a mixed waste, it must contain radioactive waste and a hazardous waste. The hazardous components of mixed waste typically are organic solvents, metallic lead, mercury, chromate, cadmium wastes, halogenated cleaning/degreasing wastes, aqueous corrosive liquids, or waste oils. For each stored LLRW in B-3, identified as containing a hazardous waste in C-2, C-3, or C-4, indicate the physical form (aqueous, bulk liquid, adsorbed liquid, uncompact/compacted solid) and the basis for that judgement. Here, one of two responses is requested; a response of T is indicative of Tested for hazardous constituent levels exceeding those listed in question C-4 by the TCLP, for its corrosivity by pH measurement (pH less than or equal to 2 or greater than or equal to 12.5), or for its ignitability by measurement of its flash point (less than 60°C/140°F). The second Basis response is PK, indicating generator reliance on process knowledge to identify a stored waste as containing a "listed" waste (Attachment 2, Tables C-1, C-2, C-3, or C-4) or to determine that the

E-1 (cont'd)

waste would fail a "characteristic" test (Question C-4). Under **Hazardous Component**, the **Name**, **EPA Hazard Waste No.**, and the **Source** or origin of the component is requested; some typical names and EPA Hazard Nos. are lead-D008, cadmium-D006, chlorofluorocarbons, trichloroethylene, tetrachloroethylene (all three are F001), chromate-D007, etc. **Cumulative Amount in Storage** requests that volume, in ft³, as of December 31, 1990.

<u>WASTE STREAM NO.</u>	<u>PHYSICAL FORM</u>	<u>BASIS (T or PK)</u>	<u>HAZARDOUS COMPONENT</u>		<u>CUMULATIVE AMOUNT IN STORAGE, 12/31/90 (ft³)</u>
			<u>NAME AND EPA HAZ. NO.</u>	<u>SOURCE</u>	
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

E-2. For each **stored** mixed waste listed in E-1, indicate the **Major Radionuclides** (e.g. ³H, ¹⁴C, ³²P, ⁵⁹Ni, ⁶³Ni, ⁹⁰Sr, ¹³⁷Cs, ⁶⁰Co, etc.) and the **radioactive waste Classification** (A, B, C). List the **Cumulative Activity** in millicuries for each **stored** waste as of December 31, 1990 and indicate, if possible, a reason for the storage (e.g., storage for decay, accumulation of wastes for future treatment or shipment, unable to treat, ship, or dispose of the waste).

<u>WASTE STREAM NO.</u>	<u>MAJ. RADIO NUCLIDES</u>	<u>CLASS (A,B,C)</u>	<u>CUMULATIVE ACTIVITY(mCi)</u>	<u>REASON FOR STORAGE</u>
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

E-2 (cont'd)

<u>WASTE STREAM NO.</u>	<u>MAJ.RADIO NUCLIDES</u>	<u>CLASS (A,B,C)</u>	<u>CUMULATIVE ACTIVITY(mCi)</u>	<u>REASON FOR STORAGE</u>
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

F. Mixed Waste Minimization

F-1. What specific actions or procedures are you using to minimize the generation of mixed waste at your facility? (Provide a narrative response in the space below; use additional pages if necessary.)

ATTACHMENT 1

Indicate your radioactive waste streams in Sections B and C and the Tables of Sections D and E by entering their code numbers from the following list. Enter a 3-digit number for those categories which are not sub-categorized, but enter a 4-digit number for a waste stream identity which is sub-categorized, e.g. lead blankets would be identified as 2231 (sub-category 1 under lead). Any of the other Waste Stream Numbers which are not sub-categorized may be augmented to indicate the presence of a hazardous "characteristic" in that waste by the addition of a 4th digit as follows: 1 - indicating flammable; 2 - indicating reactive; 3 - indicating corrosive; and 4 - indicating toxic (e.g. 2173 would indicate a corrosive mineral extraction waste).

Waste Stream

<u>No.</u>	<u>Waste Stream Name</u>
201	Biological Waste (Non-infectious) <ol style="list-style-type: none"> 1. Animal carcasses containing ^{14}C and or tritium 2. Animal carcasses containing radioisotopes other than ^{14}C or tritium 3. Other biological waste
202	Trash and or Solid Waste (not lead) - non-compacted
203	Trash and or Solid Waste (not lead) - compacted
204	Filter Media - Dewatered
205	Filter Media - Solidified
206	Filters, Mechanical
207	Gaseous Sources
208	Incinerator Ash or Residuals
209	Ion Exchange Resins - Dewatered
210	Ion Exchange Resins - Solidified
211	Irradiated Reactor or Pool Components
212	Liquids Aqueous - Absorbed
213	Liquids Aqueous - Solidified
214	Liquids Organic - (Solvents, Chlorinated Solvents, etc.)
215	Liquids Scintillation, containing ^{14}C and/or tritium - (fluids or vials) ¹
216	Liquids Scintillation, containing radioisotopes other than ^{14}C and tritium - (fluids or vials)
217	Mineral Extraction Waste
218	Uranium Sludges
219	Radioactive Sealed Sources, Devices, or Gauges
220	Solidified Evaporator Bottoms/Concentrates/Sump Sludge
221	Vitrified Ash or Resins
222	Waste Oils (Seal Oils from pumps for example) <ol style="list-style-type: none"> 1. Solvent-contaminated waste oil 2. Waste oil free from solvent contamination
223	Lead-Containing Waste <ol style="list-style-type: none"> 1. Blankets 2. Sheeting 3. Shielding 4. Batteries 5. Aqueous liquids 6. Organic liquids 7. Lead-contaminated equipment 8. Lead-contaminated trash 9. Other

¹Scintillation cocktails that contain 0.05 microcuries/g of medium or less of ^3H or ^{14}C destined for incineration or disposal shall still be counted as mixed waste for purposes of this survey.

Waste Stream No.	<u>Waste Stream Name</u>
224	Mercury-Containing Waste <ol style="list-style-type: none"> 1. Elemental mercury 2. Hydraulic oil 3. Solids 4. Liquids 5. Other
225	Paint <ol style="list-style-type: none"> 1. Water-based 2. Oil-based 3. Epoxy-based 4. Lead-based
226	Other - (Specify)

ATTACHMENT 2

Table C-1. Hazardous wastes from non-specific sources*

Industry and EPA hazardous waste No.	Hazardous waste
Generic:	
F001	The following spent halogenated solvents used in degreasing: Tetrachloroethylene, trichloroethylene, methylene chloride, 1,1,1-trichloroethane, carbon tetrachloride, and chlorinated fluorocarbons; all spent solvent mixtures/blends used in degreasing containing, before use, a total of ten percent or more (by volume) of one or more of the above halogenated solvents or those solvents listed in F002, F004, and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.
F002	The following spent halogenated solvents: Tetrachloroethylene, methylene chloride, trichloroethylene, 1,1,1-trichloroethane, chlorobenzene, 1,1,2-trichloro-1,2,2-trifluoroethane, ortho-dichlorobenzene, trichlorofluoromethane, and 1,1,2-trichloroethane; all spent solvent mixtures/blends containing, before use, a total of ten percent or more (by volume) of one or more of the above halogenated solvents or those listed in F001, F004, or F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.
F003	The following spent non-halogenated solvents: Xylene, acetone, ethyl acetate, ethyl benzene, ethyl ether, methyl isobutyl ketone, n-butyl alcohol, cyclohexanone, and methanol; all spent solvent mixtures/blends containing, before use, only the above spent non-halogenated solvents; and all spent solvent mixtures/blends containing, before use, one or more of the above non-halogenated solvents and a total of ten percent or more (by volume) of one or more of those solvents listed in F001, F002, F004, and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.
F004	The following spent non-halogenated solvents: Cresols and cresylic acid, and nitrobenzene; all spent solvent mixtures/blends containing, before use, a total of ten percent or more (by volume) of one or more of the above non-halogenated solvents or those solvents listed in F001, F002, and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.
F005	The following spent non-halogenated solvents: Toluene, methyl ethyl ketone, carbon disulfide, isobutanol, pyridine, benzene, 2-ethoxyethanol, and 2-nitropropane; all spent solvent mixtures/blends containing, before use, a total of ten percent or more (by volume) of one or more of the above non-halogenated solvents or those solvents listed in F001, F002, or F004; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.
F006	Wastewater treatment sludges from electroplating operations except from the following processes: (1) Sulfuric acid anodizing of aluminum; (2) tin plating on carbon steel; (3) zinc plating (segregated basis) on carbon steel; (4) aluminum or zinc-aluminum plating on carbon steel; (5) cleaning/stripping associated with tin, zinc, and aluminum plating on carbon steel; and (6) chemical etching and milling of aluminum.
F007	Spent cyanide plating bath solutions from electroplating operations.
F008	Plating bath residues from the bottom of plating baths from electroplating operations where cyanides are used in the process.

Table C-1. (continued)

Industry and EPA hazardous waste No.	Hazardous waste
F009	Spent stripping and cleaning bath solutions from electroplating operations where cyanides are used in the process.
F010	Quenching bath residues from oil baths from metal heat treating operations where cyanides are used in the process.
F011	Spent cyanide solutions from salt bath pot cleaning from metal heat treating operations.
F012	Quenching wastewater treatment sludges from metal heat treating operations where cyanides are used in the process.
F019	Wastewater treatment sludges from the chemical conversion coating of aluminum except from zirconium phosphating in aluminum can washing when such phosphating is an exclusive conversion coating process.
F020	Wastes (except wastewater and spent carbon from hydrogen chloride purification) from the production or manufacturing use (as a reactant, chemical intermediate, or component in a formulating process) of tri- or tetrachlorophenol, or of intermediates used to produce their pesticide derivatives. (This listing does not include wastes from the production of Hexachlorophene from highly purified 2,4,5-trichlorophenol.)
F021	Wastes (except wastewater and spent carbon from hydrogen chloride purification) from the production or manufacturing use (as a reactant, chemical intermediate, or component in a formulating process) of pentachlorophenol, or of intermediates used to produce its derivatives.
F022	Wastes (except wastewater and spent carbon from hydrogen chloride purification) from the manufacturing use (as a reactant, chemical intermediate, or component in a formulating process) of tetra-, penta-, or hexachlorobenzenes under alkaline conditions.
F023	Wastes (except wastewater and spent carbon from hydrogen chloride purification) from the production of materials on equipment previously used for the production or manufacturing use (as a reactant, chemical intermediate, or component in a formulating process) of tri- and tetrachlorophenols. (This listing does not include wastes from equipment used only for the production or use of Hexachlorophene from highly purified 2,4,5-trichlorophenol.)
F024	Process wastes, including but not limited to, distillation residues, heavy ends, tars, and reactor clean-out wastes, from the production of certain chlorinated aliphatic hydrocarbons by free radical catalyzed processes. These chlorinated aliphatic hydrocarbons are those having carbon chain lengths ranging from one to and including five, with varying amounts and positions of chlorine substitution. (This listing does not include wastewaters, wastewater treatment sludges, spent catalysts, and wastes listed in § 261.31 or § 261.32.)
F025	Condensed light ends, spent filters and filter aids, and spent desiccant wastes from the production of certain chlorinated aliphatic hydrocarbons, by free radical catalyzed processes. These chlorinated aliphatic hydrocarbons are those having carbon chain lengths ranging from one to and including five, with varying amounts and positions of chlorine substitution.

Table C-1. (continued)

Industry and EPA hazardous waste No.	Hazardous waste
F026	Wastes (except wastewater and spent carbon from hydrogen chloride purification) from the production of materials on equipment previously used for the manufacturing use (as a reactant, chemical intermediate, or component in a formulating process) of tetra-, penta-, or hexachlorobenzene under alkaline conditions.
F027	Discarded unused formulations containing tri-, tetra-, or pentachlorophenol or discarded unused formulations containing compounds derived from these chlorophenols. (This listing does not include formulations containing Hexachlorophene synthesized from prepurified 2,4,5-trichlorophenol as the sole component.)
F028	Residues resulting from the incineration or thermal treatment of soil contaminated with EPA Hazardous Waste Nos. F020, F021, F022, F023, F026, and F027.
F039	Leachate resulting from the treatment, storage, or disposal of wastes classified by more than one waste code under Subpart D, or from a mixture of wastes classified under Subparts C and D of this part. [Leachate resulting from the management of one or more of the following EPA Hazardous Wastes and no other hazardous wastes retains its hazardous waste code(s): F020, F021, F022, F023, F026, F027, and/or F028.]

*From 40 CFR 261.31.

Table C-2. Hazardous wastes from specific sources*

Industry and EPA hazardous waste No.	Hazardous waste
Wood preservation: K001	Bottom sediment sludge from the treatment of wastewaters from wood preserving processes that use creosote and/or pentachlorophenol.
Inorganic pigments: K002	Wastewater treatment sludge from the production of chrome yellow and orange pigments.
K003	Wastewater treatment sludge from the production of molybdate orange pigments.
K004	Wastewater treatment sludge from the production of zinc yellow pigments.
K005	Wastewater treatment sludge from the production of chrome green pigments.
K006	Wastewater treatment sludge from the production of chrome oxide green pigments (anhydrous and hydrated).
K007	Wastewater treatment sludge from the production of iron blue pigments.
K008	Oven residue from the production of chrome oxide green pigments.
Organic chemicals: K009	Distillation bottoms from the production of acetaldehyde from ethylene.
K010	Distillation side cuts from the production of acetaldehyde from ethylene.
K011	Bottom stream from the wastewater stripper in the production of acrylonitrile.
K013	Bottom stream from the acetonitrile column in the production of acrylonitrile.
K014	Bottoms from the acetonitrile purification column in the production of acrylonitrile.
K015	Still bottoms from the distillation of benzyl chloride.
K016	Heavy ends or distillation residues from the production of carbon tetrachloride.
K017	Heavy ends (still bottoms) from the purification column in the production of epichlorohydrin.
K018	Heavy ends from the fractionation column in ethyl chloride production.
K019	Heavy ends from the distillation of ethylene dichloride in ethylene dichloride production.
K020	Heavy ends from the distillation of vinyl chloride in vinyl chloride monomer production.
K021	Aqueous spent antimony catalyst waste from fluoromethanes production.
K022	Distillation bottom tars from the production of phenol/acetone from cumene.

Table C-2. (continued)

Industry and EPA hazardous waste No.	Hazardous waste
K023	Distillation light ends from the production of phthalic anhydride from naphthalene.
K024	Distillation bottoms from the production of phthalic anhydride from naphthalene.
K025	Distillation bottoms from the production of nitrobenzene by the nitration of benzene.
K026	Stripping still tails from the production of methy ethyl pyridines.
K027	Centrifuge and distillation residues from toluene diisocyanate production.
K028	Spent catalyst from the hydrochlorinator reactor in the production of 1,1,1-trichloroethane.
K029	Waste from the product steam stripper in the production of 1,1,1-trichloroethane.
K030	Column bottoms or heavy ends from the combined production of trichloroethylene and perchloroethylene.
K083	Distillation bottoms from aniline production.
K085	Distillation or fractionation column bottoms from the production of chlorobenzenes.
K093	Distillation light ends from the production of phthalic anhydride from ortho-xylene.
K094	Distillation bottoms from the production of phthalic anhydride from ortho-xylene.
K095	Distillation bottoms from the production of 1,1,1-trichloroethane.
K096	Heavy ends from the heavy ends column from the production of 1,1,1-trichloroethane.
K103	Process residues from aniline extraction from the production of aniline.
K104	Combined wastewater streams generated from nitrobenzene/aniline production.
K105	Separated aqueous stream from the reactor product washing step in the production of chlorobenzenes.
K107	Column bottoms from product separation from the production of 1,1-dimethylhydrazine (UDMH) from carboxylic acid hydrazines.
K108	Condensed column overheads from product separation and condensed reactor vent gases from the production of 1,1-dimethylhydrazine (UDMH) from carboxylic acid hydrazides.
K109	Spent filter cartridges from product purification from the production of 1,1-dimethylhydrazine (UDMH) from carboxylic acid hydrazides.
K110	Condensed column overheads from intermediate separation from the production of 1,1-dimethylhydrazine (UDMH) from carboxylic and hydrazides.

Table C-2. (continued)

Industry and EPA hazardous waste No.	Hazardous waste
K111	Product washwaters from the production of dinitrotoluene via nitration of toluene.
K112	Reaction by-product water from the drying column in the production of toluenediamine via hydrogenation of dinitrotoluene.
K113	Condensed liquid light ends from the purification of toluenediamine in the production of toluenediamine via hydrogenation of dinitrotoluene.
K114	Vicinals from the purification of toluenediamine in the production of toluenediamine via hydrogenation of dinitrotoluene.
K115	Heavy ends from the purification of toluenediamine in the production of toluenediamine via hydrogenation of dinitrotoluene.
K116	Organic condensate from the solvent recovery column in the production of toluene diisocyanate via phosgenation of toluenediamine.
K117	Wastewater from the reactor vent gas scrubber in the production of ethylene dibromide via bromination of ethene.
K118	Spent adsorbent solids from purification of ethylene dibromide in the production of ethylene dibromide via bromination of ethene.
K136	Still bottoms from the purification of ethylene dibromide in the production of ethylene dibromide via bromination of ethene.
Inorganic chemicals:	
K071	Brine purification muds from the mercury cell process in chlorine production, where separately prepurified brine is not used.
K073	Chlorinated hydrocarbon waste from the purification step of the diaphragm cell process using graphite anodes in chlorine production.
K106	Wastewater treatment sludge from the mercury cell process in chlorine production.
Pesticides:	
K031	By-product salts generated in the production of MSMA and cacodylic acid.
K032	Wastewater treatment sludge from the production of chlordane.
K033	Wastewater and scrub water from the chlorination of cyclopentadiene in the production of chlordane.
K034	Filter solids from the filtration of hexachlorocyclopentadiene in the production of chlordane.
K035	Wastewater treatment sludges generated in the production of creosote.

Table C-2. (continued)

Industry and EPA hazardous waste No.	Hazardous waste
K036	Still bottoms from toluene reclamation distillation in the production of disulfoton.
K037	Wastewater treatment sludges from the production of disulfoton.
K038	Wastewater from the washing and stripping of phorate production.
K039	Filter cake from the filtration of diethylphosphorodithioic acid in the production of phorate.
K040	Wastewater treatment sludge from the production of phorate.
K041	Wastewater treatment sludge from the production of toxaphene.
K042	Heavy ends or distillation residues from the distillation of tetrachlorobenzene in the production of 2,4,5-T.
K043	2,6-Dichlorophenol waste from the production of 2,4-D.
K097	Vacuum stripper discharge from the chlordane chlorinator in the production of chlordane.
K098	Untreated process wastewater from the production of toxaphene.
K099	Untreated wastewater from the production of 2,4-D.
K123	Process wastewater (including supernates, filtrates, and washwaters) from the production of ethylenebisdithiocarbamic acid and its salts.
K124	Reactor vent scrubber water from the production of ethylenebisdithiocarbamic acid and its salts.
K125	Filtration, evaporation, and centrifugation solids from the production of ethylenebisdithiocarbamic acid and its salts.
K126	Baghouse dust and floor sweepings in milling and packaging operations from the production or formulation of ethylenebisdithiocarbamic acid and its salts.
K131	Wastewater from the reactor and spent sulfuric acid from the acid dryer from the production of methyl bromide.
K132	Spent absorbent and wastewater separator solids from the production of methyl bromide.
Explosives:	
K044	Wastewater treatment sludges from the manufacturing and processing of explosives.
K045	Spent carbon from the treatment of wastewater containing explosives.
K046	Wastewater treatment sludges from the manufacturing, formulation and loading of lead-based initiating compounds.

Table C-2. (continued)

Industry and EPA hazardous waste No.	Hazardous waste
K047	Pink/red water from TNT operations.
Petroleum refining:	
K048	Dissolved air flotation (DAF) float from the petroleum refining industry.
K049	Slop oil emulsion solids from the petroleum refining industry.
K050	Heat exchanger bundle cleaning sludge from the petroleum refining industry.
K051	API separator sludge from the petroleum refining industry.
K052	Tank bottoms (leaded) from the petroleum refining industry.
Iron and steel:	
K061	Emission control dust/sludge from the primary production of steel in electric furnaces.
K062	Spent pickle liquor generated by steel finishing operations of facilities within the iron and steel industry (SIC Codes 331 and 332).
Primary copper:	
K064	Acid plant blowdown slurry/sludge resulting from the thickening of blowdown slurry from primary copper production.
Primary lead:	
K065	Surface impoundment solids contained in and dredged from surface impoundments at primary lead smelting facilities.
Primary zinc:	
K066	Sludge from treatment of process wastewater and/or acid plant blowdown from primary zinc production.
Primary aluminum:	
K088	Spent potliners from primary aluminum reduction.
Ferroalloys:	
K090	Emission control dust or sludge from ferrochromiumsilicon production.
K091	Emission control dust or sludge from ferrochromium production.
Secondary lead:	
K069	Emission control dust/sludge from secondary lead smelting.

Table C-2. (continued)

Industry and EPA hazardous waste No.	Hazardous waste
K100	Waste leaching solution from acid leaching of emission control dust/sludge from secondary lead smelting.
Veterinary pharmaceuticals:	
K084	Wastewater treatment sludges generated during the production of veterinary pharmaceuticals from arsenic or organo-arsenic compounds.
K101	Distillation tar residues from the distillation of aniline-based compounds in the production of veterinary pharmaceuticals from arsenic or organo-arsenic compounds.
K102	Residue from the use of activated carbon for decolorization in the production of veterinary pharmaceuticals from arsenic or organo-arsenic compounds.
Ink formulation:	
K086	Solvent washes and sludges, caustic washes and sludges, or water washes and sludges from cleaning tubs and equipment used in the formulation of ink from pigments, driers, soaps, and stabilizers containing chromium and lead.
Coking:	
K060	Ammonia still lime sludge from coking operations.
K087	Decanter tank tar sludge from coking operations.

*From 40 CFR 261.32.

Table C-3. Discarded commercial chemical products*
(Acute hazardous wastes)

Hazardous Waste No.	Substance
P023	Acetaldehyde, chloro-
P002	Acetamide, N-(aminothioxomethyl)-
P057	Acetamide, 2-fluoro-
P058	Acetic acid, fluoro-, sodium salt
P002	1-Acetyl-2-thiourea
P003	Acrolein
P070	Aldicarb
P004	Aldrin
P005	Allyl alcohol
P006	Aluminum phosphide
P007	5-(Aminomethyl)-3-isoxazolol
P008	4-Aminopyridine
P009	Ammonium picrate
P119	Ammonium vanadate
P099	Argentate(1-), bis(cyano-C)-, potassium
P010	Arsenic acid H_3AsO_4
P012	Arsenic oxide As_2O_3
P011	Arsenic oxide As_2O_5
P011	Arsenic pentoxide
P012	Arsenic trioxide
P038	Arsine, diethyl-
P036	Arsonous dichloride, phenyl-
P054	Aziridine
P067	Aziridine, 2-methyl-
P013	Barium cyanide

Table C-3. (continued)

Hazardous Waste No.	Substance
P024	Benzenamine, 4-chloro-
P077	Benzenamine, 4-nitro-
P028	Benzene, (chloromethyl)-
P042	1,2-Benzenediol, 4-[1-hydroxy-2-(methylamino)ethyl]-
P046	Benzeneethanamine, alpha,alpha-dimethyl-
P014	Benzenethiol
P001	2H-1-Benzopyran-2-one, 4-hydroxy-3-(3-oxo-1-phenylbutyl)-, & salts, when present at concentrations greater than 0.3%
P028	Benzyl chloride
P015	Beryllium
P017	Bromoacetone
P018	Brucine
P045	2-Butanone, 3,3-dimethyl-1-(methylthio)-, O-[(methylamino)carbonyl] oxime
P021	Calcium cyanide
P021	Calcium cyanide $\text{Ca}(\text{CN})_2$
P022	Carbon disulfide
P095	Carbonic dichloride
P023	Chloroacetaldehyde
P024	p-Chloroaniline
P026	1-(o-Chlorophenyl)thiourea
P027	3-Chloropropionitrile
P029	Copper cyanide
P029	Copper cyanide $\text{Cu}(\text{CN})_2$
P030	Cyanides (soluble cyanide salts), not otherwise specified
P031	Cyanogen
P033	Cyanogen chloride

Table C-3. (continued)

Hazardous Waste No.	Substance
P033	Cyanogen chloride CNCl
P034	2-Cyclohexyl-4, 6-dinitrophenol
P016	Dichloromethyl ether
P036	Dichlorophenylarsine
P037	Dieldrin
P038	Diethylarsine
P041	Diethyl-p-nitrophenyl phosphate
P040	O,O-Diethyl O-pyrazinyl phosphorothioate
P043	Diisopropylfluorophosphate (DFP)
P004	1,4,5,8-Dimethanonaphthalene, 1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-, (1alpha,4alpha,4abeta,5alpha,8alpha,8abeta)-
P060	1,4,5,8-Dimethanonaphthalene, 1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-, (1alpha,4alpha,4abeta,5beta,8beta,8abeta)-
P037	2,7:3,6-Dimethanonaphth[2,3-b]oxirene, 3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-, (1aalpha,2beta,2aalpha,3beta,6beta,6aalpha,7beta,7aalpha)-
P051	2,7:3,6-Dimethanonaphth[2,3-b]oxirene, 3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-, (1aalpha,2beta,2abeta,3alpha,6alpha,6abeta,7beta,7aalpha)- & metabolites
P044	Dimethoate
P046	alpha,alpha-Dimethylphenethylamine
P047	4,6-Dinitro-o-cresol & salts
P048	2,4-Dinitrophenol
P020	Dinoseb
P085	Diphosphoramidate, octamethyl-
P111	Diphosphoric acid, tetraethyl ester
P039	Disulfoton
P049	Dithiobiuret
P050	Endosulfan
P088	Endothall

Table C-3. (continued)

Hazardous Waste No.	Substance
P051	Endrin
P051	Endrin & metabolites
P042	Epinephrine
P031	Ethanedinitrile
P066	Ethanimidothioic acid, N-[[[(methylamino)carbonyl]oxy]-, methyl ester
P101	Ethyl cyanide
P054	Ethyleneimine
P097	Famphur
P056	Fluorine
P057	Fluoroacetamide
P058	Fluoroacetic acid, sodium salt
P065	Fulminic acid, mercury(2+) salt
P059	Heptachlor
P062	Hexaethyl tetraphosphate
P116	Hydrazinecarbothioamide
P068	Hydrazine, methyl-
P063	Hydrocyanic acid
P063	Hydrogen cyanide
P096	Hydrogen phosphide
P060	Isodrin
P007	3(2H)-Isoxazolone, 5-(aminomethyl)-
P092	Mercury, (acetato-O)phenyl-
P065	Mercury fulminate
P082	Methanamine, N-methyl-N-nitroso-
P064	Methane, isocyanato-

Table C-3. (continued)

Hazardous Waste No.	Substance
P016	Methane, oxybis[chloro]-
P112	Methane, tetranitro-
P118	Methanethiol, trichloro-
P050	6,9-Methano-2,4,3-benzodioxathiepin, 6,7,8,9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-, 3-oxide
P059	4,7-Methano-1H-indene, 1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-
P066	Methomyl
P068	Methyl hydrazine
P064	Methyl isocyanate
P069	2-Methylactonitrile
P071	Methyl parathion
P072	alpha-Naphthylthiourea
P073	Nickel carbonyl
P073	Nickel carbonyl $\text{Ni}(\text{CO})_4$
P074	Nickel cyanide
P074	Nickel cyanide $\text{Ni}(\text{CN})_2$
P075	Nicotine & salts
P076	Nitric oxide
P077	p-Nitroaniline
P078	Nitrogen dioxide
P076	Nitrogen oxide NO
P078	Nitrogen oxide NO_2
P081	Nitroglycerine
P082	N-Nitrosodimethylamine
P084	N-Nitrosomethylvinylamine
P085	Octamethylpyrophosphoramidate

Table C-3. (continued)

Hazardous Waste No.	Substance
P087	Osmium oxide OsO_4
P087	Osmium tetroxide
P088	7-Oxabicyclo[2,2,1]heptane-2,3-dicarboxylic acid
P089	Parathion
P034	Phenol, 2-cyclohexyl-4,6-dinitro-
P048	Phenol, 2,4-dinitro-
P047	Phenol, 2-methyl-4,6-dinitro-, & salts
P020	Phenol, 2-(1-methylpropyl)-4, 6-dinitro-
P009	Phenol, 2,4,6-trinitro-, ammonium salt
P092	Phenylmercury acetate
P093	Phenylthiourea
P094	Phorate
P095	Phosgene
P096	Phosphine
P041	Phosphoric acid, diethyl 4-nitrophenyl ester
P039	Phosphorodithioic acid, O,O-diethyl S-[2-(ethylthio)ethyl] ester
P094	Phosphorodithioic acid, O,O-diethyl S-[(ethylthio)methyl] ester
P044	Phosphorodithioic acid, O,O-dimethyl S-[2-(methylamino)-2-oxoethyl] ester
P043	Phosphorofluoridic acid, bis(1-methylethyl) ester
P089	Phosphorothioic acid, O,O-diethyl O-(4-nitrophenyl) ester
P040	Phosphorothioic acid, O,O-diethyl O-pyrazinyl ester
P097	Phosphorothioic acid, O-[4-[(dimethylamino)sulfonyl]phenyl] O,O-dimethyl ester
P071	Phosphorothioic acid, O,O-dimethyl O-(4-nitrophenyl) ester
P110	Plumbane, tetraethyl-

Table C-3. (continued)

Hazardous Waste No.	Substance
P098	Potassium cyanide
P098	Potassium cyanide KCN
P099	Potassium silver cyanide
P070	Propanal, 2-methyl-2-(methylthio)- O-[(methylamino)carbonyl]oxime
P101	Propanenitrile
P027	Propanenitrile, 3-chloro-
P069	Propanenitrile, 2-hydroxy-2-methyl-
P081	1,2,3-Propanetriol, trinitrate
P017	2-Propanone, 1-bromo-
P102	Propargyl alcohol
P003	2-Propenal
P005	2-Propen-1-ol
P067	1,2-Propylenimine
P102	2-Propyn-1-ol
P008	4-Pyridinamine
P075	Pyridine, 3-(1-methyl-2-pyrrolidiny)-, (S), & salts
P114	Selenious acid, dithallium(1+) salt
P103	Selenourea
P104	Silver cyanide
P104	Silver cyanide AgCN
P105	Sodium azide
P106	Sodium cyanide
P106	Sodium cyanide NaCN
P107	Strontium sulfide SrS
P108	Strychnidin-10-one, & salts

Table C-3. (continued)

Hazardous Waste No.	Substance
P018	Strychnidin-10-one, 2,3-dimethoxy-
P108	Strychnine, & salts
P115	Sulfuric acid, dithallium(1+) salt
P109	Tetraethyldithiopyrophosphate
P110	Tetraethyl lead
P111	Tetraethyl pyrophosphate
P112	Tetranitromethane
P062	Tetraphosphoric acid, hexaethyl ester
P113	Thallic oxide
P113	Thallium oxide Tl_2O_3
P114	Thallium(I) selenite
P115	Thallium(I) sulfate
P109	Thiodiphosphoric acid, tetraethyl ester
P045	Thiofanox
P049	Thioimidodicarbonic diamide $[(H_2N)C(S)]_2NH$
P014	Thiophenol
P116	Thiosemicarbazide
P026	Thiourea, (2-chlorophenyl)-
P072	Thiourea, 1-naphthalenyl-
P093	Thiourea, phenyl-
P123	Toxaphene
P118	Trichloromethanethiol
P119	Vanadic acid, ammonium salt
P120	Vanadium oxide V_2O_5
P120	Vanadium pentoxide
P084	Vinylamine, N-methyl-N-nitroso-

Table C-3. (continued)

Hazardous Waste No.	Substance
P001	Warfarin, & salts, when present at concentrations greater than 0.3%
P121	Zinc cyanide
P121	Zinc cyanide $\text{Zn}(\text{CN})_2$
P122	Zinc phosphide Zn_3P_2 , when present at concentrations greater than 10%

*From 40 CFR 261.33.

**Table C-4. Discarded commercial chemical products*
(Toxic wastes)**

Hazardous Waste No.	Substance
U001	Acetaldehyde
U034	Acetaldehyde, trichloro-
U187	Acetamide, N-(4-ethoxyphenyl)-
U005	Acetamide, N-9H-fluoren-2-yl-
U240	Acetic acid, (2,4-dichlorophenoxy)-, salts & esters
U112	Acetic acid ethyl ester
U144	Acetic acid, lead(2+) salt
U214	Acetic acid, thallium(1+) salt
See: F027	Acetic acid (2,4,5-trichlorophenoxy)-
U002	Acetone
U003	Acetonitrile
U004	Acetophenone
U005	2-Acetylaminofluorene
U006	Acetyl chloride
U007	Acrylamide
U008	Acrylic acid
U009	Acrylonitrile
U011	Amitrole
U012	Aniline
U136	Arsenic acid, dimethyl-
U014	Auramine
U015	Azaserine
U010	Azirino[2',3':3,4]pyrrolo[1,2-a]indole-4,7-dione, 6-amino-8-[[aminocarbonyloxy]methyl]-1,1a,2,8,8a,8b-hexahydro-8a-methoxy-5-methyl-, [1aS-(1aalpha, 8beta,8aalpha,8balpha)]-
U157	Benz[j]aceanthrylene, 1,2-dihydro-3-methyl-

Table C-4. (continued)

Hazardous Waste No.	Substance
U016	Benz[c]acridine
U017	Benzal chloride
U192	Benzamide, 3,5-dichloro-N-(1,1-dimethyl-2-propynyl)-
U018	Benz[a]anthracene
U094	Benz[a]anthracene, 7,12-dimethyl-
U012	Benzenamine
U014	Benzenamine, 4,4'-carbonimidoylbis[N,N-dimethyl]-
U049	Benzenamine, 4-chloro-2-methyl-, hydrochloride
U093	Benzenamine, N,N-dimethyl-4-(phenylazo)-
U328	Benzenamine, 2-methyl-
U353	Benzenamine, 4-methyl-
U158	Benzenamine, 4,4'-methylenebis[2-chloro]-
U222	Benzenamine, 2-methyl-, hydrochloride
U181	Benzenamine, 2-methyl-5-nitro-
U019	Benzene
U038	Benzeneacetic acid, 4-chloro-alpha-(4-chlorophenyl)-alpha-hydroxy-, ethyl ester
U030	Benzene, 1-bromo-4-phenoxy-
U035	Benzenebutanoic acid, 4-[bis(2-chloroethyl)amino]-
U037	Benzene, chloro-
U221	Benzenediamine, ar-methyl-
U028	1,2-Benzenedicarboxylic acid, bis(2-ethylhexyl) ester
U069	1,2-Benzenedicarboxylic acid, dibutyl ester
U088	1,2-Benzenedicarboxylic acid, diethyl ester
U102	1,2-Benzenedicarboxylic acid, dimethyl ester
U107	1,2-Benzenedicarboxylic acid, dioctyl ester
U070	Benzene, 1,2-dichloro-

Table C-4. (continued)

Hazardous Waste No.	Substance
U071	Benzene, 1,3-dichloro-
U072	Benzene, 1,4-dichloro-
U060	Benzene, 1,1'-(2,2-dichloroethylidene)bis[4-chloro]-
U017	Benzene, (dichloromethyl)-
U223	Benzene, 1,3-diisocyanatomethyl-
U239	Benzene, dimethyl-
U201	1,3-Benzenediol
U127	Benzene, hexachloro-
U056	Benzene, hexahydro-
U220	Benzene, methyl-
U105	Benzene, 1-methyl-2,4-dinitro-
U106	Benzene, 2-methyl-1,3-dinitro-
U055	Benzene, (1-methylethyl)-
U169	Benzene, nitro-
U183	Benzene, pentachloro-
U185	Benzene, pentachloronitro-
U020	Benzenesulfonic acid chloride
U020	Benzenesulfonyl chloride
U207	Benzene, 1,2,4,5-tetrachloro-
U061	Benzene, 1,1'-(2,2,2-trichloroethylidene)bis[4-chloro]-
U247	Benzene, 1,1'-(2,2,2-trichloroethylidene)bis[4-methoxy]-
U023	Benzene, (trichloromethyl)-
U234	Benzene, 1,3,5-trinitro-
U021	Benzidine
U202	1,2-Benzisothiazol-3(2H)-one, 1,1-dioxide, & salts
U203	1,3-Benzodioxole, 5-(2-propenyl)-

Table C-4. (continued)

Hazardous Waste No.	Substance
U141	1,3-Benzodioxole, 5-(1-propenyl)-
U090	1,3-Benzodioxole, 5-propyl-
U064	Benzo[rs]pentaphene
U248	2H-1-Benzopyran-2-one, 4-hydroxy-3-(3-oxo-1-phenyl-butyl)-, & salts, when present at concentrations of 0.3% or less
U022	Benzo[a]pyrene
U197	p-Benzoquinone
U023	Benzotrichloride
U083	2,2'-Bioxirane
U021	[1,1'-Biphenyl]-4,4'-diamine
U073	[1,1'-Biphenyl]-4,4'-diamine, 3,3'-dichloro-
U091	[1,1'-Biphenyl]-4,4'-diamine, 3,3'-dimethoxy-
U095	[1,1'-Biphenyl]-4,4'-diamine, 3,3'-dimethyl-
U225	Bromoform
U030	4-Bromophenyl phenyl ether
U128	1,3-Butadiene, 1,1,2,3,4,4-hexachloro-
U172	1-Butanamine, N-butyl-N-nitroso-
U031	1-Butanol
U159	2-Butanone
U160	2-Butanone, peroxide
U053	2-Butenal
U074	2-Butene, 1,4-dichloro-
U143	2-Butenoic acid, 2-methyl-, 7-[[[2,3-dihydroxy-2-(1-methoxyethyl)-3-methyl-1-oxobutoxy]methyl]-2,3,5,7a-tetrahydro-1H-pyrrolizin-1-yl ester, [1S-[1alpha(Z),7(2S*),3R*),7aalpha]]-
U031	n-Butyl alcohol
U136	Cacodylic acid

Table C-4. (continued)

Hazardous Waste No.	Substance
U032	Calcium chromate
U238	Carbamic acid, ethyl ester
U178	Carbamic acid, methylnitroso-, ethyl ester
U097	Carbamic chloride, dimethyl-
U114	Carbamodithioic acid, 1,2-ethanediybis-, salts & esters
U062	Carbamothioic acid, bis(1-methylethyl)-, S-(2,3-dichloro-2-propenyl) ester
U215	Carbonic acid, dithallium(1+) salt
U033	Carbonic difluoride
U156	Carbonochloridic acid, methyl ester
U033	Carbon oxyfluoride
U211	Carbon tetrachloride
U034	Chloral
U035	Chlorambucil
U036	Chlordane, alpha & gamma isomers
U026	Chlornaphazin
U037	Chlorobenzene
U038	Chlorobenzilate
U039	p-Chloro-m-cresol
U042	2-Chloroethyl vinyl ether
U044	Chloroform
U046	Chloromethyl methyl ether
U047	beta-Chloronaphthalene
U048	o-Chlorophenol
U049	4-Chloro-o-toluidine, hydrochloride
U032	Chromic acid H_2CrO_4 , calcium salt

Table C-4. (continued)

Hazardous Waste No.	Substance
U050	Chrysene
U051	Creosote
U052	Cresol (Cresylic acid)
U053	Crotonaldehyde
U055	Cumene
U246	Cyanogen bromide (CN)Br
U197	2,5-Cyclohexadiene-1,4-dione
U056	Cyclohexane
U129	Cyclohexane, 1,2,3,4,5,6-hexachloro-, (1alpha,2alpha,3beta,4alpha,5alpha,6beta)-
U057	Cyclohexanone
U130	1,3-Cyclopentadiene, 1,2,3,4,5,5-hexachloro-
U058	Cyclophosphamide
U240	2,4-D, salts & esters
U059	Daunomycin
U060	DDD
U061	DDT
U062	Diallate
U063	Dibenz[a,h]anthracene
U064	Dibenzo[a,i]pyrene
U066	1,2-Dibromo-3-chloropropane
U069	Dibutyl phthalate
U070	o-Dichlorobenzene
U071	m-Dichlorobenzene
U072	p-Dichlorobenzene
U073	3,3'-Dichlorobenzidine

Table C-4. (continued)

Hazardous Waste No.	Substance
U074	1,4-Dichloro-2-butene
U075	Dichlorodifluoromethane
U078	1,1-Dichloroethylene
U079	1,2-Dichloroethylene
U025	Dichloroethyl ether
U027	Dichloroisopropyl ether
U024	Dichloromethoxy ethane
U081	2,4-Dichlorophenol
U082	2,6-Dichlorophenol
U084	1,3-Dichloropropene
U085	1,2:3,4-Diepoxybutane
U108	1,4-Diethyleneoxide
U028	Diethylhexyl phthalate
U086	N,N'-Diethylhydrazine
U087	O,O-Diethyl S-methyl dithiophosphate
U088	Diethyl phthalate
U089	Diethylstilbesterol
U090	Dihydrosafrole
U091	3,3'-Dimethoxybenzidine
U092	Dimethylamine
U093	p-Dimethylaminoazobenzene
U094	7,12-Dimethylbenz[a]anthracene
U095	3,3'-Dimethylbenzidine
U096	alpha,alpha-Dimethylbenzylhydroperoxide
U097	Dimethylcarbamoyl chloride
U098	1,1-Dimethylhydrazine

Table C-4. (continued)

Hazardous Waste No.	Substance
U099	1,2-Dimethylhydrazine
U101	2,4-Dimethylphenol
U102	Dimethyl phthalate
U103	Dimethyl sulfate
U105	2,4-Dinitrotoluene
U106	2,6-Dinitrotoluene
U107	Di-n-octyl phthalate
U108	1,4-Dioxane
U109	1,2-Diphenylhydrazine
U110	Dipropylamine
U111	Di-n-propylnitrosamine
U041	Epichlorohydrin
U001	Ethanal
U174	Ethanamine, N-ethyl-N-nitroso-
U155	1,2-Ethanediamine, N,N-dimethyl-N'-2-pyridinyl-N'-(2-thienylmethyl)-
U067	Ethane, 1,2-dibromo-
U076	Ethane, 1,1-dichloro-
U077	Ethane, 1,2-dichloro-
U131	Ethane, hexachloro-
U024	Ethane, 1,1'-[methylenebis(oxy)]bis[2-chloro]-
U117	Ethane, 1,1'-oxybis-(1)
U025	Ethane, 1,1'-oxybis[2-chloro]-
U184	Ethane, pentachloro-
U208	Ethane, 1,1,1,2-tetrachloro-
U209	Ethane, 1,1,2,2-tetrachloro-
U218	Ethanethioamide

Table C-4. (continued)

Hazardous Waste No.	Substance
U226	Ethane, 1,1,1-trichloro-
U227	Ethane, 1,1,2-trichloro-
U359	Ethanol, 2-ethoxy-
U173	Ethanol, 2,2'-(nitrosoimino)bis-
U004	Ethanone, 1-phenyl-
U043	Ethene, chloro-
U042	Ethene, (2-chloroethoxy)-
U078	Ethene, 1,1-dichloro-
U079	Ethene, 1,2-dichloro-
U210	Ethene, tetrachloro-
U228	Ethene, trichloro-
U112	Ethyl acetate
U113	Ethyl acrylate
U238	Ethyl carbamate (urethane)
U117	Ethyl ether
U114	Ethylenebisdithiocarbamic acid, salts & esters
U067	Ethylene dibromide
U077	Ethylene dichloride
U359	Ethylene glycol monoethyl ether
U115	Ethylene oxide
U116	Ethylenethiourea
U076	Ethylidene dichloride
U118	Ethyl methacrylate
U119	Ethyl methanesulfonate
U120	Fluoranthene
U122	Formaldehyde

Table C-4. (continued)

Hazardous Waste No.	Substance
U123	Formic acid
U124	Furan
U125	2-Furancarboxaldehyde
U147	2,5-Furandione
U213	Furan, tetrahydro-
U125	Furfural
U124	Furfuran
U206	Glucopyranose, 2-deoxy-2-(3-methyl-3-nitroso-ureido)-, D-
U206	D-Glucose, 2-deoxy-2-[[[(methylnitrosoamino)- carbonyl]amino]-
U126	Glycidylaldehyde
U163	Guanidine, N-methyl-N'-nitro-N-nitroso-
U127	Hexachlorobenzene
U128	Hexachlorobutadiene
U130	Hexachlorocyclopentadiene
U131	Hexachloroethane
U132	Hexachlorophene
U243	Hexachloropropene
U133	Hydrazine
U086	Hydrazine, 1,2-diethyl-
U098	Hydrazine, 1,1-dimethyl-
U099	Hydrazine, 1,2-dimethyl-
U109	Hydrazine, 1,2-diphenyl-
U134	Hydrofluoric acid
U134	Hydrogen fluoride
U135	Hydrogen sulfide

Table C-4. (continued)

Hazardous Waste No.	Substance
U135	Hydrogen sulfide H ₂ S
U096	Hydroperoxide, 1-methyl-1-phenylethyl-
U116	2-Imidazolidinethione
U137	Indeno[1,2,3-cd]pyrene
U190	1,3-Isobenzofurandione
U140	Isobutyl alcohol
U141	Isosafrole
U142	Kepone
U143	Lasiocarpine
U144	Lead acetate
U146	Lead, bis(acetato-O)tetrahydroxytri-
U145	Lead phosphate
U146	Lead subacetate
U129	Lindane
U163	MNNG
U147	Maleic anhydride
U148	Maleic hydrazide
U149	Malononitrile
U150	Melphalan
U151	Mercury
U152	Methacrylonitrile
U092	Methanamine, N-methyl-
U029	Methane, bromo-
U045	Methane, chloro-
U046	Methane, chloromethoxy-
U068	Methane, dibromo-

Table C-4. (continued)

Hazardous Waste No.	Substance
U080	Methane, dichloro-
U075	Methane, dichlorodifluoro-
U138	Methane, iodo-
U119	Methanesulfonic acid, ethyl ester
U211	Methane, tetrachloro-
U153	Methanethiol
U225	Methane, tribromo-
U044	Methane, trichloro-
U121	Methane, trichlorofluoro-
U036	4,7-Methano-1H-indene, 1,2,4,5,6,7,8,8-octachloro-2,3,3a,4,7,7a-hexahydro-
U154	Methanol
U155	Methapyrilene
U142	1,3,4-Metheno-2H-cyclobuta[cd]pentalen-2-one, 1,1a,3,3a,4,5,5,5a,5b,6-decachlorooctahydro-
U247	Methoxychlor
U154	Methyl alcohol
U029	Methyl bromide
U186	1-Methylbutadiene
U045	Methyl chloride
U156	Methyl chlorocarbonate
U226	Methyl chloroform
U157	3-Methylcholanthrene
U158	4,4'-Methylenebis(2-chloroaniline)
U068	Methylene bromide
U080	Methylene chloride
U159	Methyl ethyl ketone (MEK)
U160	Methyl ethyl ketone peroxide

Table C-4. (continued)

Hazardous Waste No.	Substance
U138	Methyl iodide
U161	Methyl isobutyl ketone
U162	Methyl methacrylate
U161	4-Methyl-2-pentanone
U164	Methylthiouracil
U010	Mitomycin C
U059	5,12-Naphthacenedione, 8-acetyl-10-[(3-amino-2,3,6-trideoxy)-alpha-L-lyxo-hexopyranosyl]oxy]-7,8,9,10-tetrahydro-6,8,11-trihydroxy-1-methoxy-, (8S-cis)-
U167	1-Naphthalenamine
U168	2-Naphthalenamine
U026	Naphthalenamine, N,N'-bis(2-chloroethyl)-
U165	Naphthalene
U047	Naphthalene, 2-chloro-
U166	1,4-Naphthalenedione
U236	2,7-Naphthalenedisulfonic acid, 3,3'-[(3,3'-dimethyl[1,1'-biphenyl]-4,4'-diyl)bis(azo)bis[5-amino-4-hydroxy]-, tetrasodium salt
U166	1,4-Naphthoquinone
U167	alpha-Naphthylamine
U168	beta-Naphthylamine
U217	Nitric acid, thallium(1+) salt
U169	Nitrobenzene
U170	p-Nitrophenol
U171	2-Nitropropane
U172	N-Nitrosodi-n-butylamine
U173	N-Nitrosodiethanolamine
U174	N-Nitrosodiethylamine
U176	N-Nitroso-N-ethylurea

Table C-4. (continued)

Hazardous Waste No.	Substance
U177	N-Nitroso-N-methylurea
U178	N-Nitroso-N-methylurethane
U179	N-Nitrosopiperidine
U180	N-Nitrosopyrrolidine
U181	5-Nitro-o-toluidine
U193	1,2-Oxathiolane, 2,2-dioxide
U058	2H-1,3,2-Oxazaphosphorin-2-amine, N,N-bis(2-chloroethyl)tetrahydro-, 2-oxide
U115	Oxirane
U126	Oxiranecarboxyaldehyde
U041	Oxirane, (chloromethyl)-
U182	Paraldehyde
U183	Pentachlorobenzene
U184	Pentachloroethane
U185	Pentachloronitrobenzene (PCNB)
See: F027	Pentachlorophenol
U161	Pentanol, 4-methyl-
U186	1,3-Pentadiene
U187	Phenacetin
U188	Phenol
U048	Phenol, 2-chloro-
U039	Phenol, 4-chloro-3-methyl-
U081	Phenol, 2,4-dichloro-
U082	Phenol, 2,6-dichloro-
U089	Phenol, 4,4'-(1,2-diethyl-1,2-ethenediyl)bis-
U101	Phenol, 2,4-dimethyl-

Table C-4. (continued)

Hazardous Waste No.	Substance
U052	Phenol, methyl-
U132	Phenol, 2,2'-methylenebis[3,4,6-trichloro]-
U170	Phenol, 4-nitro-
See: F027	Phenol, pentachloro-
See: F027	Phenol, 2,3,4,6-tetrachloro-
See: F027	Phenol, 2,4,5-trichloro-
See: F027	Phenol, 2,4,6-trichloro-
U150	L-Phenylalanine, 4-[bis(2-chloroethyl)amino]-
U145	Phosphoric acid, lead(2+) salt (2:3)
U087	Phosphorodithioic acid, O,O-diethyl S-methyl ester
U189	Phosphorus sulfide
U190	Phthalic anhydride
U191	2-Picoline
U179	Piperidine, 1-nitroso-
U192	Pronamide
U194	1-Propanamine
U111	1-Propanamine, N-nitroso-N-propyl-
U110	1-Propanamine, N-propyl-
U066	Propane, 1,2-dibromo-3-chloro-
U083	Propane, 1,2-dichloro-
U149	Propanedinitrile
U171	Propane, 2-nitro-
U027	Propane, 2,2'-oxybis[2-chloro]-

Table C-4. (continued)

Hazardous Waste No.	Substance
U193	1,3-Propane sultone
See: F027	Propanoic acid, 2-(2,4,5-trichlorophenoxy)-
U235	1-Propanol, 2,3-dibromo-, phosphate (3:1)
U140	1-Propanol, 2-methyl-
U002	2-Propanone
U007	2-Propenamide
U084	1-Propene, 1,3-dichloro-
U243	1-Propene, 1,1,2,3,3,3-hexachloro-
U009	2-Propenenitrile
U152	2-Propenenitrile, 2-methyl-
U008	2-Propenoic acid
U113	2-Propenoic acid, ethyl ester
U118	2-Propenoic acid, 2-methyl-, ethyl ester
U162	2-Propenoic acid, 2-methyl-, methyl ester
U194	n-Propylamine
U083	Propylene dichloride
U148	3,6-Pyridazinedione, 1,2-dihydro-
U196	Pyridine
U191	Pyridine, 2-methyl-
U237	2,4-(1H,3H)-Pyrimidinedione, 5-[bis(2-chloroethyl)amino]-
U164	4(1H)-Pyrimidinone, 2,3-dihydro-6-methyl-2-thioxo-
U180	Pyrrolidine, 1-nitroso-
U200	Reserpine
U201	Resorcinol
U202	Saccharin, & salts

Table C-4. (continued)

Hazardous Waste No.	Substance
U203	Safrole
U204	Selenious acid
U204	Selenium dioxide
U205	Selenium sulfide
U205	Selenium sulfide SeS_2
U015	L-Serine, diazoacetate (ester)
See: F027	Silvex (2,4,5-TP)
U206	Streptozotocin
U103	Sulfuric acid, dimethyl ester
U189	Sulfur phosphide
See: F027	2,4,5-T
U207	1,2,4,5-Tetrachlorobenzene
U208	1,1,1,2-Tetrachloroethane
U209	1,1,2,2-Tetrachloroethane
U210	Tetrachloroethylene
See: F027	2,3,4,6-Tetrachlorophenol
U213	Tetrahydrofuran
U214	Thallium(I) acetate
U215	Thallium(I) carbonate
U216	Thallium(I) chloride
U216	Thallium chloride TlCl
U217	Thallium(I) nitrate
U218	Thioacetamide
U153	Thiomethanol

Table C-4. (continued)

Hazardous Waste No.	Substance
U244	Thioperoxydicarbonic diamide $[(H_2N)C(S)]_2S_2$, tetramethyl-
U219	Thiourea
U244	Thiram
U220	Toluene
U221	Toluenediamine
U223	Toluene diisocyanate
U328	o-Toluidine
U353	p-Toluidine
U222	o-Toluidine hydrochloride
U011	1H-1,2,4-Triazol-3-amine
U227	1,1,2-Trichloroethane
U228	Trichloroethylene
U121	Trichloromonofluoromethane
See: F027	2,4,5-Trichlorophenol
See: F027	2,4,6-Trichlorophenol
U234	1,3,5-Trinitrobenzene
U182	1,3,5-Trioxane, 2,4,6-trimethyl-
U235	Tris(2,3-dibromopropyl) phosphate
U236	Trypan blue
U237	Uracil mustard
U176	Urea, N-ethyl-N-nitroso-
U177	Urea, N-methyl-N-nitroso-
U043	Vinyl chloride
U248	Warfarin, & salts, when present at concentrations of 0.3% or less
U239	Xylene

Table C-4. (continued)

Hazardous Waste No.	Substance
U200	Yohimban-16-carboxylic acid, 11,17-dimethoxy-18-[(3,4,5-trimethoxybenzoyl)oxy]-, methyl ester, (3beta,16beta,17alpha,18beta,20alpha)-
U249	Zinc phosphide Zn_3P_2 , when present at concentrations of 10% or less

*From 40 CFR 261.33.

APPENDIX C

FIELD STRUCTURE
MIXED WASTE DATABASE

NATIONAL PROFILE ON MIXED WASTE DATA BASE

The data base for the National Profile on Mixed Waste resides in the PC-based FoxPro software. The data from each questionnaire is organized in several relational files. The files are connected by a common identification number to provide integrity of data and allow reports to be generated from all data files. The files are based on the format of the questionnaire, i.e. file FACILITY.DBF contains data found in section A, file LLRW.DBF data found in section B-1, etc. Keeping exact and range data separated while retaining both allows these data to be used in summations and other statistical calculations as described. Mixtures of hazardous chemicals are organized in subfiles and available under the names of the components of the mixtures. Unlimited comment fields provide additional information to clarify data. The descriptions of the files and their fields are as follows.

Subfile Description

FILE ID: FACILITY.DBF

FILE NAME: Mixed Waste facility file (Section A of the questionnaire)

DESCRIPTION: This file organizes identification information and includes the name and address of the facility returning the questionnaire, the name and title of the individual completing the questionnaire along with numbers identifying the facility.

FILE ID: LLRW.DBF

FILE NAME: Low-Level radioactive waste file (Section B-1 and F of the questionnaire)

DESCRIPTION: This file contains information on the total volume of LLRW shipped for disposal during the survey year by the facility. It also contains any information given on specific actions or procedures taken to minimize the generation of mixed waste at the facility.

FILE ID: LLRW_GS.DBF

FILE NAME: LLRW Generating and Storage file (Section B-2, B-3, C-1, C-2, C-3, C-4 of the questionnaire)

DESCRIPTION: This file contains information on the type of Low-Level Radioactive Waste generated and/or stored at the facility. It also includes information on LLRW generating practices and storage; states when the LLRW is considered hazardous.

FILE ID: MIX_WAST.DBF

FILE NAME: Mixed Waste file (Section D-1 of the questionnaire)

DESCRIPTION: This file contains information on each LLRW stream which is considered hazardous. Information is given on the waste stream number, physical form, basis for documenting the information, hazardous component, source, and total volume of the LLRW stream generated.

Subfile Description

FILE ID: TREATMEN.DBF

FILE NAME: Mixed Waste treatment file (Section D-2 of the questionnaire)

DESCRIPTION:

This file contains information on each LLRW stream listed in the mixed waste file. It includes the major radionuclides, the RAD waste classification, the cumulative activity, treatment site, type of treatment, and the volume treated during the year.

FILE ID: TREA_WAS.DBF

FILE NAME: Treated Mixed Waste file (Section D-3 of the questionnaire)

DESCRIPTION:

This file contains information on the results of the treatment of each LLRW stream listed in the mixed waste file. It includes the after treatment volume, activity, and effect on the hazardous component, and the volume of the LLRW stream requiring ultimate disposal.

FILE ID: STOR_WAS.DBF

FILE NAME: Stored Mixed Waste file (Section E-1 of the questionnaire)

DESCRIPTION:

This file contains information on stored mixed waste streams. Information includes the physical form and the basis for that judgement, the hazardous component and its source, and the cumulative amount in storage at the end of the reporting year.

FILE ID: RADIOACT.DBF

FILE NAME: Radioactivity of stored Mixed Waste file (Section E-2 of the questionnaire)

DESCRIPTION:

This file contains information on the major radionuclides in the stored mixed waste. It includes the major radionuclides, RAD waste classification, cumulative activity, and reason for storage.

Data Field Descriptions

FILE ID: FACILITY.DBF

FILE NAME: Mixed Waste facility file (Section A of the questionnaire)

DESCRIPTION:

This file organizes identification information and includes the name and address of the facility returning the questionnaire, the name and title of the individual completing the questionnaire along with numbers identifying the facility.

FIELD ID	FIELD NAME	FIELD DESCRIPTION
IDNUMBER	Identification number	An assigned identifier to unify the parts of the questionnaire. The first position identifies the type of facility, the second a source list, and the next four the sequence. (See Attachment 1)
FACILITY	Name of facility	Name of university, company, or plant where waste is generated or stored.
ADDRESS	Address of facility	Mailing address of facility.
CITY	City of facility	City of facility location.
STATE	State of facility	Two letter abbreviation of state location.
ZIP	Zip code	U.S. zip code, 5 or 9 digit.
FACCATEG	Facility Category	Categories are nuclear reactor, medical, academic, industrial or government, entered as a code. (See Attachment 2)
SICNUM	Standard Industrial Classification Number	
NRCSTATE	NRC/Agreement State license #	
EPAIDNO	EPA identification number	
EPACCLASS	EPA facility classification	Rated large, small, or conditionally exempt small quantity generator, entered as a code. (See Attachment 3)
NAME	Name	Name of person completing form.

Data Field Descriptions

TITLE	Title	Title of person completing form.
PHONENO	Telephone number	Telephone number of person completing form.
YEAR	Year of questionnaire	The year (2 digits) for which data were reported.
COMMENT	Comment	Field for information found in the first two pages of the questionnaire not fitting one of the above fields.

FILE ID: LLRW.DBF

FILE NAME: Low-level radioactive waste (LLRW) file (Section B-1 and F of the questionnaire)

DESCRIPTION:

This file contains information on the total volume of LLRW shipped for disposal during the survey year by the facility. It also contains any information given on specific actions or procedures taken to minimize the generation of mixed waste at the facility.

FIELD ID	FIELD NAME	FIELD DESCRIPTION
IDNUMBER	Identification number	Original assigned identifier.
FACCATEG	Facility Category	Categories are nuclear reactor, medical, academic, industrial or government, entered as a code (See Attachment 2).
STATE	State of facility	Two letter abbreviation of state location.
EPACCLASS	EPA facility classification	Rated large, small, or conditionally exempt small quantity generator, entered as a code. (See Attachment 3)
LLRWCLA	LLRW Class A	Volume of Low-Level Radioactive Waste Class A shipped for disposal during the year, reported in cubic feet/year.
LLRWCLB	LLRW Class B	Volume of Low-Level Radioactive Waste Class B shipped for disposal during the year, reported in cubic feet/year.
LLRWCLC	LLRW Class C	Volume of Low-Level Radioactive Waste Class C shipped for disposal during the year, reported in cubic

Data Field Descriptions

		feet/year.
LLRWTOTL	Total LLRW Shipped	Total volume of Low-Level Radioactive Waste shipped for disposal during the year, reported in cubic feet/year.
YEAR	Year of questionnaire	The year (2 digits) for which data were reported.
COMMENT	Comment	Field for information found in the low-level radioactive waste section of the questionnaire not fitting one of the above fields.
MWMINIM	Mixed waste minimization	Specific action or procedures used to minimize the generation of mixed waste at the facility. (See section F-1 of the questionnaire)

FILE ID: LLRW_GS.DBF

FILE NAME: LLRW Generating and Storage file (Section B-2, B-3, C-1, C-2, C-3, C-4 of the questionnaire)

DESCRIPTION: This file contains information on the type of Low-Level Radioactive Waste generated and/or stored at the facility. It also includes information on LLRW generating practices and storage; states when the LLRW is considered hazardous.

FIELD ID	FIELD NAME	FIELD DESCRIPTION
IDNUMBER	Identification number	Original assigned identifier.
FACCATEG	Facility Category	Categories are nuclear reactor, medical, academic, industrial or government entered as a code. (See Attachment 2)
COUNTNO	Repeat for IDNUMBER	A sequential number assigned to indicate the record number for a common ID number questionnaire. Numbers are G01, G02, etc. for generated waste information and S01, S02, etc. for stored waste information.
LLRWCODE	LLRW waste stream code	A number from Attachment 1 of the questionnaire identifying the LLRW waste stream being generated.

Data Field Descriptions

LLRWNAME	LLRW waste stream name	A name from Attachment 1 of the questionnaire identifying the LLRW waste stream being generated.
GENOSTOR	LLRW generated or stored	Single letter G (generated) or S (stored) indicating type of waste stream described.
LGENPRAC	LLRW generating practice	Practices at the facility generating the listed LLRW.
LSTORINF	LLRW storage information	Reason for storage of the listed LLRW.
HAZWASTE	Hazardous waste	Indicates if any of the facility's LLRW waste is considered hazardous. (Y or N)
YEAR	Year of questionnaire	The year (2 digits) for which data were reported.
COMMENT	Comment	Field for information found in the LLRW generating or storage sections of the questionnaire not fitting one of the above fields.

FILE ID: MIX_WAST.DBF

FILE NAME: Mixed Waste (Section D-1 of the questionnaire)

DESCRIPTION: This file contains information on each LLRW stream which is considered hazardous. Information is given on the waste stream number, physical form, basis for documenting the information, hazardous component, source, and total volume of the LLRW stream generated.

FIELD ID	FIELD NAME	FIELD DESCRIPTION
IDNUMBER	Identification number	Original assigned identifier.
FACCATEG	Facility Category	Categories are nuclear reactor, medical, academic, industrial or government entered as a code. (See Attachment 2)
COUNTNO	Repeat for IDNUMBER	A sequential number assigned to indicate the waste stream line number for a common ID number questionnaire. (Each waste stream will be numbered. 101, 102, etc.)

Data Field Descriptions

LLRWCODE	LLRW waste stream code	A number from Attachment 1 of the questionnaire identifying the LLRW waste stream containing hazardous materials.
PHYSFORM	Physical form	The physical form of the waste (aqueous, bulk liquid, compacted solid, etc.).
BASIS	Basis	Basis for judgement of constituents and characteristics of waste. Choices are tested (T) or process knowledge (PK).
HAZNAME name	Name of hazardous component	Names as they appear in the hazardous component section of the questionnaire without the EPA HAZ NO
SOURCE	Source of hazardous component	
TOTVOLGN	Total volume generated	Total volume of waste stream generated during the year reported in cubic feet/year. This value includes only the reported firm values.
ESUPVLGN	Estimated upper volume generated	The upper estimate of the total volume of waste stream generated during the year reported in cubic feet/year. This value includes either the firm value, the upper values for less than estimates or the upper values for range estimates.
ESLOVLGN	Estimated lower volume generated	The lower estimate of the total volume of waste stream generated during the year reported in cubic feet/year. This value includes either the firm value or the lower values for range estimates.
MIXTPURE	Mixture or Pure	Indicates whether the hazardous component is pure (P) or part of a mixture (M).
YEAR	Year of questionnaire	The year (2 digits) for which data were reported.
GROUPID	Group identification	An identification assigned by the ORNL committee.
COMMENT	Comment	Field for information found in the Mixed Waste section of the questionnaire not fitting one of the above fields.

Data Field Descriptions

Three fields that would normally be found in the above file along with an internal and external counting number assigned in sequence and the identification number are in a subfile to the above file. This subfile will have a record for each chemical that is listed in the Hazardous name field.

SUB FILE ID: MIX_SUB.DBF

IDNUMBER	Identification number	Original assigned identifier.
COUNTNO	Repeat for IDNUMBER	A sequential number assigned to indicate the waste stream line number for a common ID number questionnaire. (Each waste stream line is numbered 101, 102, etc.)
HAZCHEM	Name of hazardous chemical	Chemical name of one of the components of the hazardous component name (if only one is found in the above field it will be repeated here)
CASRN	CAS Registry number of chemical	Chemical Abstract Service Registry number for the preceding chemical.
EPAHAZNO	EPA Hazardous Waste No.	Number from Attachment 2 of the questionnaire, selected by using the chemical name.
COUNTER	Repeat for COUNTNO	A sequential number assigned to identify each individual chemical in the hazardous mixture.(1, 2, 3, etc.)

FILE ID: TREATMEN.DBF

FILE NAME: Mixed Waste treatment file (Section D-2 of the questionnaire)

DESCRIPTION:

This file contains information on each LLRW stream listed in the mixed waste file. It includes the major radionuclides, the RAD waste classification, the cumulative activity, treatment site, type of treatment, and the volume treated during the year.

FIELD ID	FIELD NAME	FIELD DESCRIPTION
IDNUMBER	Identification number	Original assigned identifier.
FACCATEG	Facility Category	Categories are nuclear reactor, medical, academic, industrial or government, entered as a code. (See Attachment 2)

Data Field Descriptions

COUNTNO	Repeat for IDNUMBER	A sequential number assigned to indicate the record number for a common ID number questionnaire. (Lines of information are numbered 101, 102, etc.)
LLRWCODE	LLRW waste stream code	A number found in Attachment 1 of the questionnaire identifying the LLRW waste stream containing hazardous materials.
MAJNUCLI	Major radionuclides	Major radionuclides found in the LLRW waste stream.
3H	Hydrogen-3	True or false: the hydrogen-3 isotope is found in the waste stream.
14C	Carbon-14	True or false: the carbon-14 isotope is found in the waste stream.
32P	Phosphorus-32	True or false: the phosphorus-32 isotope is found in the waste stream.
59NI	Nickel-59	True or false: the nickel-59 isotope is found in the waste stream.
63NI	Nickel-63	True or false: the nickel-63 isotope is found in the waste stream.
90SR	Strontium-90	True or false: the strontium-90 isotope is found in the waste stream.
137CS	Cesium-137	True or false: the cesium-137 isotope is found in the waste stream.
134CS	Cesium-134	True or false: the cesium-134 isotope is found in the waste stream.
60CO	Cobalt-60	True or false: the cobalt-60 isotope is found in the waste stream.
35S	Sulfur-35	True or false: the sulfur-35 isotope is found in the waste stream.
125I	Iodine-125	True or false: the iodine-125 isotope is found in the waste stream.
51CR	Chromium-51	True or false: the chromium-51 isotope is found in the waste stream.

Data Field Descriptions

22NA	Sodium-22	True or false: the sodium-22 isotope is found in the waste stream.
36CL	Chlorine-36	True or false: the chlorine-36 isotope is found in the waste stream.
235U	Uranium-235	True or false: the uranium-235 isotope is found in the waste stream.
239U	Uranium-239	True or false: the uranium-239 isotope is found in the waste stream.
65ZN	Zinc-65	True or false: the zinc-65 isotope is found in the waste stream.
207BI	Bismuth-207	True or false: the bismuth-207 isotope is found in the waste stream.
54MN	Manganese-54	True or false: the manganese-54 isotope is found in the waste stream.
59FE	Iron-59	True or false: the iron-59 isotope is found in the waste stream.
133BA	Barium-133	True or false: the barium-133 isotope is found in the waste stream.
CLASS	Classification	The radioactive waste classification (A, B, C).
MIXTPURE	Mixture or Pure	Indicates whether the radioactive component is pure (P) or part of a mixture (M).
CUMACTIV	Cumulative Activity	Cumulative activity in millicuries for each waste during year reported. This value includes firm values, the upper values for less than estimates, and the upper values for range estimates.
ESUPCUAC	Estimated upper cumulative activity	Upper estimate of the cumulative activity in millicuries for each waste during year reported. This value includes the upper values for less than estimates and the upper values for range estimates.
ESLOCUAC	Estimated lower cumulative activity	Lower estimate of the cumulative activity in millicuries for each waste during year reported. This value includes only the lower value for range estimates.

Data Field Descriptions

TREATSIT	Treatment On-Site	True or false: the waste was treated onsite.
TREATTYP	Treatment type	Waste treatment, burned for energy, storage for decay, etc., entered as a code. (See Attachment 4)
VOLTREAT	Volume treated	Volume of mixed waste treated during the year reported in cubic feet. This value includes only the reported firm values.
ESUPVLTR	Estimated upper volume treated	Upper estimate for the volume of mixed waste treated during the year reported in cubic feet. This value includes the reported firm values, the upper values for less than estimates or the upper values for range estimates.
ESLOVLTR	Estimated lower volume treated	Lower estimate for the volume of mixed waste treated during the year reported in cubic feet. This value includes either the firm values or the lower values for range estimates.
YEAR	Year of questionnaire	Year (2 digits) for which data were reported.
GROUPID	Group identification	An identification assigned by the ORNL committee.
COMMENT	Comment	Field for information found in the Mixed Waste radioactivity section of the questionnaire not fitting one of the above fields.

FILE ID: TREA_WAS.DBF

FILE NAME: Treated Mixed Waste file (Section D-3 of the questionnaire)

DESCRIPTION: This file contains information on the results of the treatment of each LLRW stream listed in the mixed waste file. It includes the after treatment volume, activity, and effect on the hazardous component, and the volume of the LLRW stream requiring ultimate disposal.

FIELD ID	FIELD NAME	FIELD DESCRIPTION
IDNUMBER	Identification number	Original assigned identifier.

Data Field Descriptions

FACCATEG	Facility Category	Categories are nuclear reactor, medical, academic, industrial or government, entered as a code. (See Attachment 2)
COUNTNO	Repeat for IDNUMBER	A sequential number assigned to indicate the record number for a common ID number questionnaire. (Lines of information will be 101, 102, etc.)
LLRWCODE	LLRW waste stream code	A number from Attachment 1 of the questionnaire identifying the LLRW waste stream containing hazardous materials.
TREATVOL	After treatment volume	The volume (cubic feet) of the mixed waste after treatment. This value includes only the reported firm values.
MIXTPURE	Mixture or Pure	Indicates whether the hazardous component is pure (P) or part of a mixture (M).
ESUPTRVL	Estimated upper after treat volume	Upper estimate of the volume (cubic feet) of the mixed waste after treatment. This value includes the reported firm value, the upper values for less than estimates or the upper values for range estimates.
ESLOTRVL	Estimated lower after treat volume	Lower estimate of the volume (cubic feet) of the mixed waste after treatment. This value includes the firm values or the lower values for range estimates.
TREATACT	After treatment activity	Radioactivity of the mixed waste after treatment. This value includes firm values, the upper values for less than estimates, and the upper values for range estimates.
ESUPTRAC	Estimated upper after treat activity	Upper estimate of the radioactivity of the mixed waste after treatment. This value includes the upper values for greater than estimates and the upper values for range estimates.
ESLOTRAC	Estimated lower after treat activity	Lower estimate of the radioactivity of the mixed waste after treatment. This value includes only the lower value for range estimates.
TRTHAZCO	Hazardous component	Effect of the treatment on the hazardous component in the mixed waste.

Data Field Descriptions

VOLDISPO	Volume for disposal	Volume (cubic feet) of the mixed waste remaining after treatment requiring ultimate disposal. This value includes only the firm values.
ESUPVLDS	Estimated upper volume for disposal	Upper estimate of the volume (cubic feet) of the mixed waste remaining after treatment requiring ultimate disposal. This value includes the firm values, the upper values for greater than estimates or the upper values for range estimates.
ESLOVLDS	Estimated lower volume for disposal	Lower estimate of the volume (cubic feet) of the mixed waste remaining after treatment requiring ultimate disposal. This value includes either the firm values or the lower values for range estimates.
YEAR	Year of questionnaire	Year (2 digits) for which data were reported.
GROUPID	Group identification	An identification assigned by the ORNL committee.
COMMENT	Comment	Field for information found in the treated Mixed Waste section of the questionnaire not fitting one of the above fields.

FILE ID: STOR_WAS.DBF

FILE NAME: Stored Mixed Waste file (Section E-1 of the questionnaire)

DESCRIPTION:

This file contains information on stored mixed waste streams. Information includes the physical form and the basis for that judgement, the hazardous component and its source, and the cumulative amount in storage at the end of the reporting year.

FIELD ID	FIELD NAME	FIELD DESCRIPTION
IDNUMBER	Identification number	Original assigned identifier.
FACCATEG	Facility Category	Categories are nuclear reactor, medical, academic, industrial or government, entered as a code. (See Attachment 2)

Data Field Descriptions

COUNTNO	Repeat for IDNUMBER	A sequential number assigned to indicate the waste stream line number for a common ID number questionnaire. (Each waste stream line will be numbered 501, 502, etc.)
LLRWCODE	LLRW waste stream code	Number from Attachment 1 of the questionnaire identifying the LLRW waste stream containing hazardous materials.
PHYSFORM	Physical form	Physical form of the waste (aqueous, bulk liquid, compacted solid, etc.).
BASIS	Basis	Basis for judgement of constituents and characteristics of waste. Choices are tested (T) or process knowledge (PK).
HAZNAME	Name of hazardous component	Names as they appear in the hazardous component name section of the questionnaire without the EPA HAZ NO
SOURCE	Source of hazardous component	
AMTSTORD	Amount stored	Cumulative amount (cubic feet/year) of mixed waste in storage as of December 31 of reporting year. This value includes firm values only.
MIXTPURE	Mixture or Pure	Indicates whether the hazardous component is pure (P) or part of a mixture (M).
ESUPAMST	Upper estimate of amount stored	Upper estimate of the cumulative amount (cubic feet/year) of mixed waste in storage as of December 31 of the reporting year. This value includes the firm values, the upper values for less than estimates or the upper values for range estimates.
ESLOAMST	Lower estimate of amount stored	Lower estimate of the cumulative amount (cubic feet/year) of mixed waste in storage as of December 31 of the reporting year. This value includes either the firm value or the lower values for range estimates.
YEAR	Year of questionnaire	Year (2 digits) for which data were reported.
GROUPID	Group identification	An identification assigned by the ORNL committee.
COMMENT	Comment	Field for information found in the stored Mixed Waste

Data Field Descriptions

section of the questionnaire not fitting one of the above fields.

Three fields that would normally be found in the above file along with an internal and external counting number assigned in sequence and the identification number are in a subfile to the above file. This subfile will have a record for each chemical that is listed in the Hazardous name field.

SUB FILE ID: STOR_SUB.DBF

IDNUMBER	Identification number	Original assigned identifier.
COUNTNO	Repeat for IDNUMBER	A sequential number assigned to indicate the waste stream line number for a common ID number questionnaire. (Each waste stream line will be numbered 501, 502, etc.)
HAZCHEM	Name of hazardous chemical	Chemical name of one of the components of the hazardous component name (if only one component is found in the above field it will be repeated here)
CASRN	CAS Registry number of chemical	Chemical Abstract Service Registry number for the preceding chemical.
EPAHAZNO	EPA Hazardous Waste No.	This number from Attachment 2 of the questionnaire. It should be selected by using the chemical name listed above.
COUNTER	Repeat for COUNTNO	A sequential number assigned to identify each individual chemical contained in the hazardous mixture. (Numbers will be 1, 2, 3, etc.)

FILE ID: RADIOACT.DBF

FILE NAME: Radioactivity of stored Mixed Waste file (Section E-2 of the questionnaire)

DESCRIPTION:

This file contains information on the major radionuclides in the stored mixed waste. It includes the major radionuclides, RAD waste classification, cumulative activity, and reason for storage.

FIELD ID	FIELD NAME	FIELD DESCRIPTION
IDNUMBER	Identification number	Original assigned identifier.

Data Field Descriptions

FACCATEG	Facility Category	Categories are nuclear reactor, medical, academic, industrial or government, entered as a code. (See Attachment 2)
COUNTNO	Repeat for IDNUMBER	A sequential number assigned to indicate the record number for a common ID number questionnaire. (Lines of information will be numbered 101, 102, etc.)
LLRWCODE	LLRW waste stream code	A number from Attachment 1 of the questionnaire which identifies the LLRW waste stream containing hazardous materials.
MAJNUCLI	Major radionuclides	List of the major radionuclides found in the LLRW waste stream.
3H	Hydrogen-3	True or false: the hydrogen-3 isotope is found in the waste stream.
14C	Carbon-14	True or false: the carbon-14 isotope is found in the waste stream.
32P	Phosphorus-32	True or false: the phosphorus-32 isotope is found in the waste stream.
59N	Nickel-59	True or false: the nickel-59 isotope is found in the waste stream.
63NI	Nickel-63	True or false: the nickel-63 isotope is found in the waste stream.
90SR	Strontium-90	True or false: the strontium-90 isotope is found in the waste stream.
137CS	Cesium-137	True or false: the cesium-137 isotope is found in the waste stream.
134CS	Cesium-134	True or false: the cesium-134 isotope is found in the waste stream.
60CO	Cobalt-60	True or false: the cobalt-60 isotope is found in the waste stream.
35S	Sulfur-35	True or false: the sulfur-35 isotope is found in the waste stream.

Data Field Descriptions

125I	Iodine-125	True or false: the iodine-125 isotope is found in the waste stream.
51CR	Chromium-51	True or false: the chromium-51 isotope is found in the waste stream.
22NA	Sodium-22	True or false: the sodium-22 isotope is found in the waste stream.
36CL	Chlorine-36	True or false: the chlorine-36 isotope is found in the waste stream.
235U	Uranium-235	True or false: the uranium-235 isotope is found in the waste stream.
239U	Uranium-239	True or false: the uranium-239 isotope is found in the waste stream.
65ZN	Zinc-65	True or false: the zinc-65 isotope is found in the waste stream.
207BI	Bismuth-207	True or false: the bismuth-207 isotope is found in the waste stream.
54MN	Manganese-54	True or false: the manganese-54 isotope is found in the waste stream.
59FE	Iron-59	True or false: the iron-59 isotope is found in the waste stream.
133BA	Barium-133	True or false: the barium-133 isotope is found in the waste stream.
CLASS	Classification	Radioactive waste classification (A, B, C).
CUMACTIV	Cumulative Activity	Cumulative activity in millicuries for each mixed waste as of December 31 of the reporting year. This value includes firm values, the upper values for less than estimates, and the upper values for range estimates.
MIXTPURE	Mixture or Pure	Indicates whether the radioactive component is pure (P) or part of a mixture (M).
ESUPCUAC	Upper estimate of cumulative activity	Upper estimate of the cumulative activity in millicuries for each mixed waste as of December 31 of the reporting year. This value includes the upper values

Data Field Descriptions

		for less than estimates and for range estimates.
ESLOCUAC	Lower estimate of cumulative activity	Lower estimate of the cumulative activity in millicuries for each mixed waste as of December 31 of the reporting year. This value includes only the lower values for range estimates.
REASSTOR	Reason stored	Reason for the mixed waste storage (storage for decay, unable to treat, unable to ship, etc.). (See Attachment 5)
YEAR	Year of questionnaire	Year (2 digits) for which data were reported.
GROUPID	Group identification	An identification assigned by the ORNL committee.
COMMENT	Comment	Field for information found in the radioactivity of stored Mixed Waste section of the questionnaire not fitting one of the above fields.

ATTACHMENT 1

Decode for IDNUMBER

This field will be a 6 character alphanumeric field as follows:

1st position: **U - Utilities**
 M - Medical
 A - Academic
 I - Industrial
 G - Government

2nd position: **1 - ORNL list**
 2 - Shippers List Excluding ORNL list
 3 - NRC with EPA permit
 4 - NRC without EPA Permit

3rd, 4th, 5th, 6th position: 1 to 9999, assigned by ORNL committee and is the sample number.

ATTACHMENT 2

FACILITY CATEGORY DECODE FILE (FACCATEG)

Nuclear Reactor Facility	100
Boiling Water Reactor	110
Pressurized Water Reactor	120
Research & Test Reactors	130
Medical (non-Federal)	200
Hospital	210
<250 beds	211
250-750 beds	212
>750 beds	213
Medical college/hospital	220
Laboratory	230
Research	240
Academic	300
<10,000 students	310
10,000-20,000 students	320
>20,000 students	330
Industrial	400
Manufacturing	410
<50 employees on site	411
50-200 employees on site	412
>200 employees on site	413
Research and Development	420
Decontamination facility & waste reduction	430
Sealed source/gauge/instrument user	440
Waste broker/processor	450
Nuclear fuel cycle other than power reactors	460
Commercial radiopharmacy	470
Government	500
Federal	510
Hospital	511
Research & Development	512
Military	513
State	520
Other	530*

*530 is for any type of facility which appears frequently in the questionnaires and does not have a category listed.

ATTACHMENT 3

DECODE FOR EPA FACILITY CLASSIFICATION(EPACCLASS)

Large quantity generator (>1000 Kg/month)	LQ
Small quantity generator (100-1000 Kg/month)	SQ
Conditionally exempt small quantity generator (<100 Kg/month)	CON
No EPA Classification	NO

ATTACHMENT 4

TREATMENT TYPE DECODE FILE

Burned for energy	1
Evaporation	2
Incineration	3
Not treated	4
Radioactive contaminant removal	5
Solidification	6
Storage for decay	7
Compaction	8
Neutralization	9
Filtration	10

ATTACHMENT 5

REASON STORED DECODE FILE

Accumulation	10
Evaluating options	20
Holding for deregulation	30
Storage for decay	40
Unable to treat	50
Unable to ship	60
Using as a shield	70

APPENDIX D

DETAILED "AS REPORTED" DATA TABLES

Table D.1 Mixed waste generated in 1990
[As reported (ft³)]

	Facility category					Total
	Academic	Government	Industrial	Medical	Nuclear utilities	
Northeast Compact (79) ¹	283	4	1,216	217	62	1,782
Appalachian Compact (136) ¹	1,882	11,989	3,148	474	1,388	18,881
Southeast Compact (131) ¹	3,284	3,566	5,896	2,923	2,687	18,356
Central States Compact (30) ¹	352	42	8	54	232	688
Midwest Compact (166) ¹	6,359	448	4,614	201	860	12,482
Central Midwest Compact (47) ¹	1,531	787	640	770	2,610	6,338
Rocky Mountain Compact (11) ¹	135	9	120	0 ²	0 ³	264
Northwest Compact (48) ¹	781	469	42	384	30	1,706
Southwestern Compact (125) ¹	2,547	160	2,143	2,401	5,010	12,261
Unaligned						
DC (11) ¹	140	533	0 ²	4	0 ⁴	677
ME (7) ¹	10	0 ²	0 ³	0 ³	112	122
MA (77) ¹	1,666	23	637	599	70	2,995
NH (3) ¹	0 ²	0 ³	0 ²	0 ²	0 ³	0 ³
NY (110) ¹	982	249	575	1,109	160	3,075
PR (0) ¹	0 ⁵	0 ⁵	0 ⁵	0 ²	0 ⁴	0 ³
RI (1) ¹	0 ²	0 ²	0 ²	0 ³	0 ⁴	0 ³
TX (27) ¹	269	45	17	1,015	27	1,373
VT (5) ¹	200	0 ²	0 ³	0 ²	27	227
TOTAL (1,014) ¹	20,421	18,324	19,056	10,151	13,275	81,227

¹Numbers in () represent the number of facilities returning questionnaires within this compact/state.

²No facilities were surveyed in this particular category (e.g., no industrial facilities were surveyed in New Hampshire).

³At least one facility in this category within the compact/state returned a MW survey and all facilities returning surveys in this category and within the compact/state reported generating no mixed waste.

⁴No facilities are present in this category within the compact/state (i.e., nuclear reactors in DC, PR, & RI).

⁵Facilities were surveyed in this category, but none of these facilities returned their surveys.

Table D.2 National Mixed Waste Profile
[Generation rate in 1990 (ft³/year)]

As Reported													
Hazardous waste stream													
LSF	Oil	Org-Cl	Org-FI	CFC	Org-Other	Pb	Hg	Cr	Cd	Curr	Other ¹	Total	
Academic	18,996	10	351	0	0	181	32	0	4	0	49	797	20,420
Government	13,599	4	999	0	0	2,475	165	0	83	1	990	8	18,324
Industry	9,600	381	298	0	70	1,918	975	331	518	0	1,139	3,825	19,055
Medical	9,621	0	217	0	0	268	17	7	0	0	2	20	10,151
Nuclear utilities	10	4,588	49	0	3,585	1,124	1,200	4	247	8	152	2,308	13,276
TOTAL	51,826	4,983	1,914	0	3,655	5,966	2,389	342	852	9	2,332	6,958	81,226

Weighted													
LSF	Oil	Org-Cl	Org-FI	CFC	Org-Other	Pb	Hg	Cr	Cd	Curr	Other ¹	Total	
Academic	26,918	15	512	0	0	251	44	0	5	0	71	1,165	28,982
Government	20,315	4	1,179	0	0	3,525	200	0	100	1	1,167	9	26,500
Industry	34,088	531	494	0	319	4,091	1,365	413	643	0	1,442	7,043	50,430
Medical	18,862	0	269	0	0	676	43	25	0	0	2	27	19,904
Nuclear utilities	11	4,709	50	0	3,679	1,154	1,231	4	254	8	156	2,369	13,625
TOTAL	100,194	5,259	2,504	0	3,998	9,697	2,883	442	1,002	9	2,838	10,613	139,441

Table D.3 National Mixed Waste Profile
[Amount in storage as of 12/31/90 (ft³)]

As reported												
Hazardous waste stream												
LSF	Oil	Org-Cl	Org-FI	CFC	Org-Other	Pb	Hg	Cr	Cd	Corr	Other	Total
Academic	3,068	4	144	0	0	366	22	1	1	0	49	3,874
Government	713	5	12	0	0	617	204	0	82	1	0	1,692
Industry	1,304	937	110	99	130	557	52	1,967	825	8,000	1	16,078
Medical	947	0	3	0	0	91	0	0	0	1	117	1,158
Nuclear utilities	146	4,931	499	0	8,380	1,250	4,336	406	738	10	352	21,403
TOTAL	6,178	5,877	768	99	8,510	2,881	4,614	2,374	1,646	8,011	403	44,205

Weighted												
LSF	Oil	Org-Cl	Org-FI	CFC	Org-Other	Pb	Hg	Cr	Cd	Corr	Other	Total
Academic	4,289	6	201	0	0	526	30	1	1	0	68	5,448
Government	1,598	6	21	0	0	746	247	0	100	1	0	2,789
Industry	5,157	1,217	215	122	393	1,163	171	2,448	1,025	26,304	1	42,280
Medical	1,622	0	4	0	0	443	0	0	0	1	157	2,227
Nuclear utilities	168	5,061	512	0	8,600	1,284	4,451	416	757	11	361	21,985
TOTAL	12,834	6,290	953	122	8,993	4,162	4,899	2,865	1,883	26,316	431	74,729

Table D.4 National Mined Waste Profile
[Waste generated in 1990 that currently cannot be treated(ft³)]

Hazardous waste stream											
	LSF	Oil	Org-Cl	Org-Fl	CFC	Org-Other	Pb	Hg	Cr	Cd	Total
Academic	72	2	23	0	0	128	1	0	0	0	253
Government	639	0	9	0	0	311	143	0	83	0	1,183
Industry	1	6	34	0	1	24	45	32	0	0	370
Medical	175	0	0	0	0	2	6	0	0	0	493
Nuclear utilities	0	295	5	0	866	76	119	2	37	0	1,432
TOTAL	887	303	71	0	867	525	314	34	120	0	3,731

Weighted

	LSF	Oil	Org-Cl	Org-Fl	CFC	Org-Other	Pb	Hg	Cr	Cd	Other	Total
Academic	105	3	31	0	0	175	2	0	0	0	16	353
Government	794	0	13	0	0	375	173	0	100	0	0	1,455
Industry	2	21	90	0	1	63	148	40	0	0	469	834
Medical	330	0	0	0	0	3	8	0	0	0	384	726
Nuclear utilities	0	303	5	0	889	79	123	2	38	0	8	1,470
TOTAL	1,231	327	139	0	890	695	454	42	138	0	877	4,838

Table D.5 Facility mixed waste profile - Academic
As reported (ft³)

Hazardous Stream	Amount generated in 1990	Amount treated on-site in 1990	Amount treated off-site in 1990	Amount generated in 1990 that cannot be currently treated	Amount in storage as of 12/31/90
Organics	18,996	133	39,878	165	3,068
Liquid Scintillation Fluids	10	10	1	2	4
Waste Oil	351	40	277	23	144
Chlorinated Organics	0	0	0	0	0
Fluorinated Organics	0	0	0	0	0
Chlorinated Fluorocarbons (CFCs)	181	117	305	34	366
Other Organics					
Metals					
Lead	32	14	1	1	22
Mercury	0	0	0	0	1
Chromium	4	0	2	0	1
Cadmium	0	0	0	0	0
Aqueous Corrosives	49	43	0	15	49
Other Hazardous Materials	797	30	125	12	220
TOTAL	20,420	387	40,589	252	3,875

Table D.6 Facility mixed waste profile -- Government
As reported (ft³)

Hazardous Stream	Amount generated in 1990	Amount treated on-site in 1990	Amount treated off-site in 1990	Amount generated in 1990 that cannot be currently treated	Amount in storage as of 12/31/90
Organics	13,599	2,313	8,890	644	713
Liquid Scintillation Fluids	4	0	0	0	5
Waste Oil	999	0	0	9	12
Chlorinated Organics	0	0	0	0	0
Fluorinated Organics	0	0	0	0	0
Chlorinated Fluorocarbons (CFCs)	0	0	0	0	0
Other Organics	2,475	4,790	90	306	617
Metals					
Lead	165	0	0	143	204
Mercury	0	0	0	0	0
Chromium	83	0	0	83	82
Cadmium	1	0	0	0	1
Aqueous Corrosives	990	1	0	0	0
Other Hazardous Materials	8	0	0	0	58
TOTAL	18,324	7,104	8,980	1,185	1,692

Table D.7 Facility mixed waste profile - Industrial
As reported (ft³)

Hazardous Stream	Amount generated in 1990	Amount treated on-site in 1990	Amount treated off-site in 1990	Amount generated in 1990 that cannot be currently treated	Amount in storage as of 12/31/90
Organics					
Liquid Scintillation Fluids	9,600	787	8,202	1	1,304
Waste Oil	381	5	1	6	937
Chlorinated Organics	298	8	72	34	110
Fluorinated Organics	0	0	0	0	99
Chlorinated Fluorocarbons (CFCs)	70	0	0	1	130
Other Organics	1,918	1,148	267	24	557
Metals					
Lead	975	0	45	45	52
Mercury	331	22	0	32	1,967
Chromium	518	0	0	0	825
Cadmium	0	0	0	0	8,000
Aqueous Corrosives	1,139	0	0	0	1
Other Hazardous Materials	3,825	2,292	105	227	2,096
TOTAL	19,055	4,262	8,692	370	16,078

Table D.8 Facility mixed waste profile - Medical
As reported (ft³)

Hazardous Stream	Amount generated in 1990	Amount treated on-site in 1990	Amount treated off-site in 1990	Amount generated in 1990 that cannot be currently treated	Amount in storage as of 12/31/90
Organics					
Liquid Scintillation Fluids	9,621	353	8,434	175	947
Waste Oil	0	0	0	0	0
Chlorinated Organics	217	0	136	0	3
Fluorinated Organics	0	0	0	0	0
Chlorinated Fluorocarbons (CFCs)	0	0	0	0	0
Other Organics	268	2	235	2	91
Metals					
Lead	17	10	7	6	0
Mercury	7	0	8	0	0
Chromium	0	0	0	0	0
Cadmium	0	0	0	0	0
Aqueous Corrosives	2	0	1	0	1
Other Hazardous Materials	20	0	0	309	117
TOTAL	10,152	365	8,821	492	1,159

Table D.9 Facility mixed waste profile - Nuclear utilities
As reported (ft³)

Hazardous Stream	Amount generated in 1990	Amount treated on-site in 1990	Amount treated off-site in 1990	Amount generated in 1990 that cannot be currently treated	Amount in storage as of 12/31/90
Organics					
Liquid Scintillation Fluids	10	0	4	0	146
Waste Oil	4,588	4,216	548	295	4,931
Chlorinated Organics	49	0	0	5	499
Fluorinated Organics	0	0	0	0	0
Chlorinated Fluorocarbons (CFCs)	3,585	115	11	866	8,380
Other Organics	1,124	15	7	76	1,250
Metals					
Lead	1,200	0	8	119	4,535
Mercury	4	0	0	2	406
Chromium	247	134	0	37	738
Cadmium	8	3	0	0	10
Aqueous Corrosives	152	23	0	23	352
Other Hazardous Materials	2,308	163	2,215	7	354
TOTAL	13,275	4,669	793	1,430	21,402

Table D.10 Facility mixed waste profile - All facilities
As reported (ft³)

Hazardous Stream	Amount generated in 1990	Amount treated on-site in 1990	Amount treated off-site in 1990	Amount generated in 1990 that cannot be currently treated	Amount in storage as of 12/31/90
Organics					
Liquid Scintillation Fluids	51,826	3,585	65,408	887	6,178
Waste Oil	4,983	4,231	550	303	5,877
Chlorinated Organics	1,914	48	485	71	768
Fluorinated Organics	0	0	0	0	99
Chlorinated Fluorocarbons (CFCs)	3,655	115	12	867	8,510
Other Organics	5,966	6,073	904	525	2,881
Metals					
Lead	2,389	24	61	314	4,614
Mercury	342	22	8	34	2,374
Chromium	852	134	2	120	1,646
Cadmium	9	2	0	0	8,011
Aqueous Corrosives	2,332	67	1	38	403
Other Hazardous Materials	6,958	2,486	2,445	571	2,845
TOTAL	81,226	16,787	69,876	3,730	44,206

Table D.11 National Mixed Waste Profile
[Amount generated in 1990 (¢)]

Hazardous stream = other

FAC ID	Vol	Name	Source
A10032	1.9	TRASH	CLEANUP
A10056	0.1	URANYL NITRATE	ELECTION MICROSCOPY
A10066	4.0	Uranyl Acetate, Nitrate	Electron Mic. stains &
A10077	0.1	SODIUM CYANIDE	RESEARCH
A10077	0.1	POTASSIUM CYANIDE	RESEARCH
A10089	20.0	BIOLOGICAL WASTE	
A10089	40.0	TRASH	
A10089	10.0	METALS	LAB EXPERIMENTS
A10090	10.0	TRASH	
A10096	0.5	OSMIUM TETROXIDE	STAINING PROCEDURES
A10097	1.3	ARSENIC AND 32P	
A10101	0.9	BIOLOGICAL WASTE	
A10101	63.0	TRASH	
A10101	0.9	SEALED SOURCES	SEALED SOURCES
A10101	0.6	PAINT WASTE	
A20009	7.5	TRASH	
A20011	10.0	TNT	USED FOR RESEARCH CLEANI
A20026	22.5	RADIONUCLIDES	RESEARCH
A20026	4.0	RADIONUCLIDES	RESEARCH
A20044	0.1	URANYL ACETATE	
A20061	7.5	PAPER, PLASTIC GLASS	LAB EXPERIMENTS IN BIOL
A20071	7.5	TRASH	TRASH
A20101	562.5	COMPACTED SOLID TRASH	RESEARCH
A20101	15.0	SOIL	RESEARCH
A20190	11.5	BERYLLIUM	SEALED SOURCES
G10004	7.5	MISCELLANEOUS	
I10048	7.4	MISCELLANEOUS	
I10079	22.5	CORROSIVITY, REACTIVITY	EXPIRED PRODUCTS
I10113	7.3	MISCELLANEOUS	
I10128	2180.0	CADMIUM, CHROMIUM, LEAD	INCINERATOR ASH
I10155	272.0	METAL MIXTURE	ANALYTICAL PROCESS
I10155	227.6	METAL MIXTURE	ANALYTICAL PROCESS
I10165	30.0	BIOLOGICAL WASTE	RESEARCH
I10168	4.0	RESIDUAL SOILS	COMBUSTION OF 14C RESID
I20056	22.5	TOLUENE, GRANITE SALTS	BIOCHEMISTRY PROTEIN AS
I20059	15.0	SEALED SOURCES - NICKEL	PRODUCTION SOURCES WAST
I20111	82.5	SODIUM AZIDE	MANUFACTURE PROCESS
I20122	4.0	THORIUM NITRATE	
I20129	37.0	MG-TH ALLOY	
I20196	15.0	CARCASSESS	RESEARCH ANIMALS
I20196	15.0	URINE AND FECES	RESEARCH ANIMALS
I20196	15.0	TRASH	SAMPLE PREP, LAB BENCH
I20234	750.0	BARIUM	MELTING OF MAG/2% TH ME
I20234	100.0	METAL CLEANING SOLUTION	CASTING CLEANING
I20288	1.0	MISCELLANEOUS	
I20340	10.0	SODIUM AZIDE	BUFFER COMPONENT
I40013	7.0	HAZARDOUS WASTE LIQUID	MANUFACTURE OF RADIOLAB
M10049	6.0	ANIMAL CARCASSES	TRITIUM AND C-14
M10049	2.0	ANIMAL CARCASSES	Ca-45
M10053	7.5	LAB CLEANUP	LAB CLEANING
M10069	0.2	URANYL NITRATE/ACETATE	
P10006	27.3	LEAD, MERCURY, CADMIUM	PAINT/SOLVENTS, PAINT/T
P10017	7.5	DRIED PAINT	MAINTENANCE ACTIVITIES
P10026	0.1	EPOXY PAINT	MAINTENANCE
P10030	23.0	LEAD, CHROMIUM, SELENIU	PUMPS

Table D.11 (continued)

FAC ID	Vol	Name	Source
P10040	15.0	LEAD, CADMIUM, CARBON T	SPENT SOLVENTS - DEGREASING
P10042	2188.0	LEAD, OIL, SOLVENTS AND	EQUIPMENT MAINTENANCE
P10042	7.5	PROCESSING USED OIL/LEA	FILTER BAGS
P10045	5.0	CORROSIVE LIQUID, CADMI	EQUIPMENT REPAIR/REPLACEMENT
P10048	10.0	LEAD, MERCURY, BARIUM,	DECONTAMINATION
P10048	25.0	IGNITABLE, MERCURY, BAR	MAINTENANCE ACTIVITIES

Total 6,958

Notes:

The first column is the facility ID Number: A = Academic, G = Government, I = Industrial, M = Medical, P = Nuclear Power Facilities.

The second column is the amount of this type waste generated in 1990. The decision to place a particular waste stream in the "Other " category was made by ORNL, based on information provided in the next two columns and on other information contained in the completed questionnaire.

The third and fourth column contain abbreviated comments on the hazardous name and source that give some indication of the type of material present in this stream.

APPENDIX E

ESTIMATION PROCEDURES

ESTIMATION PROCEDURES

National Profile on Commercially Generated Low-Level Radioactive Mixed Waste

The steps for estimation of volumes related to the National Profile on Commercially Generated Low-Level Radioactive Mixed Wastes and consistent with stratified random sampling as presented in Appendix A of "Technical Letter Report for Task Three FIN L-1647-0," September 30, 1991, and in Appendix A of this report, are as follows.

Step 1. Assume that the original frame construction placed each facility in its correct stratum ij as indicated in Table 1. At this point, the extent to which this assumption is false is believed to be negligible.

		<i>j</i>				
		1	2	3	4	
			Shipper's List Exclusive ORNL List	NRC List With EPA Permit	NRC List Without EPA Permit	TOTALS
<i>i</i>	P Power Plant	78	0	0	0	78
	M Medical	66	360	19	83	528
	A Academic	85	192	77	134	488
	I Industrial	116	900	166	546	1728
	G Government	18	80	5	155	258
TOTALS		363	1532	267	918	3080

TABLE 1. Original (Sampled) Universe Sizes

Step 2. A stratified random sample of size 1334 was selected (i.e., a simple random sample was selected within each stratum and independently of the other strata) as shown in Table 2.

		<i>j</i>			
		1	2	3	4
			Shipper's List Exclusive	NRC List With	NRC List Without
		ORNL List	ORNL List	EPA Permit	EPA Permit
					TOTALS
P	Power Plant	78	0	0	0
M	Medical	66	95	1	4
<i>i</i> A	Academic	85	192	77	44
I	Industrial	116	355	24	39
G	Government	18	30	5	55
	TOTALS	363	722	107	142
					1334

TABLE 2. Original Stratified Random Sample Size Distribution

Step 3. Following Step 2, 95 *additional* facilities were identified from late submittals from various states and included in the sample with certainty with the following distribution assignments. Note that no attempt was made to identify and eliminate possible duplicates among the 95 that might have already been in the universe or sample.

<i>i</i>	<i>j</i>				TOTALS
	1	2	3	4	
P	0	0	0	0	0
M	13	0	0	0	13
A	26	0	0	0	26
I	53	0	0	0	53
G	3	0	0	0	3
TOTALS	95	0	0	0	95

TABLE 3. Additional Sample Sizes

Step 4. Combining the results of Tables 1, 2, and 3 yields,

		<i>j</i>				
		1	2	3	4	TOTALS
<i>i</i>	P	78 + 0 = 78 78 + 0 = 78	0 + 0 = 0 0 + 0 = 0	0 + 0 = 0 0 + 0 = 0	0 + 0 = 0 0 + 0 = 0	78 78
	M	66 + 13 = 79 66 + 13 = 79	360 + 0 = 360 95 + 0 = 95	19 + 0 = 19 1 + 0 = 1	83 + 0 = 83 4 + 0 = 4	541 179
	A	85 + 26 = 111 85 + 26 = 111	192 + 0 = 192 192 + 0 = 192	77 + 0 = 77 77 + 0 = 77	134 + 0 = 134 44 + 0 = 44	514 424
	I	116 + 53 = 169 116 + 53 = 169	900 + 0 = 900 355 + 0 = 355	166 + 0 = 166 24 + 0 = 24	546 + 0 = 546 39 + 0 = 39	1781 587
	G	18 + 3 = 21 18 + 3 = 21	80 + 0 = 80 80 + 0 = 80	5 + 0 = 5 5 + 0 = 5	155 + 0 = 155 55 + 0 = 55	261 161
	TOTALS	458 458	1532 722	267 107	918 142	3175 1429

TABLE 4. Preliminary Universe and Sample Sizes

where within stratum *ij* the top number is the preliminary number of facilities in the sampling frame and the bottom number is the preliminary number of facilities in the sample.

Step 5. Following a review (based on matching) of all sample facilities during data collection, duplicates were discovered as follows.

Case	First Stratum	Second Stratum	Number of Duplicates	Recommended Action for Identified Sample Duplicates
1	A1	A1	1	Delete 1 from A1 sample
2	A1	A2	22	Delete 22 from A2 sample
3	A1	A3	1	Delete 1 from A3 sample
4	A1	A4	3	Delete 3 from A4 sample
5	A1	M2	2	Delete 2 from A1 sample
6	A2	A2	3	Delete 3 from A2 sample
7	A2	A3	3	Delete 3 from A3 sample
8	A2	A4	11	Delete 11 from A4 sample
9	A2	I2	1	Delete 1 from A2 sample
10	A2	M1	1	Delete 1 from A2 sample
11	A2	M4	1	Delete 1 from M4 sample
12	A3	M1	1	Delete 1 from M1 sample
13	G1	G2	4	Delete 4 from G2 sample
14	G1	G4	1	Delete 1 from G4 sample
15	G1	M1	2	Delete 2 from M1 sample
16	G1	P1	1	Delete 1 from G1 sample
17	G2	G2	1	Delete 1 from G2 sample
18	G2	G3	1	Delete 1 from G3 sample
19	G2	G4	2	Delete 2 from G4 sample
20	G2	P1	1	Delete 1 from G2 sample
21	G3	I2	1	Delete 1 from I2 sample
22	G4	I2	1	Delete 1 from I2 sample
23	G4	M1	1	Delete 1 from M1 sample
24	I1	I1	2	Delete 2 from I1 sample
25	I1	I2	16	Delete 16 from I2 sample
26	I1	M1	1	Delete 1 from I1 sample
27	I1	P1	2	Delete 2 from I1 sample
28	I2	I2	9	Delete 9 from I2 sample
29	I2	I4	1	Delete 1 from I4 sample
30	I2	P1	4	Delete 4 from I2 sample
31	I4	P1	1	Delete 1 from I4 sample
32	M1	M1	1	Delete 1 from M1 sample
33	M1	M2	2	Delete 2 from M2 sample
34	M2	M2	1	Delete 1 from M2 sample
			106	106

TABLE 5. Identified Duplicates in the Sample

In the last column of Table 5, each duplicate was deleted from the stratum sample for which it was least appropriate. The total number in each stratum (frame) was reduced proportionally by the number of sample deletions from that stratum.

Step 6. Thus, using the results of Tables 4 and 5, the following table gives the **STATE OF THE DATA BASE** used in the estimation procedures.

<i>i</i>	<i>j</i>				TOTALS
	1	2	3	4	
P	$N_{P1} = 78$ $n_{P1} = 78$ $r_{P1} = 76$ $o_{P1} = 0$	$N_{P2} = 0$ $n_{P2} = 0$ $r_{P2} = 0$ $o_{P2} = 0$	$N_{P3} = 0$ $n_{P3} = 0$ $r_{P3} = 0$ $o_{P3} = 0$	$N_{P4} = 0$ $n_{P4} = 0$ $r_{P4} = 0$ $o_{P4} = 0$	$N_P = 78$ $n_P = 78$ $r_P = 76$ $o_P = 0$
M	$N_{M1} = 79$ (74/79) = 74 $n_{M1} = 79-5 = 74$ $r_{M1} = 53$ $o_{M1} = 1$	$N_{M2} = 360$ (92/95) = 349 $n_{M2} = 95-3 = 92$ $r_{M2} = 64$ $o_{M2} = 1$	$N_{M3} = 19$ $n_{M3} = 1$ $r_{M3} = 1$ $o_{M3} = 0$	$N_{M4} = 83$ (3/4) = 63 $n_{M4} = 4-1 = 3$ $r_{M4} = 2$ $o_{M4} = 0$	$N_M = 505$ $n_M = 170$ $r_M = 120$ $o_M = 2$
A	$N_{A1} = 111$ (108/111) = 108 $n_{A1} = 111-3 = 108$ $r_{A1} = 80$ $o_{A1} = 0$	$N_{A2} = 192$ (165/192) = 165 $n_{A2} = 192-27 = 165$ $r_{A2} = 111$ $o_{A2} = 0$	$N_{A3} = 77$ (73/77) = 73 $n_{A3} = 77-4 = 73$ $r_{A3} = 58$ $o_{A3} = 0$	$N_{A4} = 134$ (30/44) = 92 $n_{A4} = 44-14 = 30$ $r_{A4} = 18$ $o_{A4} = 0$	$N_A = 438$ $n_A = 376$ $r_A = 267$ $o_A = 0$
I	$N_{I1} = 169$ (164/169) = 164 $n_{I1} = 169-5 = 164$ $r_{I1} = 129$ $o_{I1} = 3$	$N_{I2} = 900$ (324/355) = 822 $n_{I2} = 355-31 = 324$ $r_{I2} = 239$ $o_{I2} = 11$	$N_{I3} = 166$ $n_{I3} = 24$ $r_{I3} = 18$ $o_{I3} = 0$	$N_{I4} = 546$ (37/39) = 518 $n_{I4} = 39-2 = 37$ $r_{I4} = 27$ $o_{I4} = 4$	$N_I = 1670$ $n_I = 549$ $r_I = 413$ $o_I = 18$
G	$N_{G1} = 21$ (20/21) = 20 $n_{G1} = 21-1 = 20$ $r_{G1} = 16$ $o_{G1} = 1$	$N_{G2} = 80$ (74/80) = 74 $n_{G2} = 80-6 = 74$ $r_{G2} = 61$ $o_{G2} = 0$	$N_{G3} = 5$ (4/5) = 4 $n_{G3} = 5-1 = 4$ $r_{G3} = 2$ $o_{G3} = 0$	$N_{G4} = 155$ (52/55) = 147 $n_{G4} = 55-3 = 52$ $r_{G4} = 40$ $o_{G4} = 0$	$N_G = 245$ $n_G = 150$ $r_G = 119$ $o_G = 1$
TOTALS	$N_{..} = 444$ $n_{..} = 444$ $r_{..} = 354$ $o_{..} = 5$	$N_{.2} = 1410$ $n_{.2} = 655$ $r_{.2} = 475$ $o_{.2} = 12$	$N_{.3} = 262$ $n_{.3} = 102$ $r_{.3} = 79$ $o_{.3} = 0$	$N_{.4} = 820$ $n_{.4} = 122$ $r_{.4} = 87$ $o_{.4} = 4$	$N_{..} = 2936$ $n_{..} = 1323$ $r_{..} = 995$ $o_{..} = 21$

TABLE 6. Overall View: Universe, Sample, and Response Sizes
After Deletion of Identified Sample Duplicates and Adjustment of Stratum Universe Sizes

where in stratum ij ,

N_{ij} = the estimated total universe size for stratum ij .

n_{ij} = the total sample size for stratum ij .

r_{ij} = the number out of n_{ij} sample facilities that responded *with data*, including zeros reported over the telephone, and that *were still in business* at the time of the survey.

o_{ij} = the number out of n_{ij} sample facilities that responded but *were not still in business* at the time of the survey.

NOTE that the total number of respondents in stratum ij is $r_{ij} + o_{ij}$.

Step 7. Estimation

The fundamental setting for sample selection was stratum ij . Thus, the fundamental setting for estimation is also stratum ij . We consider two cases. Actually, Case 2 includes Case 1.

CASE 1: Estimation Consistent With (Along) Stratum Boundaries

Parameters To be specific, let $WST_{ij1}, WST_{ij2}, \dots, WST_{ijN_{ij}}$ be the volumes of low level mixed wastes (*llmw*) generated during 1990 by the N_{ij} facilities in stratum ij . Then

- the total volume of *llmw* *WST* generated during 1990 by the N_{ij} facilities in stratum ij is

$$T_{WST(ij)} = \sum_{k=1}^{N_{ij}} WST_{ijk} \quad (1)$$

and

- the total volume of *llmw* *WST* generated during 1990 by *all* of the facilities in category i (i.e., $i1, i2, i3$, and $i4$) is

$$T_{WST(i\cdot)} = T_{WST(i1)} + T_{WST(i2)} + T_{WST(i3)} + T_{WST(i4)} \quad (2)$$

for $i = A, G, I, M$, and P .

The desire is to estimate $T_{WST(i\cdot)}$ for $i = A, G, I, M$, and P . Parameters similar to $T_{WST(ij)}$ and $T_{WST(i\cdot)}$ can be defined for other specific *llmw* substances such as SCINT LIQUID, LEADWASTE, etc.

Estimation of $T_{WST(ij)}$ and $T_{WST(i)}$

We focus on the substance *llmw WST*. Estimators of total volumes for other substances would be similar.

Within stratum ij , we assume that the $n_{ij} - (r_{ij} + o_{ij})$ sample nonrespondents are “missing at random” (Little and Rubin, 1983). According to Little and Rubin (1983), “if the process leading to missing (WST) values (and in particular, the probability that a particular value of (WST) is missing) does not depend on the values of ... (WST), then the missing data are called *missing at random* and the observed data are *observed at random*.” In such cases, it is appropriate (Oh and Scheuren, 1983; Rubin, 1983; Cochran, 1983; and NAS Panel on Incomplete Data, 1983) to assign sampling weights as follows:

$$w_{ij} = \frac{N_{ij}}{r_{ij} + o_{ij}} = \frac{N_{ij}}{n_{ij}} \left(\frac{n_{ij}}{r_{ij} + o_{ij}} \right) \quad (3)$$

for each of the $r_{ij} + o_{ij}$ respondents.

The sampling weights used are given below in Table 7.

$$\begin{aligned} w_{P1} &= \frac{78}{76+0} = 1.0263 & w_{P2} &= 0.0000 & w_{P3} &= 0.0000 & w_{P4} &= 0.0000 \\ w_{M1} &= \frac{74}{53+1} = 1.3704 & w_{M2} &= \frac{349}{64+1} = 5.3692 & w_{M3} &= \frac{19}{1+0} = 19.0000 & w_{M4} &= \frac{63}{2+0} = 31.5000 \\ w_{A1} &= \frac{108}{80+0} = 1.3500 & w_{A2} &= \frac{165}{111+0} = 1.4865 & w_{A3} &= \frac{73}{58+0} = 1.2586 & w_{A4} &= \frac{92}{18+0} = 5.1111 \\ w_{I1} &= \frac{164}{129+3} = 1.2424 & w_{I2} &= \frac{822}{239+11} = 3.2880 & w_{I3} &= \frac{166}{18+0} = 9.2222 & w_{I4} &= \frac{518}{27+4} = 16.7097 \\ w_{G1} &= \frac{20}{16+1} = 1.1765 & w_{G2} &= \frac{74}{61+0} = 1.2131 & w_{G3} &= \frac{4}{2+0} = 2.0000 & w_{G4} &= \frac{147}{40+0} = 3.6750 \end{aligned}$$

TABLE 7. Sampling Weights

Within stratum ij , assume the raw sample data values are

<u>r_{ij} sample values</u>	<u>o_{ij} sample values</u>
WST_{ij1}	WST_{ij1}
WST_{ij2}	WST_{ij2}
$\cdot$	$\cdot$
$\cdot$	$\cdot$
$\cdot$	$\cdot$
$WST_{ijr_{ij}}$	$WST_{ijo_{ij}}$

NOTE: We take *all* sample values for the o_{ij} respondents to be zeros. (This assumption seems ok if we think “domain estimation” for facilities that are “still in business.”)

An estimator for $T_{WST(ij)}$ is

$$\hat{T}_{WST(ij)} = \sum_{k=1}^{r_{ij}+o_{ij}} WST_{ijk} \cdot w_{ij} \quad (4)$$

The estimator $\hat{T}_{WST(ij)}$ is a random variable whose value depends on which sample is selected (and which facilities respond). Thus, $\hat{T}_{WST(ij)}$ has a variance which can be denoted by $Var(\hat{T}_{WST(ij)})$.

An estimator of $Var(\hat{T}_{WST(ij)})$ is

$$\hat{Var}(\hat{T}_{WST(ij)}) = N_{ij}(N_{ij} - r_{ij} - o_{ij}) \frac{S_{WST(ij)}^2}{r_{ij} + o_{ij}} \quad (5)$$

where

$$S_{WST(ij)}^2 = \frac{\sum_{k=1}^{r_{ij}+o_{ij}} [WST_{ijk} - \bar{WST}_{ij}]^2}{r_{ij} + o_{ij} - 1}$$

and

$$\bar{WST}_{ij} = \frac{\sum_{k=1}^{r_{ij}+o_{ij}} WST_{ijk}}{r_{ij} + o_{ij}} .$$

NOTE: Again, all sample values for the o_{ij} respondents are zeros. This can be viewed as making estimates of volumes generated in 1990 for facilities still in business at the time of the survey. This changes the definition of the total being estimated slightly.

Hence, an estimator of the *standard error* of $\hat{T}_{WST(ij)}$ is

$$\text{s.e.} (\hat{T}_{WST(ij)}) = \sqrt{\hat{V}ar(\hat{T}_{WST(ij)})} . \quad (6)$$

It follows that an estimator of $T_{WST(i.)}$, for the i^{th} category facilities, is

$$\hat{T}_{WST(i.)} = \hat{T}_{WST(i1)} + \hat{T}_{WST(i2)} + \hat{T}_{WST(i3)} + \hat{T}_{WST(i4)} , \quad (7)$$

and an estimator of the standard error of $\hat{T}_{WST(i.)}$ is

$$\text{s.e.} (\hat{T}_{WST(i.)}) = \sqrt{\hat{V}ar(\hat{T}_{WST(i1)}) + \hat{V}ar(\hat{T}_{WST(i2)}) + \hat{V}ar(\hat{T}_{WST(i3)}) + \hat{V}ar(\hat{T}_{WST(i4)})} \quad (8)$$

Also, an estimator of $T_{WST(..)} = \sum_i T_{WST(i.)}$, for all facilities is

$$\hat{T}_{WST(..)} = \sum_i \hat{T}_{WST(i.)} , \quad (9)$$

and an estimator of the standard error of $\hat{T}_{WST(..)}$ is

$$\text{s.e.} (\hat{T}_{WST(..)}) = \sqrt{\sum_i [\text{s.e.} (\hat{T}_{WST(i.)})]^2} \quad (10)$$

CASE 2: Estimation Not Necessarily Consistent With (Along) Stratum Boundaries: Domain Estimation

It may be of interest to estimate the total volume of *llmw WST* generated during 1990 by a subuniverse (domain) of facilities which does not coincide with the sampling stratum boundaries. For example, if D is the collection of Academic Institutions or the collection of all facilities in the Southeastern Compact, then one may want to proceed as follows to estimate $T_{WST(D)}$ which would be the total *llmw WST* generated in 1990 by all facilities in domain D , say Academic Institutions (that were still in business during the time of the survey). *This method of estimation is also important if there is concern about the extent to which facilities were assigned to incorrect strata in the frame.* As under Case 1, we should first work within stratum ij . An estimator of the total portion of $T_{WST(D)}$ which is in stratum ij is

$$\hat{T}_{WST(D,ij)} = \sum_{\substack{k \text{ over all} \\ p \text{ facilities} \\ \text{in stratum} \\ ij \text{ among the} \\ r_{ij} + o_{ij} \\ \text{respondents}}} (WST_{D(ijk)}) (w_{ij}) . \quad (11)$$

(See e.g. Cochran (1977), Section 2.13.)

NOTE: Once again, taking all $WST_{D(ijk)}$ sample values for the o_{ij} respondents as zeros, changes the definition of the estimated total volume to those still in business at the time of the survey.

An estimator of the variance (see Cochran (1977), Section 2.13) of $\hat{T}_{WST(D,ij)}$ is

$$\hat{V}ar(\hat{T}_{WST(D,ij)}) = N_{ij}(N_{ij} - r_{ij} - o_{ij}) \frac{S_{WST(D,ij)}^2}{r_{ij} + o_{ij}} \quad (12)$$

where $S_{WST(D,ij)}^2 =$

$$\frac{\sum_{\substack{k \text{ over all} \\ p \text{ facilities} \\ \text{in stratum} \\ ij \text{ among the} \\ r_{ij} + o_{ij}}} [WST_{D(ijk)}]^2 - (r_{ij} + o_{ij}) \left[\sum_{\substack{k \text{ over all} \\ p \text{ facilities} \\ \text{in stratum} \\ ij \text{ among the} \\ r_{ij} + o_{ij}}} WST_{D(ijk)} / (r_{ij} + o_{ij}) \right]^2}{r_{ij} + o_{ij} - 1} .$$

The estimator of the standard error of $\hat{T}_{WST(D,ij)}$ is

$$\text{s.e.}(\hat{T}_{WST(D,ij)}) = \sqrt{\hat{V}ar(\hat{T}_{WST(D,ij)})} . \quad (13)$$

Thus, our estimator of $T_{WST(D)}$ is

$$\hat{T}_{WST(D)} = \sum_i \sum_j \hat{T}_{WST(D,ij)} , \quad (14)$$

and our estimator of the standard error of $\hat{T}_{WST(D)}$ is

$$\text{s.e.}(\hat{T}_{WST(D)}) = \sqrt{\sum_i \sum_j \hat{Var}(\hat{T}_{WST(D,ij)})} . \quad (15)$$

From Table 4.3, $\hat{T}_{(D)} = 28,982$ and $\text{s.e.}(\hat{T}_{(D)}) = 3,055$ where $D = \text{Academic}$.

NOTES:

- Actually, all estimators of total volumes can be obtained as described under Case 2. Case 1 was presented first mainly to help the presentation of Case 2.
- If one is only interested in estimating totals such as with $\hat{T}_{WST(D)}$ and not in estimating standard errors such as $\text{s.e.}(\hat{T}_{WST(D)})$, then an easy way to view the process in general is to take each respondent's sample value for *llmw WST* and multiply it by its sampling weight and sum all of these products for those sample units in domain D . This gives the same $\hat{T}_{WST(D)}$ described under (14); and when D coincides with strata boundaries, it gives the same result for estimation of a total as would be obtained under Case 1. Recall that taking all sample values for o_i respondents as zeros changes the definition of the total being estimated slightly to the estimate of total volume generated in 1990 by those facilities still in business at the time of the survey.
- One may only want to estimate standard errors only for estimated total volumes at the category level ($i = A, G, I, M, \text{ and } P$) or higher due to possibly small sample sizes at lower levels and hence less reliable estimators of standard error. See Table 4.3.
- Assuming that the general estimator $\hat{T}_{X(D)}$ has an approximate normal distribution, then an approximate, say 95%, confidence interval for $T_{X(D)}$, the total volume generated for substance X for some domain D , is given by

$$\hat{T}_{X(D)} - 1.96[\text{s.e.}(\hat{T}_{X(D)})] , \quad \hat{T}_{X(D)} + 1.96[\text{s.e.}(\hat{T}_{X(D)})] .$$

References

1. Cochran, W. G. (1977). *Sampling Techniques (9rd Ed)*, Wiley and Sons, New York.
2. Cochran, W. G. (1983). "Historical Perspective," pp. 20-21, in *Incomplete Data in Sample Surveys, Vol. 2*, (W. G. Madow, I. Olkin, and D. R. Rubin, eds.), Academic Press, New York.
3. Little, R. J. A. and Rubin, D. B. (1983). "Missing Data in Large Data Sets," in *Statistical Methods and the Improvement of Data Quality*, (T. Wright, ed.), Academic Press, New York.
4. NAS Panel on Incomplete Data (1983). "Review of Theory," Chapter 5, in *Incomplete Data in Sample Surveys, Vol. 1*, (W. G. Madow, H. Nisselson, and I. Olkin, eds.), Academic Press, New York.
5. Oh, H. L. and Scheuren, F. J. (1983). "Weighting Adjustment for Unit Nonresponse," in *Incomplete Data in Sample Surveys, Vol. 2*, (W. G. Madow, I. Olkin, and D. R. Rubin, eds.), Academic Press, New York.
6. Rubin, D. B. (1983). "Conceptual Issues in the Presence of Nonresponse," in *Incomplete Data for Sample Surveys, Vol. 2*, (W. G. Madow, I. Olkin, and D. R. Rubin, eds.), Academic Press, New York.

APPENDIX F

RECOMMENDATION FOR CHANGES TO SURVEY QUESTIONNAIRE

RECOMMENDATION FOR CHANGES TO SURVEY QUESTIONNAIRE

As outlined in Sect. 1.2.4, twenty members of Appalachian Compact Users of Radioactive Isotopes (ACURI), the association of radioactive licensees within the Appalachian Compact agreed to cooperate in the initial test phase of the national mixed waste survey. Based on the data collected, comments received, and various discussions among the mixed waste profile team members, the pretest survey questionnaire was modified to enhance its usefulness. The final survey questionnaire is included in Appendix B.

However, after receiving over 1,000 responses to the mixed waste questionnaire, we still found that respondents to the questionnaire were able to interpret some of the questions in ways we felt were impossible.

The following are comments or suggestions that the mixed waste profile team are making if any reissuance of the survey is attempted.

GENERAL:

An additional note defining scintillation fluids needs to be added. 'Scintillation fluids with activity both above and below the 0.05 $\mu\text{Ci/g}$ level for carbon-14 and tritium are requested. Only information on scintillation fluids containing RCRA hazardous materials such as toluene or xylene is requested.' This clarification could possibly be added under the definition of "Mixed" waste on page i of the questionnaire.

SECTION C

Need to add a statement that a positive answer to C-1, for one or more wastes, should not preclude testing the other LLRW by answering C-2, C-3, and C-4.

SECTION D-1

Add; 'Source - Process or procedure that produced the waste'.

SECTION D-2

Volume Treated During 1990; Should be worded to indicate the 'amount of the 1990 generated waste that has been treated to date'. also "treated (on-site/off-site)" in the directions should be changed to 'treated (indicate on-site or off-site)'.

SECTION D-3

Need to add a statement that emphasized that the information requested 'included treatment already carried out or expected to be carried out under current conditions'. Should also read "For each mixed waste stream shown as being generated in D-1,'.

Need to add a statement that in general, volume, activity, and effect on the hazard component for incineration are respectively 0, 0, destroyed.

SECTION E-1

Need to add a statement that "This waste may or may not have been actually generated in 1990.'

SECTION E-1

Add; 'Source - Process or procedure that produced the waste'.

APPENDIX G

PERMITS AND LICENSES FOR COMPANIES TREATING MIXED WASTES

Appendix G

Permits, Licenses, or Authorizations for Companies Treating Mixed Waste

Exhibit A	List of current and potential future commercial mixed waste treatment facilities.
Exhibit B1	List of permits, licenses, or authorizations pertaining to DSSI.
Exhibit B2	Radioactive materials license for DSSI.
Exhibit B3	Treatment, storage, and disposal permit for DSSI.
Exhibit B4	Air Pollution Control Permit for DSSI.
Exhibit B5	National Emissions Standards for Hazardous Air Pollution Permit for DSSI.
Exhibit B6	Hazardous wastes acceptable for receipt at DSSI.
Exhibit C1	List of permits, licenses, or authorizations pertaining to NSSI.
Exhibit C2	Hazardous waste permit for NSSI.
Exhibit C3	RCRA Part B Permit for NSSI.
Exhibit C4	Radioactive materials license for NSSI.
Exhibit D1	List of permits, licenses, or authorizations pertaining to Quadrex.
Exhibit D2	RCRA hazardous waste permit for Quadrex.
Exhibit D3	RCRA Part B Permit for Quadrex.
Exhibit D4	Radioactive materials license for Quadrex.
Exhibit D5	FDER Used Oil Registration for Quadrex.
Exhibit E1	List of permits, licenses, or authorizations pertaining to RAMP.
Exhibit E2	Radioactive materials license for RAMP.
Exhibit E3	RCRA Part B Permit for RAMP.
Exhibit E4	Hazardous wastes acceptable for receipt at RAMP.
Exhibit F1	List of permits, licenses, or authorizations pertaining to Envirocare.
Exhibit F2	Radioactive materials license for Envirocare.
Exhibit F3	RCRA permit for Envirocare.
Exhibit F4	Hazardous wastes acceptable for disposal at Envirocare.
Exhibit G	Acceptance limits and criteria for contaminated oils at SEG.

Exhibit A

Current and Potential Future Commercial Industries Treating Mixed Wastes

Company Name and Location	Status of Mixed Waste Treatment Capability	Phone Number
DSSI P.O. Box 863 Kingston, TN 37763	Current	615-376-0084
NSSI P.O. Box 34042 Houston, TX 77234	Current	713-641-0391
Quadrex Corp. 1940 NW 67th Place Gainesville, FL 32606-1649	Current	904-373-6066
RAMP Industries 1127 W. 46th Ave. Denver, CO 80211	Current	303-480-1481
Envirocare Salt Lake City, UT 84111	Planned for future	801-532-1330
SEG P.O. Box 2530 1560 Bear Creek Rd. Oak Ridge, TN 37830	Planned for future	615-481-0222

Exhibit B1

LIST OF PERMITS, LICENSES, OR AUTHORIZATIONS PERTAINING TO DSSI

List of permits, licenses, or authorizations pertaining to DSSI				
Type	Number	Issue date	Expiration date	Issued by
Radioactive Materials License	R-73014-H95	August 10, 1990	August 31, 1995	Tennessee Dept. of Health and Environment Division of Radiological Health TERRA Building 150 Ninth Avenue, North Nashville, TN 37219
TSD Type B - Hazardous Waste Permit	TNHW-024	August 4, 1989	August 4, 1999	Tennessee Dept. of Health and Environment Division of Solid Waste Management Customs House 701 Broadway Nashville, TN 37247
Air Pollution Permit	931365-F	August 16, 1991	November 1, 1991	Tennessee Dept. of Health and Environment Division of Air Pollution Control Customs House 701 Broadway Nashville, TN 37247
NESHAP	None specified	April 11, 1989	None specified	U.S. EPA, Region IV Air Pesticides & Toxics Management Division 345 Courtland Street Atlanta, GA 30365
Small Power Production Facility FERC Permit	Docket Number QF-89-280-000	June 22, 1989	None specified	Federal Energy Regulatory Commission Office of the Secretary 825 North Capitol Street, NE Washington, DC 20246
EPA Generators Number	TND 98 210 9142	October 5, 1987	None specified	Tennessee Dept. of Health and Environment Division of Air Pollution Control Customs House 701 Broadway Nashville, TN 37247

Exhibit B2

RADIOACTIVE MATERIALS LICENSE FOR DSSI

STATE OF TENNESSEE
DEPARTMENT OF HEALTH AND ENVIRONMENT
CORDELL HULL BUILDING
NASHVILLE, TENNESSEE 37219-5402

August 10, 1990

Diversified Scientific Services, Inc.
508 N. Kentucky Street
Kingston, TN 37763

Attention: James T. McVey, RSO

Gentlemen:

Attached to this letter is your Tennessee Radioactive Material License numbered R-73014-H95 issued to expire on August 31, 1995.

A copy of 'State Regulations for Protection Against Radiation' referred to in Condition 12 of the license conditions is being sent to you by a separate mailing. Your attention is directed to State Regulations and to specific license Conditions 11 through 27 which are to be followed in the use of this license.

Also attached to this letter are several copies of Form RHS 8-3 for posting as noted on that form.

If we can be of further assistance to you, please contact us.

Sincerely,

Robert N. Young
Health Physicist
Division of Radiological Health

Attachments:

RNY/ry

TENNESSEE DEPARTMENT OF HEALTH AND ENVIRONMENT
DIVISION OF RADIOLOGICAL HEALTH

RADIOACTIVE MATERIAL LICENSE

Pursuant to Tennessee Department of Health and Environment Regulations, and in reliance on statements and representations heretofore made by the licensee, a license is hereby issued authorizing the licensee to receive, acquire, possess and transfer radioactive material listed below; and to use such radioactive material for the purpose(s) and at the place(s) designated below. This license is subject to all applicable rules and regulations of the Tennessee Department of Health and Environment and orders of the Division of Radiological Health, now or hereafter in effect and to any conditions specified below.

<p align="center">LICENSEE</p> <p>1. Name Diversified Scientific Services, Inc.</p> <p>2. Address 508 N. Kentucky Street Kingston, TN 37763</p>		<p>3. License number R-73014-H95</p> <p>4. Expiration date August 31, 1995</p> <p>5. File no. R-73014</p>
<p>6. Radioactive Material (Element and Mass Number)</p> <p align="center">SEE SUPPLEMENTARY SHEETS</p>	<p>8. Chemical and/or physical form</p> <p align="center">SEE SUPPLEMENTARY SHEETS</p>	<p>9. Maximum Radioactivity and/or quantity of material which licensee may possess at any one time.</p> <p align="center">SEE SUPPLEMENTARY SHEETS</p>

10. Authorized Use

SEE SUPPLEMENTARY SHEETS

CONDITIONS

11. Unless otherwise specified, the authorized place of use is the licensee's address stated in item 2, above.

SEE SUPPLEMENTARY SHEETS

Date of Issuance August 10, 1990

For the Commissioner
Tennessee Department of Health and Environment

By:

DIVISION OF RADIOLOGICAL HEALTH
Robert N. Young
Health Physicist

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TDPH-ORH
PH-0382 Rev 6/83

TENNESSEE DEPARTMENT OF HEALTH AND ENVIRONMENT
DIVISION OF RADIOLOGICAL HEALTH

RADIOACTIVE MATERIAL LICENSE

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License Number R-73014-H95

6. <u>Radioactive Material (Element and Mass Number)</u>	8. <u>Chemical and/or Physical Form</u>	9. <u>Maximum Radioactive Material Which Licensee May Possess at Any One Time</u>
A. Hydrogen 3	A. Any as associated with liquid scintillation type fluids, solutes, solvents, and associated materials.	A. The total combined isotopic activities <u>shall not exceed</u> 10 Curies at any one time.
B. Carbon 14	B. Same as in 8A.	B. See Item 9A.
C. Sulfur 35	C. Same as in 8A.	C. See Item 9A.
D. Chlorine 36	D. Same as in 8A.	D. See Item 9A.
E. Calcium 45	E. Same as in 8A.	E. See Item 9A.
F. Iron 55	F. Same as in 8A.	F. See Item 9A.
G. Iron 59	G. Same as in 8A.	G. See Item 9A.
H. Cesium 137	H. Same as in 8A.	H. See Item 9A.
I. Cobalt 60	I. Same as in 8A.	I. See Item 9A.
J. Cobalt 58	J. Same as in 8A.	J. See Item 9A.
K. Cobalt 57	K. Same as in 8A.	K. See Item 9A.
L. Gadolinium 153	L. Same as in 8A.	L. See Item 9A.
M. Zinc 65	M. Same as in 8A.	M. See Item 9A.
N. Phosphorus 32	N. Same as in 8A.	N. See Item 9A.
O. Phosphorus 33	O. Same as in 8A.	O. See Item 9A.
P. Sodium 22	P. Same as in 8A.	P. See Item 9A.
Q. Rubidium 86	Q. Same as in 8A.	Q. See Item 9A.

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CORRECTED COPY

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R. Mercury 203	R. Same as in 8A.	R. See Item 9A.
S. Indium 111	S. Same as in 8A.	S. See Item 9A.
T. Gallium 67	T. Same as in 8A.	T. See Item 9A.
U. Manganese 54	U. Same as in 8A.	U. See Item 9A.
V. Scandium 46	V. Same as in 8A.	V. See Item 9A.
W. Selenium 75	W. Same as in 8A.	W. See Item 9A.
X. Cadmium 109	X. Same as in 8A.	X. See Item 9A.
Y. Nickel 63	Y. Same as in 8A.	Y. See Item 9A.
Z. Copper 64	Z. Same as in 8A.	Z. See Item 9A.
AA. Tin 113	AA. Same as in 8A.	AA. See Item 9A.
BB. Tin 119m	BB. Same as in 8A.	BB. See Item 9A.
CC. Iodine 125	CC. Same as in 8A.	CC. See Item 9A.
DD. Iodine 131	DD. Same as in 8A.	DD. See Item 9A.
EE. Bismuth 207	EE. Same as in 8A.	EE. See Item 9A.
FF. Cerium 141	FF. Same as in 8A.	FF. See Item 9A.
GG. Gold 195	GG. Same as in 8A.	GG. See Item 9A.
HH. Any Radioactive Material with Atomic numbers 1 through 95, inclusive (except U-233, U-235, and any isotope of plutonium)	HH. Sealed Source in plated encapsulated, embedded, or flame sealed (liquid) form.	HH. No single source to exceed 100 microcuries. Total not to exceed One (1) millicurie.
II. Nickel 63	II. Sealed Source (New England Nuclear Model NEN-004)	II. Three (3) sources not to exceed 20 millicuries each.

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License Number R-73014-H95

10. Authorized use

A. through GG. For the burning of liquid scintillation type fluids as fuel in accordance with statements, representations, and procedures contained in material referenced in Condition 27. of this license.

HH. For use in instrument calibration and standardization.

II. For use in Tracor Models 111019 or 115500 electron capture detectors as part of Tracor 540 gas chromatographs.

Conditions (continued)

12. The licensee shall comply with applicable provisions of 1200-2-4, 1200-2-5, and 1200-2-10 of "State Regulations for Protection Against Radiation".

13. Radioactive material authorized by this license shall be used only at Route 3 Gallaher Road, (Junction of Gallaher Road and I-40), Kingston, Tennessee 37763.

14. Radioactive material authorized by this license shall be used by, or under the supervision and in the physical presence of, James R. Sims, Joseph Crider, or James T. McVey.

The radiation safety officer for this license is James T. McVey.

15. Pursuant to 1200-2-8-.21 of "State Regulations for Protection Against Radiation", the licensee may dispose of radioactive material by incineration in accordance with procedures contained in application dated October 5, 1987, with attachments and material referenced in Condition 27 of this license. The quantity of radioactive material burned, by the licensee, in any one year shall not exceed Twenty Two and a half (22.5) Curies of Hydrogen 3 and Carbon 14 combined total and One and a half (1.5) Curies combined total of all other isotopes authorized by this license. In addition, no fluids shall be burned which have concentrations in excess of 0.05 microcurie/gram of Hydrogen 3 and Carbon 14 combined, or 0.002 microcurie/gram of all other isotopes authorized by this license combined.

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The radioactivity in the gaseous effluent from the facility shall not exceed the limits specified for air in either Schedule RNS 8-1, Table II, Column 1 of "State Regulations for Protection Against Radiation" or the National Emission Standards for Hazardous Air Pollutants; Standards for Radionuclides (40 CFR Part 61) which ever are more restrictive.

16. The licensee shall maintain complete and accurate records of the receipt and disposal of radioactive material. The licensee shall, for radioactive material no longer useful for any purpose and for any equipment or supplies contaminated with such material for which further use and decontamination is not planned, define those materials as radioactive waste and treat them as such in accordance with the following provisions:
 - A. Radioactive waste material shall not be stored with non-radioactive waste.
 - B. A written record of all radioactive waste material shall be maintained until it has been determined by a suitable survey or radioassay that it has decayed to background levels or until it has been shipped to an authorized recipient in accordance with all applicable regulations. Accountability of radioactive waste material prepared for shipment but not yet shipped from the licensee's premises shall be maintained by the licensee by an internal record system such that the licensee is constantly aware of the material's location and the proposed time of shipment. Individuals who are involved in the shipping of such material and/or the storage of such material prior to shipment, shall be trained in the precautions necessary for such handling and storage.
 - C. For material which has decayed to background levels as determined by radioassay or external level as measured with appropriately calibrated instruments, records shall indicate that the material was determined to be no longer radioactive and will indicate the methods and results of the survey or analysis.
 - D. Shipment records of radioactive waste material shall be maintained and the licensee shall require written confirmation from the authorized recipient of such material that this material has been received.
 - E. All records and written confirmations required by this condition shall be maintained for inspection by the Department.

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The requirements for this condition are in addition to any other requirements for the handling and/or disposal of radioactive material contained in this license and "State Regulations for Protection Against Radiation".

- 17.A. Sealed sources authorized by this license shall be tested for leakage and/or contamination at intervals not to exceed three (3) years. In the absence of a certificate from a transferor indicating that a test has been made within six (6) months prior to transfer, the sealed source shall not be put into use until tested.
 - B. The test shall be capable of detecting the presence of 0.005 microcurie of radioactive material on the test sample. The test sample shall be taken from the sealed source or from the surface of the device in which the sealed source is permanently mounted or stored on which one might expect contamination to accumulate. Records of leak tests shall be kept in units of microcuries and maintained for inspection by the Department.
 - C. If the test reveals the presence of 0.005 microcurie or more of removable contamination, the licensee shall immediately withdraw the sealed source from use and shall cause it to be decontaminated and repaired or to be disposed of in accordance with Department regulations. A report shall be filed within five (5) days of the test with the Division of Radiological Health, Tennessee Department of Health and Environment, 150 9th Avenue North, Nashville, Tennessee, 37247-3201, describing the equipment involved, the test results, and the corrective action taken.
 - D. Tests for leakage and/or contamination shall be performed in accordance with statements, representations, and procedures contained in application dated October 5, 1987, with attachments, and material reference in Condition 27 of this license or by persons specifically licensed by this Department, the U. S. Nuclear Regulatory Commission, or another Agreement State to perform such services.
18. Notwithstanding the periodic leak test required by Condition 17, any licensed sealed source is exempt from such leak tests when the source contains 100 microcuries or less of beta and/or gamma emitting material or 10 microcuries or less of alpha emitting material.
19. Detector cells containing Nickel 63 authorized by this license shall only be used in conjunction with a properly operating temperature control mechanism which prevents the temperature of the foil from exceeding 400 degrees centigrade.

TENNESSEE DEPARTMENT OF HEALTH AND ENVIRONMENT
DIVISION OF RADIOLOGICAL HEALTH

RADIOACTIVE MATERIAL LICENSE

SUPPLEMENTARY SHEET

Page 7 of 8 Pages

License Number R-73014-H95

20. Maintenance and repair of detector cells containing radioactive material shall be performed only by the manufacturer or by other persons specifically authorized by the Department, the U. S. Nuclear Regulatory Commission or another Agreement State to perform such services.
21. Detector cells containing licensed material shall not be opened or the foil sources removed from the detector cell by the licensee.
22. When not installed in a gas chromatograph, detector cells containing licensed material shall be stored in a properly labeled container under lock and key to prevent access by unauthorized individuals.
23. In lieu of using the conventional radiation caution colors (magenta or purple on yellow background) as provided in 1200-2-5-.12(1) of "State Regulations for Protection Against Radiation", the licensee is hereby authorized to label detector cells and cell baths, containing byproduct material and used in gas chromatography devices, with conspicuously etched or stamped radiation caution symbols without a color requirement.
24. Survey instrument calibration shall be performed in accordance with statements, representations, and procedures contained in application dated October 5, 1987, with attachments, and material referenced in Condition 27 of this license.
25. No provision of this license relieves the licensee from compliance with other Federal, State and local laws, ordinances, and regulations applicable to the licensee's activities.
26. The licensee is authorized to perform instrument calibration and leak testing of sealed sources in accordance with statements, representations, and procedures contained in correspondence referenced in Condition 27 of this license.

The tests shall be capable of detecting the presence of 0.005 microcurie of radioactive material on the test sample, or in the case of radium, the escape of radon at the rate of 0.001 microcurie per 24 hours. The customer shall be furnished a report of the results in units of microcuries.

If the test reveals the presence of 0.005 microcurie or more of removable contamination, or in the case of radium, the escape of radon at the rate of 0.001 microcurie or more per 24 hours, the customer of the licensee shall be informed of the Department's requirements as follows: "The

TENNESSEE DEPARTMENT OF HEALTH AND ENVIRONMENT
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RADIOACTIVE MATERIAL LICENSE

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License Number R-73014-H95

licensee shall immediately withdraw the sealed source from use and shall cause it to be decontaminated and repaired or to be disposed of in accordance with Department regulations."

A report shall be filed within five (5) days of the test with the Division of Radiological Health, Tennessee Department of Health and Environment, 150 9th Avenue North, Nashville, Tennessee 37247-3201, describing the equipment involved, the test results, and the corrective action taken.

27. Except as specifically provided otherwise by this license, the licensee shall possess and use radioactive material described in Items 6, 8, and 9 of this license in accordance with statements, representations, and procedures contained in application dated October 5, 1987, with attachments, and letters dated August 18, 1987, with attachments, October 5, 1987, with attachments, November 10, 1987, with attachments, March 3, 1988, with attachments, April 13, 1988, with attachments, April 14, 1988, with attachments, June 14, 1988, with attachments, September 2, 1988, with attachments, June 5, 1989, with attachments, April 24, 1990, with attachments, July 5, 1990, with attachments, and August 7, 1990, with attachments.

TENNESSEE DEPARTMENT OF HEALTH AND ENVIRONMENT
DIVISION OF RADIOLOGICAL HEALTH

RADIOACTIVE MATERIAL LICENSE

Amendment 1

Page 1 of 3 Pages

License Number R-73014-H95

Diversified Scientific Services, Inc.
P.O. Box 863
Kingston, TN 37763

Attention: James T. McVey, Executive Vice President

Gentlemen:

As requested by James T. McVey and in accordance with his letters dated December 10, 1990, January 17, 1991, February 25, 1991 with attachments, March 5, 1991 with attachments, March 14, 1991 with attachments (two letters), and March 18, 1991, your Tennessee Radioactive Material license is amended as follows:

To add:

6. Radioactive Material (Element and <u>Mass Number</u>)	8. Chemical and/or <u>Physical Form</u>	9. Maximum Radioactivity and/or quantity of material which licensee may possess at <u>any one time</u>
JJ. Any radioactive material with atomic numbers 1 through 83, inclusive, except as in A. through II. and KK. through TT.	JJ. Same as in 8A.	JJ. The total combined isotopic activities <u>shall not exceed</u> 1 Curie at any one time.
KK. Cr-51	KK. Same as in 8A.	KK. 2 Curies
LL. Cs-134	LL. Same as in 8A.	LL. 2 Curies
MM. Tc-99	MM. Same as in 8A.	MM. 2 Curies

TENNESSEE DEPARTMENT OF HEALTH AND ENVIRONMENT
DIVISION OF RADIOLOGICAL HEALTH

RADIOACTIVE MATERIAL LICENSE

Amendment 1

Page 2 of 3 Pages

License Number R-73014-H95

NN. Ge-68	NN. Same as in 8A.	NN. 2 Curies
OO. Uranium (not U-233 or U-235)	OO. Same as in 8A.	OO. Total quantity authorized in Items OO. and PP. is 200 kilograms
PP. Thorium	PP. Same as in 8A.	PP. See Item OO.
QQ. Radium	QQ. Same as in 8A.	QQ. 10 milliCuries
RR. Uranium 235	RR. Same as in 8A.	RR. 175 grams*
SS. Uranium 233	SS. Same as in 8A.	SS. 100 grams*
TT. Plutonium	TT. Same as in 8A.	TT. 100 grams*

* For each kind of special nuclear material, determine the ratio between the quantity of that special nuclear material and the quantity specified here for the same kind of special nuclear material. The sums of such ratios for all kinds of special nuclear material in combination shall not exceed "1" (i.e., unity). In accordance with letter dated January 17, 1991 and signed by James T. McVey, the amount of special nuclear material allowed under this license is one-half of the amount defined in "State Regulations for Protection Against Radiation" 1200-2-4-.04(oo).

10. Authorized Use

JJ. through TT. Same as A. through GG.

To change Condition 27. This condition will now read as follows:

27. Except as specifically provided otherwise by this license, the licensee shall possess and use radioactive material described in Items 6, 8, and 9 of this license in accordance with statements, representations, and procedures contained in application dated October 5, 1987 with attachments and letters dated August 18, 1987 with attachments, October 5, 1987 with attachments, November 10,

TENNESSEE DEPARTMENT OF HEALTH AND ENVIRONMENT
DIVISION OF RADIOLOGICAL HEALTH

RADIOACTIVE MATERIAL LICENSE

Amendment 1

Page 3 of 3 Pages

License Number R-73014-H95

1987 with attachments, March 3, 1988 with attachments, April 13, 1988 with attachments, April 14, 1988 with attachments, June 14, 1988 with attachments, September 2, 1988 with attachments, June 5, 1989 with attachments, April 24, 1990 with attachments, July 5, 1990 with attachments, August 7, 1990 with attachments, December 10, 1990, January 17, 1991, February 25, 1991 with attachments, March 5, 1991 with attachments, March 14, 1991 with attachments (two letters), and March 18, 1991.

This amendment authorizes by reference the design and installation of air sampling probes in accordance with letters signed by James T. McVey dated February 25, 1991 with attachments, March 5, 1991 with attachments, and March 14, 1991 with attachments.

All other parts of this license remain unchanged.

Date: March 19, 1991

For the Commissioner
Tennessee Department of Health
and Environment

By:

John Hoffelt
Environmental Specialist
Division of Radiological Health

TENNESSEE DEPARTMENT OF HEALTH AND ENVIRONMENT
DIVISION OF RADIOLOGICAL HEALTH

RADIOACTIVE MATERIAL LICENSE

Amendment 2

Page 1 of 2 Pages

License Number R-73014-H95

Diversified Scientific Services, Inc.
P.O. Box 863
Kingston, TN 37763

Attention: James T. McVey, Executive Vice President

Gentlemen:

As requested by James T. McVey and in accordance with his letter dated April 15, 1991, your Tennessee Radioactive Material License number R-73014-H95 is amended as follows:

To add Condition 28. This condition shall read as follows:

28. The licensee is authorized to store drums of materials described in letter dated April 15, 1991 in excess of 180 days not to exceed June 1, 1991.

To change Condition 27. This condition will now read as follows:

27. Except as specifically provided otherwise by this license, the licensee shall possess and use radioactive material described in Items 6, 8, and 9 of this license in accordance with statements, representations, and procedures contained in application dated October 5, 1987 with attachments and letters dated August 18, 1987 with attachments, October 5, 1987 with attachments, November 10, 1987 with attachments, March 3, 1988 with attachments, April 13, 1988 with attachments, April 14, 1988 with attachments, June 14, 1988 with attachments, September 2, 1988 with attachments, June 5, 1989 with attachments, April 24, 1990 with attachments, July 5, 1990 with attachments, August 7, 1990 with attachments, December 10, 1990, January 17, 1991, February 25, 1991 with attachments, March 5, 1991 with attachments, March 14, 1991 with attachments (two letters), March 18, 1991, and April 15, 1991.

All other parts of this license remain unchanged.

TENNESSEE DEPARTMENT OF HEALTH AND ENVIRONMENT
DIVISION OF RADIOLOGICAL HEALTH

RADIOACTIVE MATERIAL LICENSE

Amendment 2

Page 2 of 2 Pages

License Number R-73014-H95

Date: April 17, 1991

For the Commissioner
Tennessee Department of Health
and Environment

By:

John Hoffelt
Environmental Specialist
Division of Radiological Health

Exhibit B3

TREATMENT, STORAGE, AND DISPOSAL PERMIT FOR DSSI

State of Tennessee
Department of Health and Environment
Division of Solid Waste Management

Hazardous Waste Management Program
4th Floor, Customs House
701 Broadway
Nashville, Tennessee 37219-5403
(615) 741-3424

PERMIT

Permittee: Diversified Scientific Services Incorporated
Route 3, Gallaher Road
P.O. Box 863
Kingston, Tennessee 37763
Installation Identification Number: TND 98 210 9142
Permit Number: TNHW-024

Pursuant to the Tennessee Hazardous Waste Management Act, as amended (Tennessee Code Annotated 68-46-101 et seq), and regulations (Chapter 1200-1-11) promulgated thereunder by the Tennessee Solid Waste Disposal Control Board, a permit is issued to Diversified Scientific Services Incorporated (hereinafter called the Permittee or DSSI), to construct and operate a hazardous waste storage facility to be located at Gallaher Road near Interstate 40 just outside Kingston, Tennessee, Roane County at latitude 35° 52' 05" and longitude 84° 27' 10". The Permittee will be allowed to store and recycle hazardous waste subject to the terms of this permit.

The Permittee must comply with all terms and conditions of this permit. This permit consists of the conditions contained herein (including those in any attachments) and the applicable regulations contained in Rule Chapter 1200-1-11, as specified in the permit. Applicable regulations are those which are in effect on the date of issuance of the permit, except for the applicable fee requirements of Rule 1200-1-11-.08, applicable land disposal restriction requirements of Rule 1200-1-11-.10, and the permit continuation, transfer, modification, revocation and reissuance, and termination provisions at Rule 1200-1-11-.07(9). Any lawfully promulgated modification made to these excepted regulations during the effective life of this permit shall be considered applicable regulations.

Continuation, Transfer, Modification, Revocation and Reissuance, and Termination of this permit must comply with and conform to Rule 1200-1-11-.07(9).

This permit is based on the assumption that the information submitted in the original permit application and subsequent modifications thereto (hereinafter referred to as the application) is accurate and that the facility will be constructed, operated, maintained, and closed as specified in the application. The Permittee's failure in the application to disclose fully all relevant facts, or the Permittee's misrepresentation of any relevant facts at any time may be grounds for termination of this permit and potential enforcement action. The Commissioner may modify this permit if information is received which was not available at the time of permit issuance and which justifies the application of different permit conditions at the time of issuance. The Permittee must inform the Tennessee Department of Health and Environment, Division of Solid Waste

Management, of any deviation from or changes in the information in the application which would affect the Permittee's ability to comply with the applicable regulations or permit conditions.

This permit is effective as of August 4, 1989, and shall remain in effect until August 4, 1999, unless revoked and reissued, or terminated, or continued.

A handwritten signature in cursive script, appearing to read "Tom Tiesler", is written over a horizontal line.

Tom Tiesler, Director
Division of Solid Waste Management
Tennessee Department of Health and Environment

JTT/kl

STATE OF TENNESSEE
CUSTOMS HOUSE
701 BROADWAY
DEPARTMENT OF HEALTH AND ENVIRONMENT
NASHVILLE, TENNESSEE 37247

January 23, 1991

Mr. James T. McVay
Diversified Scientific Services, Inc.
P.O. Box 863
Kingston, TN 37763

Dear Mr. McVay:

The Tennessee Division of Solid Waste Management acknowledges your request of December 14, 1990 for a major modification pursuant to the rules governing Tennessee Rule Chapter 1200-1-11-.07(9)(c)(5)(xiii)(I) to add the additional EPA waste codes (Attachment 1).

The modification to your permit will be processed under the now pending regulations dealing with the new TCLP and modification classifications by March 1, 1991.

This letter serves as notice that the facility can handle the new waste codes until the final modification is made to the facility permit No. TNHW-024.

If there are any additional concerns, please feel free to contact Ms. Hymelia Norris of my staff at (615) 741-3424.

Sincerely,

A handwritten signature in cursive script, likely of Tom Tiesler, is written over the "Sincerely," line.

Tom Tiesler, Director
Division of Solid Waste Management

JTT/F5081022

cc: James Scarbrough, EPA, Region IV
Dale Ozier
Jack Crabtree, Knoxville F.O.
Rick Brown, Knoxville F.O.
Jacqueline Okoreeh-Baah, Chief Hazardous Permitting

PA ID Number (enter from page 1)

Secondary ID Number (enter from page 1)

7 110 982 109 142

Description of Hazardous Wastes (continued)

Number	A. EPA ID HAZARDOUS WASTE NO. (enter code)	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE (enter code)	D. PROCESSES						(2) PROCESS DESCRIPTION (if code 1 not entered in D(1))			
	(1) PROCESS CODES (enter)												
1	0001	240,000	G	7	0	4	5	0	1	5	0	2	included above
2	0001	included above	"										
3	0002												
4	0003												
5	0004												
6	0007												
7	0012												
8	0019												
9	0027												
10	0029												
11	0031												
12	0037												
13	0044												
14	0052												
15	0053												
16	0055												
17	0056												
18	0057												
19	0068												
20	0070												
21	0071												
22	0072												
23	0076												
24	0077												
25	0080												
26	0083												
27	0108												
28	0110												
29	0112												
30	0117												
31	0121												
32	0122												
33	0124												

EPA ID Number (enter from page 1)

Secondary ID Number (enter from page 1)

7-0982109142

XIV. Description of Hazardous Wastes (continued)

Line Number	A. EPA ID HAZARDOUS WASTE NO. (enter code)	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE (enter code)	D. PROCESSES (enter code)					
				(1) PROCESS CODES (enter)	(2) PROCESS DESCRIPTION (if a code is not entered in D(1))				
	4140	included as above							
	4154								
	4159								
	4161								
	4165								
	4169								
	4171								
	4196								
	4208								
	4209								
	4210								
	4211	✓	✓	✓	✓	✓	✓	✓	✓
	4213								
	4220								
	4226								
	4227								
	4228								
	4235								
	4237								
	4328								
	4353								
	4359								
	F001								
	F002								
	F003								
	F004								
	F005								
	P002								
	P003								
	P075	✓	✓	✓	✓	✓	✓	✓	✓

Exhibit B4

AIR POLLUTION CONTROL PERMIT FOR DSSI

TENNESSEE AIR POLLUTION CONTROL BOARD
DEPARTMENT OF HEALTH AND ENVIRONMENT
NASHVILLE, TENNESSEE 37247-3101

Permit to Construct or Modify an Air Contaminant Source Issued Pursuant to Tennessee Air Quality Act

Date Issued: **AUG 16 1991**

Permit Number:

Date Expires:

November 1, 1991

931365F

Issued To:

Installation Address:

Diversified Scientific Services, Inc.

**I-40 & Gallaher Road
Kingston**

Installation Description:

Emission Source Reference No:

**Dual Fuel Boiler: Modification to Expand From
D001 Solvent to D001, F001 thru F005 Solvents;
Dry Baghouse Scrubber and Packed Tower Control
PES 01**

73-0137-01

The holder of this permit shall comply with the conditions contained in this permit as well as all applicable provisions of the Tennessee Air Pollution Control Regulations.
This is not a permit to operate.

CONDITIONS:

1. This permit does not cover any air contaminant source that does not conform to the conditions of this permit and the information given in the approved application. This includes compliance with the following operating parameters:

The rated heat input for this source shall not exceed 14.5 million Btu per hour.

2. Particulate matter emitted from this source shall not exceed 0.48 pounds per million Btu heat input (6.96 pounds per hour).
3. Hydrogen chloride emitted from this source shall not exceed 5.0 pounds per hour.
4. Chlorine gas emitted from this source shall not exceed 0.029 pounds per hour.
5. Gaseous fluoride (as hydrogen fluoride) emitted from this source shall not exceed 0.0124 pounds per hour.

(continued on the next page)

HAROLD E. HODGES, P.E.
TECHNICAL SECRETARY

No Authority is Granted by this Permit to Operate, Construct, or Maintain any Installation in Violation of any Law, Statute, Code, Ordinance, Rule or Regulation of the State of Tennessee or any of its Political Subdivisions.

NON TRANSFERABLE

POST AT INSTALLATION ADDRESS

G-37
PH-0515

F5221225

AUG 16 1991

931365F

6. Visible emissions shall not exceed 20% opacity as specified in Rule 1200-3-5-.01 of the Tennessee Air Pollution Control Regulations (aggregate count). Visible emissions from stacks will be determined by Tennessee Visible Emission Evaluation Method 2 as adopted by the Tennessee Air Pollution Control Board on August 24, 1984.
7. This permit shall serve as a temporary operating permit from initial start-up to the receipt of a standard operating permit, (regardless of the expiration date), provided the operating permit is applied for within thirty (30) days of initial start-up and the conditions of this permit and any applicable emission standards are met.
8. The Technical Secretary shall be notified in writing at least ten (10) days prior to start-up of the source.
9. Liquid propane gas, and the following solvents D001, F001 thru F005 only shall be used as fuel(s) for this source.
10. The boiler shall be operated at a temperature of at least 1,800°F.
11. This permit is valid only for the storage tank(s) listed below:

<u>Tank I.D.</u>	<u>Contents</u>	<u>Capacity</u>	<u>Turnovers/year</u>
01, 02, 03	D001, F001-F005 (mixture)	10,000 gallons (each)	55 (each)

12. A log of the boiler operating temperature and solvents burned (amount and type) on a daily basis must be maintained at the source location and kept available for inspection by the Technical Secretary or his representative. This log must be retained for a period of not less than two years.
13. Within 90 days after the issued date of this permit, a source test for chloride shall be conducted. The owner or operator shall furnish the Technical Secretary a written report of the results of this emissions performance test within 45 days of testing. Chloride emissions shall be determined utilizing EPA Method 26 as promulgated in the Federal Register, Volume 56; Number 30, February 13, 1991, beginning on page 5770 with the contents of the third and fourth impingers being analyzed for chlorine utilizing ion chromatography.

(continued on the next page)

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AUG 16 1991

931365F

14. Within 90 days after the issued date of this permit, a source test for gaseous fluorides shall be conducted. The owner or operator shall furnish the Technical Secretary a written report of the results of this emissions performance test within 45 days of testing. Gaseous fluoride emissions shall be determined utilizing either EPA Method 13A or 13B as published in the Federal Register, Vol. 45, No. 121, June 20, 1990, and subsequent amendments. For purpose of compliance with the gaseous fluoride emission standard contained in Condition 5 only the fluoride catch in the impingers will be considered. In conducting this testing the filter is to be placed between the probe and first impinger and the probe and filter shall be recovered and analyzed separately from the impingers.
15. The Technical Secretary shall be notified in writing at least 20 days prior to performing these compliance tests so that his representative may be present.
16. The chlorine and fluorine mass content of the fuel burned shall not exceed that which is equivalent to the contents in the fuel burned during the source tests required in conditions 13 and 14 of this permit.

F5221225

Exhibit B5

**NATIONAL EMISSIONS STANDARDS FOR
HAZARDOUS AIR POLLUTION PERMIT FOR DSSI**

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION IV

345 COURTLAND STREET
ATLANTA, GEORGIA 30365

APR 11 1989

4APT-AC

Mr. James T. McVey
Executive Vice President
Diversified Scientific Services, Inc.
P.O. Box 863
Kingston, Tennessee 37763

Subject: NESHAP Construction/Operation Approval Letter for Diversified Scientific Services, Incorporated (DSSI) Scintillation Fluid Burning System

Dear Mr. McVey:

In accordance with the provisions of 40 CFR 61, we have reviewed information submitted on June 16, 1988; October 13, 1988; January 20, 1989; and March 9, 1989, to determine the ability of the referenced facility to comply with the NESHAP radionuclide emission standards promulgated at 40 CFR 61, Subpart I. Based upon this review, approval is hereby given for the construction and operation of the scintillation fluid burning system at DSSI's Kingston site, based upon the regulations currently in effect, i.e. those promulgated at 50 FR 5195 on February 5, 1985.

Although approval for the burner is being issued on the basis of it being able to comply with the regulations currently in effect, you should be aware of the potential impact that recently proposed revisions to 40 CFR 61, Subpart I may have on your facility. For your information, we have enclosed the full text of the revisions proposed on March 7, 1989. The portions of the package which are of primary importance to you are the regulations in §61.100 to §61.108 and the compliance demonstration procedures outlined in Appendices B, D and E. One important fact you should keep in mind is that EPA is proposing dose standards that correspond to four different control approaches and that, based upon which of the four approaches is chosen at promulgation, the dose standard for NRC-licensed facilities could range anywhere from 0.03 mrem/yr to 10 mrem/yr effective dose equivalent (ede).

The dose standards for the proposed regulations are calculated differently than the whole body and critical organ dose standards in the current regulation. Since the 10 mrem/yr ede standard under approaches A and B in the proposed regulation is roughly equivalent to the 25 mrem/yr whole body standard in the existing regulation, we would not anticipate you having any trouble complying with the emission standard in approaches A or B if the burner is constructed and operated as described in the Application. If the standards in approaches C or D are chosen for the promulgated standards, then you would either have to reduce the quantity of radionuclides processed in the burner or would have to install additional pollution controls. Since construction of the burner will begin after proposal of the Subpart I revisions, the burner will be considered to be a new source under the new regulations also. Therefore, the revised standards

will apply to your facility upon promulgation and you will not be eligible for a compliance waiver under the provisions of 40 CFR §61.10 and §61.11.

In addition to the provisions of 40 CFR 61, Subparts A and I, approval to construct and operate the burner is also contingent upon compliance with the following additional terms and conditions:

1. The facility shall be designed, constructed, and operated as described in the NESHAP application dated October 13, 1988, and additional information dated June 16, 1988; January 20, 1989; and March 9, 1989, (hereinafter referred to as the Application), unless superseded by a more stringent condition below.
2. All flue gas from the burner shall pass through an air pollution control system consisting of a prefilter, HEPA filter, and carbon adsorber.
3. The Applicant shall maintain a log of all radioactive receipts for the facility and shall include the following information in the log: the date of shipment, the radionuclide inventory at the time of shipment, the date of receipt, verification results when conducted, and comparison of the verification results with the reported inventory. A separate log shall be maintained and shall include a cumulative inventory for each radionuclide received and treated. In addition, the Applicant shall notify the Agency whenever the cumulative inventory of radionuclides in the waste burned in a calendar year exceeds either of the quantities listed below:
 - a. Total tritium and carbon-14 :22.5 Ci
 - b. Total for radionuclides other than tritium and carbon-14 :1.5 Ci
4. For any radionuclide not listed in the Application, the Applicant shall establish a Maximum Acceptable Quantity (MAQ) of the radionuclide to be treated each year if that quantity is likely to exceed a minimum amount. The minimum amount is based on the quantity of the radionuclide that would result in a calculated effective dose equivalent of 1/100 of the NESHAP standards. Upon receiving a request for disposal of a radionuclide for which a MAQ has not been established and which is greater than the minimum amount, the Applicant shall perform a dose equivalent assessment for the radionuclide prior to establishing a MAQ. The dose equivalent assessment shall be conducted using the same techniques and data bases as outlined in the Application, with the exception that assessment must be performed only at the previously established point of maximum impact. Concurrent with the notification to the generator of waste acceptance, and prior to receiving the first shipment for a new radionuclide, which exceeds the minimum amount, the Applicant shall notify the Agency in writing of its intent to receive a waste containing a radionuclide not originally analyzed in the Application. The notification shall include the MAQ established for the new radionuclide, the

composition of the waste, the expected quantity of waste to be received annually, and the estimated dose resulting from treating the waste in combination with all other doses associated with activities at DSSI's Kingston site.

5. The exhaust stack shall be provided with testing facilities as follows:
 - a. Sampling ports adequate for test methods applicable to such facility.
 - b. Safe sampling platform(s).
 - c. Safe access to sampling platform(s).
 - d. Utilities for sampling and testing equipment.
6. Procedures in §61.107 of the Subpart I revisions to be promulgated on or about August 31, 1989, shall be used for determining radionuclide emissions from the burner. If the burner starts up prior to August 31, 1989, procedures in the version of §61.107 proposed on March 7, 1989, shall be used to determine the burner's radionuclide emissions in the period of time between proposal and promulgation of the revisions. The Applicant shall maintain a record of all radionuclides emitted and shall notify the Agency whenever the cumulative emissions during a calendar year exceed either of the quantities listed below:
 - a. Total tritium and carbon-14 :22.5 Ci
 - b. Total for radionuclides other than tritium and carbon-14 :1.5 Ci
7. Within 90 days after the effective date of the Subpart I revisions to be promulgated on or about August 31, 1989, the Applicant shall notify the Agency as to whether or not the burner will be capable of complying with the offsite dose standard in the promulgated regulation. Details of this notification appear at 40 CFR 61.10.
8. Thirty (30) days after the end of each calendar quarter, the Applicant shall report the radionuclide release rate from the facility (expressed as curies per month for each radionuclide emitted) during each of the previous three months.
9. No condition presented herein precludes the Applicant from adherence to additional or more stringent conditions or requirements of any other Federal, State, or local approval or permit.
10. Failure to comply with the conditions of this approval may result in revocation of the approval and/or enforcement action by the Agency.
11. At all times, including periods of startup, shutdown, and malfunction, the burner shall be maintained and operated in a manner consistent with good air pollution control practices for minimizing emissions.

12. All notifications, reports, and correspondence shall be submitted to the Chief, Air Compliance Branch, Air, Pesticides and Toxics Management Division, U.S. EPA, 345 Courtland Street, Atlanta, Georgia 30365 with copies to the Director, Tennessee Division of Radiological Health; and Director, Tennessee Division of Air Pollution Control.

This approval is granted solely under Section 112 of the Clean Air Act and implementing regulations at 40 C.F.R. 61 and in no way affects approvals under other Federal or State regulatory authorities.

If you have questions concerning this approval, please contact me at 404/347-3043.

Sincerely yours,

Winston A. Smith, Director
Air, Pesticides and Toxics
Management Division

Enclosure

cc: Mr. Harold Hodges, Director
Division of Air Pollution Control
Tennessee Department of Public Health
Customs House, 4th Floor
701 Broadway
Nashville, Tennessee 37219-5403

Mr. Michael Mobley, Director
Division of Radiological Health
Tennessee Department of Health and Environment
150 9th Avenue, North
TERRA Building
Nashville, Tennessee 37219-5404

Exhibit B6

HAZARDOUS WASTES ACCEPTABLE FOR RECEIPT AT DSSI

**CHEMICALS ACCEPTABLE FOR RECEIPT AT
DIVERSIFIED SCIENTIFIC SERVICES, INC.**

<u>Chemical Name</u>	<u>Hazardous Waste Code Number</u>
1,1 Dichloroethane	U076
1,2 Dichloroethane	U077
1,1,1-Trichloroethane	F001/F002/U226
1,1,2-Trichloroethane	F002/U227
1,1,2-Trichlorotrifluorethane	F001/F002
1,2-Dichlorobenzene	F002/U070
1,4-Dioxane	U108/D001
2-butenal	U053
2-ethoxyethanol (ethylene glycol monethyl ether)	F005/U359
2-Nitropropane	F005/U171
Acetaldehyde	U001
Acetone	F003/U002
Acetonitrile	U003
Acetophenone	U004
Aniline	U012
Acrylamide	U007
Benzene	F005/U019
n-Butyl alcohol	F003/U031
Carbon Disulfide	F005/P002
Carbon Tetrachloride	F001/U211
Chlorobenzene	F002/U037
Chloroform	U044
m-Cresol	F004/U052
o-Cresol	F004/U052
p-Cresol	F004/U052
Cresylic acid	F004
Cumene	U055
Cyclohexane	U056
Cyclohexanone	F003/U057
o-Dichlorobenzene	F002/U070
m-Dichlorobenzene	F002/U071
p-Dichlorobenzene	F002/U072
Dichloroisopropyl ether	U027
Dipropylamine	U110
Ethanol	D001
Ethyl Acetate	F003/U112
Ethyl Benzene	F003
Ethyl Ether	F003/U117
Ethylene glycol	D001
Formaldehyde	U122
Furan	U124

<u>Chemical Name</u>	<u>Hazardous Waste Code Number</u>
Heptane	D001
Hexane	D001
Isoamyl alcohol	D001
Isobutyl alcohol	F005/U140
Isoctane/2,2,4-Trimethylpentane	D001
Methane, bromo-	U029
Methane, dibromo	U068
Methane, trichloro	U044
Methanol	F003/U154
Methylene Chloride	F002/U080
Methyl Ethyl Ketone	F005/U159
Methyl Isobutyl Ketone	F003/U161
Methyl Pyrrole	D001
Mineral Spirits	D001
Naphthalene	U165
Nitrobenzene	F004/U169
Nonane	D001
Octane	D001
Propanol	D001
Pentane	D001
Propane, 1,2-dichloro	U083
2-Propenal	P003
Propylene glycol	D001
Pyridine	F005/P075/U196
Tetrahydrofuran	U213
1,1,2,2-Tetrachloroethane	U209
1,1,1,2-Tetrachloroethane	U208
Tetrachloroethylene	F001/F002/U210
Toluene	F005/U220/D001
o-Toluidine	D001/U328
m-Toluidine	D001
p-Toluidine	D001/U353
Trichloroethylene	F001/F002/U228
Trichlorofluoromethane	F002/U121
Trichloromethane	U044/D001
m-Xylene	F003/U239/D001
o-Xylene	F003/U239/D001
p-Xylene	F003/U239/D001
Unlisted Ignitable Waste	D001
Spent Solvents	F001
Spent Solvents	F002
Spent Solvents	F003
Spent Solvents	F004
Spent Solvents	F005
Arsenic	D004
Barium	D005

Chemical NameHazardous Waste Code Number

Cadmium	D006
Chromium	D007
Lead	D008
Mercury	D009
Selenium	D010
Silver	D011
Endrin	D012
Lindane	D013
Methoxychlor	D014
Toxaphene	D015
2,4-D	D016
2,4,5-TP (silvex)	D017
Benzene	D018
Carbon Tetrachloride	D019
Chlordane	D020
Chlorobenzene	D021
Chloroform	D022
o-Cresol	D023
m-Cresol	D024
p-Cresol	D025
Cresol	D026
1,4-Dichlorobenzene	D027
1,2-Dichloroethane	D028
1,1-Dichloroethylene	D029
2,4-Dinitrotoluene	D030
Heptachlor (and its epoxide)	D031
Hexachlorobenzene	D032
Hexachlorobutadiene	D033
Hexachloroethane	D034
Methyl ethyl Ketone	D035
Nitrobenzene	D036
Pentachlorophenol	D037
Pyridine	D038
Tetrachloroethylene	D039
Trichloroethylene	D040
2,4,5-Trichlorophenol	D041
2,4,6-Trichlorophenol	D042
Vinyl Chloride	D043

Exhibit C1

LIST OF PERMITS, LICENSES, OR AUTHORIZATIONS PERTAINING TO NSSI

List of permits, licenses, or authorizations pertaining to NSSI				
Type	Number	Issue date	Expiration date	Issued by
Radioactive Materials License	L01811	None specified	April 30, 1995	Texas Department of Health Bureau of Radiation Control 1100 West 49th Street Austin, TX 78756-3189
TSD Type B - Hazardous Waste Permit	HW-50269	January 29, 1992	October 3, 2000	Texas Water Commission P. O. Box 13087 Capitol Station 1700 North Congress Avenue Austin, TX 78711-3087
EPA Generators Number	TXD 98 256 0294	None specified	None specified	Texas Water Commission P. O. Box 13087 Capitol Station 1700 North Congress Avenue Austin, TX 78711-3807

Exhibit C2

HAZARDOUS WASTE PERMIT FOR NSSI

Texas Water Commission

INTEROFFICE MEMORANDUM

TO : Texas Water Commission DATE: 8-2-90

THRU : Michael E. Field, Chief Hearings Examiner

FROM : *ckf for* Carl X. Forrester, Senior Administrative Law Judge

SUBJECT: NSSI/Recovery Services, Inc.; Proposed Permit No. HW-50269

NSSI/Recovery Services, Inc. of Houston, Texas, has applied to the Texas Water Commission for proposed Permit No. HW-50269 which would authorize NSSI/Recovery Services, Inc., to operate a commercial hazardous waste storage and processing facility in east Harris County, Texas. The facility will store and process wastes in 20 tanks totaling 58,530 gallons capacity and four container storage areas totaling 114,620 gallons capacity. The facility site is located on eighteen city lots in a mixed commercial, residential and industrial area located at 5711 Etheridge, Houston, Texas. The site is located in Segment No. 1006 of the San Jacinto River Basin.

Carl X. Forrester, Attorney, a Commission Senior Administrative Law Judge (ALJ), conducted an adjudicative public hearing in Houston, Texas on May 15, 1990 after proper notice of the hearing was given pursuant to Section 26.022 of the Texas Water Code, as amended, and Section 361.082 of the Texas Health and Safety Code.

The ALJ designated the following as parties to the hearing: the applicant (represented by Tom Buckle, Attorney); the Commission's Executive Director (represented by Bob Renbarger, Attorney); the Commission's Public Interest Counsel (represented by Leslie Sachanowicz, Attorney); Treatment One/SET Environmental, Inc. (represented by Keith Hopson, Attorney); and Harris County (represented by David Melasky, Attorney). Six employees of the City of Houston were present but did not seek party status and offered no public comment.

Prior to the start of the trial of the issues, the parties negotiated a complete settlement of the issues. As a result of that settlement, the attached proposed permit has been modified to include the regulatory provisions regarding air pollution control which were agreed to by the parties. As a result of that agreement and inclusion of the air pollution control provisions in the permit, the protests of this application have been dropped and this application has become uncontested.

Memorandum to the Commission
NSSI/Recovery Services, Inc.

The ALJ believes that it is in the public interest and the interest of this agency to support negotiated settlements of parties to contested hearings whenever possible. Therefore, the Judge recommends that the Commission approve the application and issue the attached Permit No. HW-50269 which includes the agreed provisions of the parties.

Because the application is now uncontested, no Order with Findings of Fact and Conclusions of Law contained therein has been prepared.

Claire P. Aronson for

Carl X. Forrester, Attorney
Senior Administrative Law Judge

TEXAS WATER COMMISSION

B. J. Wynne, III, Chairman
John O. Houchins, Commissioner
John E. Birdwell, Commissioner

John J. Vay, General Counsel
Michael E. Field, Chief Hearings Examiner
Brenda W. Foster, Chief Clerk

October 11, 1990

Allen Beinke, Executive Director

RE: NSSI/RECOVERY SERVICES, INC.; Permit No. HW-50269

Dear Permittee:

Enclosed is a copy of:

X 1. Permit for a wastewater treatment facility issued pursuant to Chapter 26 of the Texas Water Code. In order that you may comply with monitoring requirements of your permit, self-reporting forms and instructions will be forwarded to you from the Water Quality Division at an early date. If your facility is not yet operating, please use the attached Notification of Completion of Facilities form to advise this agency and our district office of the completion or placement in operation of proposed facilities in accordance with the special provision incorporated into the permit.

2. Amended permit for a wastewater treatment facility issued pursuant to Chapter 26 of the Texas Water Code. Please continue using the self-reporting forms you have on hand until new forms are forwarded by the Water Quality Division. If your facility is not yet operating, please use the attached Notification of Completion of Facilities form to advise this agency and our district office of the completion or placement in operation of proposed facilities in accordance with the special provision incorporated into the permit.

3. Renewal of a permit for a wastewater treatment facility issued pursuant to Chapter 26 of the Texas Water Code. If your facility is not yet operating, please use the attached Notification of Completion of Facilities form to advise this agency and our district office of the completion or placement in operation of proposed facilities in accordance with the special provision incorporated into the permit.

4. Permit for a hazardous or solid waste facility issued pursuant to Art. 4477-7, Texas Revised Civil Statutes. Your attention is directed to Commission Rule 335.5 which may be applicable to your facility.

5. Permit or amended permit for a waste disposal well or an injection well issued pursuant to Chapter 27 of the Texas Water Code. In accordance with the Texas Water Code, you must file a copy of the permit with the city and county health authorities.

If there are any questions concerning this permit, please let us know.

A handwritten signature in cursive script that reads "Brenda W. Foster".

Brenda W. Foster, Chief Clerk

cc w/enclosures

TWC District No. 7

G-61

ACKNOWLEDGEMENT OF NOTIFICATION
OF HAZARDOUS WASTE ACTIVITY

DEC 27 1984

This is to acknowledge that you have filed a Notification of Hazardous Waste Activity for the installation located at the address shown in the box below to comply with Section 3010 of the Resource Conservation and Recovery Act (RCRA). Your EPA Identification Number for that installation appears in the box below. The EPA Identification Number must be included on all shipping manifests for transporting hazardous wastes; on all Annual Reports that generators of hazardous waste, and owners and operators of hazardous waste treatment, storage and disposal facilities must file with EPA; on all applications for a Federal Hazardous Waste Permit; and other hazardous waste management reports and documents required under Subtitle C of RCRA.

EPA ID NUMBER

TXD982560294

NSSI/RECOVERY SVCS INC.
ROBERT GALLAGHER

P.O. BOX 34042

HOUSTON, TX. 77234

INSTALLATION ADDRESS

5709 ETHERIDGE

HOUSTON, TX. 77087

TEXAS WATER COMMISSION

JAN 31 1992

1. *Chrysomelidae* (10 species)

**TEXAS WATER COMMISSION
FIELD OPERATIONS DIVISION
AREA OFFICES**

DISTRICT 1

3918 Canyon Drive
Amarillo, Texas 79109-4996
806/353-9251 (TEX-AN 8-862-0071)
Don Manning, District Manager

DISTRICT 2

5303 50th Street, Suite 306-4
Lubbock, Texas 79414-1875
806/796-7092 (TEX-AN 8-840-1067)
Larry L. Smith, District Manager

DISTRICT 3

14000 Woodway Drive
Waco, Texas 76712-3193
817/751-0335 (TEX-AN 8-820-1465)
Larry Fergusson, District Manager

DISTRICT 4

1019 N. Duncanville Rd.
Duncanville, Texas 75116-2201
214/298-6171 (TEX-AN 8-831-5650)
Charles D. Gill, District Manager

DISTRICT 5

2916 Teague Drive
Tyler, Texas 75701-3734
903/595-5468 (TEX-AN 8-831-5256)
John Witherspoon, District Manager

DISTRICT 6

4820 Ward Drive
Beaumont, Texas 77705-0328
409/842-9413 (TEX-AN 8-850-1383)
Keith Anderson, District Manager

DISTRICT 7

5144 East Sam Houston Parkway North
Houston, Texas 77015
713/457-5191 (TEX-AN 8-730-0200 or 0300)
William F. Bowles, District Manager

TWC LABORATORY

5144 East Sam Houston Parkway North
Houston, Texas 77015
713/457-5229 (TEX-AN 8-730-0200 or 0300)
Jim Busceme, Lab Manager

DISTRICT 8

140 Heimer Road, Suite 360
San Antonio, Texas 78232-5042
512/490-3096 (TEX-AN 8-820-1308
and 820-1314)
Billy Boggs, District Manager

DISTRICT 9

102 Canyon Road
San Angelo, Texas 76904
915/655-9479 or 655-1336
Kenneth W. Krueger, District Manager

DISTRICT 10

2626 J.B. Shepperd Parkway Blvd.
Bldg. B-129
Odessa, Texas 79761
915/362-6997 (TEX-AN 8-840-1432)
William F. Lockey, District Manager

DISTRICT 11

813 E. Pike Blvd.
Weslaco, Texas 78596-4935
512/968-3165 (TEX-AN 8-820-1826)
John Sturgis, District Manager

DISTRICT 12

4410 Dillon Lane, Suite 47
Corpus Christi, Texas 78415-5326
512/851-8484 (TEX-AN 8-820-1632)
Chip Volz, District Manager

DISTRICT 14

1700 South Lamar, Bldg. 1, No. 101
Austin, Texas 78704-3360
512/463-7803 (TEX-AN 8-255-7803)
W. John Young, District Manager

DISTRICT 15

7500 Viscount Blvd., Suite 147
El Paso, Texas 79925
915/778-9634 (TEX-AN 8-846-8183)
Hector Villa, District Manager

*Note: The addresses and telephone numbers above are current as of 09/30/91, however, they are subject to change.
Telephone ahead to confirm location if planning a visit to one of the Commission's field offices.*

LOCATION OF FIELD OFFICES

DISTRICT	LOCATION
1	AMARILLO
2	LUBBOCK
3	WACO
4	DUNCANVILLE
5	TYLER
6	BEAUMONT
7	HOUSTON
8	SAN ANTONIO
9	SAN ANGELO
10	ODESSA
11	WESLACO
12	CORPUS CHRISTI
14	AUSTIN
15	EL PASO
TWC LAB	HOUSTON

TEXAS WATER COMMISSION
Stephen F. Austin State Office Building
Austin, Texas

**PERMIT FOR INDUSTRIAL
SOLID WASTE MANAGEMENT SITE**
Issued under provisions of TEX.
HEALTH & SAFETY CODE ANN.
Chapter 361 (Vernon)

PERMIT NO. HW-50259

REGISTRATION NO. 38669

EPA I.D. NO. TXD 982560294

This permit supersedes and replaces
Permit No. HW-50259 approved October 3, 1990.

Name of Permittee:

NSSI/Recovery Services, Inc.
P.O. Box 34042
Houston, Texas 77234

Site Owner:

Robert D. Gallagher
c/o NSSI/Recovery Services, Inc.
P.O. Box 34042
Houston, Texas 77234

Registered Agent for Service:

Robert D. Gallagher
c/o NSSI/Recovery Services, Inc.
P.O. Box 34042
Houston, Texas 77234

Classification of Site:

Hazardous waste storage and processing,
commercial

The permittee is authorized to store and process wastes in accordance with limitations, requirements and other conditions set forth herein. This permit is granted subject to the rules of the Commission and other Orders of the Commission and laws of the State of Texas. Nothing in this permit exempts the permittee from compliance with the applicable rules and regulations of the Texas Air Control Board.

This permit will be valid until cancelled, amended or revoked by the Commission. Authorization to store and process wastes shall expire midnight, October 3, 2000.

The provisions in this permit stem from both State and Federal authority. Those provisions marked with an asterisk (*) stem from Federal authority and will implement the applicable requirements of HSWA which are not yet authorized to the State of Texas.

APPROVED, ISSUED, AND EFFECTIVE this 20th day of January 1992

ATTEST:

[Signature]

[Signature]
For the Commission

Table of Contents
NSSI/Recovery Services, Inc.

Section

- I. Size and Location of Facility
- II. Units and Operations Authorized
 - A. Wastes Authorized
 - B. Units Authorized
 - C. Processing Functions Authorized
- III. Facility Design, Construction, and Operation
 - A. General Design, Construction, and Operation
 - B. General Operational Requirements
 - C. Tank Design, Construction, and Operation Requirements
 - D. Container Storage Area Design, Construction and Operation Requirements
- IV. Closure
 - A. General Closure Requirements
 - B. Hazardous Waste Management Unit Closure Requirements
- V. Standard Permit Conditions
- VI. Incorporated Regulatory Requirements
- VII. Incorporated Application Materials
- VIII. Standard Permit Conditions Applicable to Off-site Facilities
- IX. Standard Permit Conditions Applicable to Marketers of Hazardous Waste Fuel
- X. RCRA Facility Investigation
- XI. Air Quality Provisions

NAME: NSSI/Recovery Services, Inc.

I. Size and Location of Facility

- A. The hazardous waste management facility is located on 18 city lots in a mixed commercial, residential and industrial area at 5711 Etheridge, Houston, Harris County, Texas. The location is described as being in watershed area 1006 of the San Jacinto River Basin (North Latitude 29° 40'32", West Longitude 95°18'24").
- B. The legal description and site plan submitted in the application for Permit No. HW-50269 are hereby made parts of this permit as Attachments A and B.

II. Units and Operations Authorized

A. Wastes Authorized:

The permittee is authorized to manage hazardous and industrial solid waste listed in the application and described herein, subject to the limitations provided herein.

Wastes include those generated at this facility and from off-site sources. Any hazardous waste may be accepted from a household source.

Hazardous and industrial solid wastes authorized to be managed under this permit are limited as follows:

1. Hazard Code Group Codes (as prescribed by U. S. Environmental Protection Agency regulations) in effect upon date of permit approval:

<u>x</u> Ignitable (I)	<u>x</u> Acute Hazardous Waste (H)
<u>x</u> Toxic (T)	<u>x</u> Toxicity Characteristic (E)
<u>x</u> Corrosive (C)	<u>x</u> Reactive (R)

2. <u>Waste Descriptions</u>	<u>TWC</u> <u>Waste Class</u>	<u>Hazard Codes</u>
a. Spent Halogenated Solvents	IH	T,E
b. Spent Non-Halogenated Solvents	IH	I,T,E
c. Acetone	IH	I
d. Benzene	IH	I,T,E
e. n-Butyl Alcohol	IH	I
f. Cumene	IH	I
g. Cyclohexane	IH	I
h. Cyclohexanone	IH	I
i. 1,4 Dioxane	IH	T
j. Ethyl Acetate	IH	I
k. Ethyl Ether	IH	I
l. Formaldehyde	IH	T

NAME: NSSI/Recovery Services, Inc.

[II.A.2.]

<u>Waste Descriptions</u>	TWC <u>Waste Class</u>	<u>Hazard Codes</u>
m. Isobutanol	IH	I, T
n. Methanol	IH	I
o. Methyl Ethyl Ketone	IH	I, T, E
p. Methyl Isobutyl Ketone	IH	I
q. Naphthalene	IH	T
r. Pyridene	IH	T, E
s. Toluene	IH	T
t. Xylene	IH	I
u. Empty Containers	I	
v. Misc. Chemical-contaminated Materials	IH	I, C, R, E, H, T
w. Labpacks and Containers to be Consolidated into labpacks	IH	I, C, R, E, H, T
x. Oil and Solvents	IH	I, T, E
y. Paint Sludge	IH	I, C, E, H, T
z. Paint Sludge containing Chlorinated Solvents	IH	I, C, E, H, T
aa. Cyanides	IH	R, T
bb. Wastewater containing Organics, Metals, and Oil	IH	E, H, T
cc. Organic Liquids	IH	I, E, H, T
dd. Sludge from Oxidation/Reduction	IH	I, C, E, H, T
ee. Solids from Solvent Still	IH	I, E, H, T
ff. Stabilized Waste	IH	E, H, T
gg. Sludge from Blending/Separation/ Storage Tanks	IH	I, C, E, H, T
hh. Waste Carbon Adsorption Media and Solids	IH	I, E, H, T
ii. Waste Ion Exchange Media and Solids	IH	C, E, H, T
jj. Filter Solids and Media	IH	I, C, E, H, T
kk. Hazardous Solid Material	IH	I, C, E, H, T, R
ll. Consolidated Hazardous Liquids	IH	I, C, R, E, H, T
mm. Consolidated Hazardous Solids	IH	I, C, R, E, H, T
nn. Blended Hazardous Waste Fuel	IH	I, C, E, R
oo. Compressed Hazardous Waste Gas	IH	I, C, E, R, H, T

3. Mixed Radioactive and Hazardous Wastes

So long as the permittee shall hold and abide the restrictions of a radioactive materials license from the Texas Department of Health, radioactive or nuclear waste materials (i.e., waste material which emits ionizing radiation spontaneously) which also fit the waste descriptions in Provision II.A.2. above may be received from off-site and managed in accordance with the provisions of this permit.

NAME: NSSI/Recovery Services, Inc.

[II.A.]

4. Prohibited Wastes and Waste Limitations:

Explosive material as defined by the Department of Transportation (DOT) under 49 CFR 173.

5. Prior to accepting any additional wastes with chemical characteristics similar to those authorized by Provision II.A.2., the permittee shall satisfy the following requirements:

- a. Notify the Executive Director;
- b. Provide a characterization of the waste demonstrating its similarity;
- c. Submit, upon request of the Executive Director, sufficient information to ascertain similarity of the waste material. If the Executive Director determines the material is not similar, the permittee must obtain a permit amendment before accepting the waste.
- d. Receive written response from the Executive Director informing the permittee that the material is similar to those materials authorized by Provision II.A.2. and that a permit amendment or modification is not required in order to receive the waste.

B. Units Authorized:

The permittee is authorized to operate the following units for storage and processing subject to the limitations contained herein. All waste management activities subject to permitting are to be confined to the following units:

1. Tank, stainless steel, above-grade, capacity 3,000 gallons, identified as Tank No. 1 in the application (NOR No. 07), for storage and processing of wastes described in Provisions II.A.2.a.-t., x., cc., ll., and nn.
2. Tank, stainless steel, above-grade, capacity 3,000 gallons, identified as Tank No. 2 in the application (NOR No. 07), for storage and processing of wastes described in Provisions II.A.2.a.-t., x., cc., ll., and nn.
3. Tank, stainless steel, above-grade, capacity 3,000 gallons, identified as Tank No. 3 in the application (NOR No. 07), for storage and processing of wastes described in Provisions II.A.2.a.-t., x., cc., ll., and nn.

NAME: NSSI/Recovery Services, Inc.

[II.B.]

4. Tank, stainless steel, above-grade, capacity 3,000 gallons, identified as Tank No. 4 in the application (NOR No. 07), for storage and processing of wastes described in Provisions II.A.2.a.-t., x., cc., ll., and nn.
5. Tank, stainless steel, above-grade, capacity 1,700 gallons, identified as Tank No. 5 in the application (NOR No. 07), for storage and processing of wastes described in Provisions II.A.2.a.-t., x., cc., ll., and nn.
6. Tank, stainless steel, above-grade, capacity 1,700 gallons, identified as Tank No. 6 in the application (NOR No. 07), for storage and processing of wastes described in Provisions II.A.2.a.-t., x., cc., ll., and nn.
7. Tank, stainless steel, above-grade, capacity 1,100 gallons, identified as Tank No. 7 in the application (NOR No. 07), for storage and processing of wastes described in Provisions II.A.2.a.-t., x., cc., ll., and nn.
8. Tank, stainless steel, above-grade, capacity 1,100 gallons, identified as Tank No. 8 in the application (NOR No. 07), for storage and processing of wastes described in Provisions II.A.2.a.-t., x., cc., ll., and nn.
9. Tank, stainless steel, above-grade, capacity 1,100 gallons, identified as Tank No. 9 in the application (NOR No. 07), for storage and processing of wastes described in Provisions II.A.2.a.-t., x., cc., ll., and nn.
10. Tank, stainless steel, above-grade, capacity 900 gallons, identified as Tank No. 10 in the application (NOR No. 07), for storage and processing of wastes described in Provisions II.A.2.a.-t., x., cc., ll., and nn.
11. Tank, stainless steel, above-grade, capacity 3,000 gallons, identified as Tank No. 11 in the application (NOR No. 07), for storage and processing of wastes described in Provisions II.A.2.a.-t., x., cc., ll., and nn.
12. Tank, stainless steel, above-grade, capacity 1,700 gallons, identified as Tank No. 12 in the application (NOR No. 07), for storage and processing of wastes described in Provisions II.A.2.a.-t., x., cc., ll., and nn.

NAME: NSSI/Recovery Services, Inc.

[II.B.]

13. Tank, stainless steel, above-grade, capacity 10,000 gallons, identified as Tank No. 13 in the application (NOR No. 07), for storage and processing of wastes described in Provisions II.A.2.bb.
14. Tank, stainless steel, above-grade, capacity 10,000 gallons, identified as Tank No. 14 in the application (NOR No. 07), for storage and processing of wastes described in Provisions II.A.2.a.-t., x., cc., ll., and nn.
15. Tank, stainless steel, above-grade, capacity 10,000 gallons, identified as Tank No. 15 in the application (NOR No. 07), for storage and processing of wastes described in Provisions II.A.2.bb.
16. Tank, stainless steel, above-grade, capacity 1,300 gallons, identified as Acid-Base Neutralization Tank in the application (NOR No. 03), for storage and processing of all authorized acids and bases.
17. Tank, carbon steel, glass-lined, above-grade, capacity 650 gallons, identified as the 600-gallon Oxidation-Reduction Tank in the application (NOR No. 04), for processing of all authorized wastes.
18. Tank, carbon steel, glass-lined, above-grade, capacity 360 gallons, identified as the 400-gallon Oxidation-Reduction Tank in the application (NOR No. 04), for processing of all authorized wastes.
19. Tank, stainless steel, above-grade, capacity 960 gallons, identified as Grinder Tank No. 1 in the application (NOR No. 16), for storage and processing of wastes described in Provisions II.A.2.a.-t., x., cc., and ll.
20. Tank, stainless steel, above-grade, capacity 960 gallons, identified as Grinder Tank No. 2 in the application (NOR No. 16), for storage and processing of wastes described in Provisions II.A.2.a.-t., x., cc., and ll.
21. Container storage area, closed on all sides, maximum capacity 79,860 gallons, identified as the Building 1 Container Storage Area in the application (NOR No. 08), for storage and processing of wastes described in Provisions II.A.2.a.-nn.

NAME: NSSI/Recovery Services, Inc.

[II.B.]

22. Container storage area, closed on all sides, maximum capacity 29,700 gallons, identified as the Building 2 Container Storage Area in the application (NOR No. 17), for storage and processing of all authorized wastes which are not reactive and not ignitable.
23. Container storage area, containing two "explosive" storage buildings, each closed on all sides, maximum capacity 500 gallons, identified as the Reactive Container Storage Area in the application (NOR No. 12), for storage of all authorized reactive wastes.
24. Container storage area, closed on all sides, maximum capacity 33,215 gallons, identified as the Building 3 Container Storage Area in the application (NOR No. __), for storage of all authorized wastes.

C. Functions Authorized:

The permittee is authorized to perform the following functions, subject to the limitations contained herein:

1. Blending of wastes to form a fuel for use off-site;
2. Consolidation of waste containers into lab packs;
3. Breaking down lab packs for re-consolidation for off-site disposal or on-site processing;
4. Neutralization, oxidation, reduction, and other chemical reactions to render wastes less hazardous or more suitable for off-site disposal or on-site processing;
5. Recycling of solvents;
6. Cleaning of dross or particulate solids, empty drums, and equipment;
7. Centrifugation, filtration, and ion exchange in portable equipment within an authorized container storage area;
8. Solidification or stabilization in containers within an authorized container storage area;
9. Shredding of containers for recovery of contents;
10. Consolidation of miscellaneous compatible hazardous wastes;

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[II.C.]

11. Chemical and/or mechanical treatment to accomplish separation, settling, or clarification in portable equipment within an authorized container storage area;
 12. Removal of hazardous constituents by absorption on solid media in portable equipment within an authorized container storage area;
 13. Drying of solids to meet off-site disposal criteria for release of water only; and
 14. Recovery of waste chemicals and other material for re-use or resale.
- D. Authorization to operate these units is contingent upon maintenance of financial assurance pursuant to Provision IV.A.1. and maintenance of liability coverage in compliance with the requirements of, and in a form outlined in, 40 CFR Part 264, Subpart H. Authorization to begin operation of new units is contingent upon compliance with Provisions IV.A.1. and V.C. The permittee may not store or process waste unless compliant with all financial assurance requirements and liability requirements, to include all related financial assurance instruments and liability coverage instruments being in full force and effect.
- E. The units and operational methods authorized are limited to those described both herein and by the application and related plans and specifications which were included in the permit application submittals dated November 4, 1988; June 29, 1989; August 24, 1989, March 15, 1991 and September 5, 1991. Prior to constructing or operating any unit in a manner which differs from either the related plans and specifications or the limitations of this permit, the permittee is required to
1. Notify the TWC and submit plans and specifications for the proposed changes; and
 2. Receive written authorization of the Executive Director for such changes, if the Executive Director determines that a permit amendment or modification is not required by TWC rules.
- F. Any proposed unit changes, addition of units, or expansion in capacity which has not been addressed by the terms of this permit must be authorized in accordance with TWC permit amendment or modification rules.

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III. Facility Design, Construction, and Operation

A. General Design, Construction, and Certification Requirements:

1. Facility design, construction, and operation must comply with this permit, Texas Water Commission (TWC) Rules, and be in accordance with the plans and specifications for design, construction and operation approved herein. All plans submitted with the application dated November 4, 1988; June 29, 1989; August 24, 1989; March 15, 1991 and September 5, 1991 are approved, subject to the terms of this permit and any other orders of the Texas Water Commission which are hereby incorporated by reference and made a part of this permit.
2. The entire hazardous waste management facility shall be designed, constructed, operated, and maintained to prevent the release and/or migration of any hazardous waste beyond the zone of engineering control and to prevent inundation of and discharge from the areas surrounding the facility components. Each receipt, storage, and processing area, including unloading areas, shall be provided with a secondary containment system which will meet the requirements of 40 CFR 264.193 and which will collect spills and incident precipitation in such a manner as to:
 - a. Preclude the release from the system of any collected spills, leaks, or precipitation, except as provided in Provision III.B.2. This requirement shall be met by, at a minimum, providing a base and sides which are free of cracks or gaps and are sufficiently impervious to contain leaks, spills, or precipitation until the collected material is removed, and providing curbs or sides designed to withstand a full hydrostatic head;
 - b. Prevent washout of any hazardous waste by a 100-year flood;
 - c. Prevent run-on into the system from non-storage and processing areas; and
 - d. Have sufficient capacity to contain the volume of the largest tank or 10% of the total tank and/or container free liquid capacity, whichever is greater, plus (for uncovered areas) the volume of rainwater which would be collected by the 25-year, 24-hour rainfall event (9.8 in.).
3. All authorized units shall be clearly identified as numbered in Provision II.B. At a minimum, the container areas are to have signs, and the tanks are to have painted labels indicating "TWC PERMIT UNIT NO. (from Provision II.B.)" (for example, Tank 1 shall be labelled "TWC PERMIT UNIT NO. 1").

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[III.A.]

4. Within seven months of October 3, 1990, or 60 days prior to use, the permittee shall construct and submit to the Executive Director and to the TWC District 7 Office as-built drawings and certifications prepared in accordance with Provision V.C. for Tanks 1-15, two Grinder Tanks, the Building 2 Container Storage Area, and the Building 3 Container Storage Area.

B. General Operational Requirements:

1. Incompatible wastes shall not be commingled in any storage or processing facility component, unless the permittee takes precautions to prevent the adverse reactions identified in 40 CFR 264.17(b). The permittee shall comply with the requirements of 40 CFR 264.17(a) for ignitable wastes.
2. Collected spills, leaks, clean-up residues, and contaminated rainfall runoff including stormwater from all waste management areas shall be removed within 24 hours after the spillage and/or rainfall event by a method(s) in Provision III.B.4.
3. The permittee shall manage all wastes within the facility unit in a manner in which particulate emissions of waste to the air meet Texas Air Control Board and Texas Water Commission requirements.
4. All contaminated water as identified by Provision III.B.5., Provision IV.B.2., and Provision IV.B.3. shall be managed by the following method(s):
 - a. Removal to an on-site, authorized industrial solid waste unit;
 - b. Discharge to the sanitary sewer, after satisfying all requirements of the City of Houston for such discharge;
 - c. Discharge in accordance with a washwater discharge permit and/or;
 - d. Removal off-site to an authorized industrial solid waste management facility.
5. The permittee shall ensure that any equipment which has come in contact with hazardous waste has been decontaminated prior to exiting the unit. At a minimum, all contaminated equipment shall be washed sufficiently to remove waste residues. All wash water generated shall be collected and disposed of in accordance with Provision III.B.4.

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[III.B.]

6. The annual site activity report required by Provision V.F. shall be submitted to the TWC Central Office and District 7 Office by January 25 of each year for the preceding year's activities. This annual report shall include, at a minimum, the following information:
 - a. All information and records required by 31 Texas Administrative Code (TAC) 335.154;
 - b. Volume of fuel-from-waste shipped;
 - c. Amounts of non-fuel materials received as waste and sold without processing;
 - d. Volume of all wastes stored at the facility unit authorized in Provision II.B.; and
 - e. Summary of the annual cost estimate adjustments for facility closure.
7. The permittee shall ensure that all waste analyses utilized for waste identification or verification have been performed in accordance with methods specified in the current editions of "Test Methods for Chemical Analysis of Water and Wastes" or "Test Methods for the Evaluation of Solid Waste" (SW-846) or other methods which are officially approved by the EPA. The permittee shall utilize only laboratories which follow a quality control/quality assurance program conforming to the program specified in "Test Methods for the Evaluation of Solid Waste" (SW-846).
8. The permittee shall develop and use inspection forms which include all units to be inspected and a list of all items to be inspected at each unit. Any remedial actions taken in response to unit inspections and the date of the remediation shall be included on the inspection forms.
9. The permittee shall ensure that all facility personnel handling hazardous waste successfully complete a program of classroom instruction and on-the-job training that teaches them to perform their duties in a way which ensures the facility's compliance with this permit. The permittee shall comply with 40 CFR 264.16.
10. All tanks, sumps, pumps, fire and spill control equipment, decontamination equipment, and all other equipment and structures authorized or required by this permit shall be maintained in good functional condition.

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[III.B.]

11. The permittee shall comply with the security requirements of 40 CFR 264.14.

C. Tank Design, Construction, and Operation Requirements:

The permittee shall comply with the following minimum requirements for the tanks authorized by Provision II.B.:

The tanks shall be constructed and operated in such a way as to comply with the standards presented in 40 CFR 264.192-264.199.

D. Container Storage Area Design, Construction and Operation Requirements:

1. The container storage areas shall be constructed and operated in such a way as to comply with the standards presented in 40 CFR 264.171 - 264-178.
2. In addition, within 30 days of amendment issuance by the TWC, the permittee shall comply with the following minimum requirements for the container storage areas authorized by Provision II.B.
 - a. The permittee shall provide a nominal 30" aisle spacing between double rows of drums in adjacent drum storage rows.
 - b. Drums of 55 gallons or more capacity shall not be stacked more than three high;
 - c. Pallets shall be used between layers of stacked drums; and
 - d. Drums of incompatible wastes shall be separated by an impermeable barrier.

IV. Closure

A. General Closure Requirements:

1. The permittee shall provide financial assurance for closure in accordance with the form outlined in 40 CFR Part 264, Subpart H in an initial amount not less than \$692,091 in 1988 dollars plus an additional \$164,105 in 1991 dollars. This financial assurance amount shall be adjusted annually as specified in Provision IV.A.2.a. Financial assurance shall be secured and maintained in compliance with Commission regulations on hazardous waste financial requirements (31 TAC Section 335.152 and 40 CFR Part 264, Subpart H).
2. The permittee shall submit to the Executive Director upon request such information as may be necessary to determine the adequacy of financial assurance.

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[IV.A.2.]

- a. Within 60 days prior to the anniversary date of the financial assurance documents, or within 30 days after the firm's fiscal year for firms using the financial test or corporate guarantee, the facility's closure cost estimate shall be updated for inflation and submitted to the Executive Director. The adjustment shall be made by recalculating costs in current dollars, or by using an inflation factor derived from the most recent Implicit Price Deflator. Pursuant to 31 TAC 335.176, the cost estimate for closure shall be based on off-site disposal during closure of all waste and waste residue for all units not required to close as landfills.
 - b. If changes in the closure plan will increase the cost of closure, then the cost estimate shall be revised within 30 days after approval of the plan by the Executive Director. The revised cost shall also be adjusted as specified in Provision IV.A.2.a.
3. Facility closure shall commence:
- a. Upon direction of the Texas Water Commission or the Executive Director for violation of the permit, TWC Rules, or State Statutes;
 - b. Upon suspension, cancellation, or revocation of the terms and conditions of this permit concerning the authorization to store, process, or dispose of waste materials;
 - c. Upon abandonment of the site;
 - d. Upon direction of the Executive Director for failure to secure and maintain an adequate bond or other financial assurance as required in Provision IV.A.1.; or
 - e. When necessary to comply with Provision VII.C.
4. The permittee shall submit a written request for a permit amendment or modification to authorize a change in operating plans, unit design, or the approved closure plan in accordance with the time frames of Provisions IV.A.5.a.-d. The written request shall include a copy of the amended closure plan for approval by the Executive Director. The permittee shall submit a written request for a permit amendment or modification to authorize a change in the approved closure plan whenever:
- a. Changes in operating plans or facility design affect the approved closure plan;

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[IV.A.4.]

- b. There is a change in the expected year of final closure, if applicable;
 - c. In conducting partial or final closure activities, unexpected events require amendment of the approved closure plan; or
 - d. Requested by the Executive Director under the conditions described in Provisions IV.A.4.a.-c.
5. The permittee shall submit a written request for a permit amendment or modification:
- a. At least 60 days prior to the proposed change in unit design or operation which will affect the approved closure plan;
 - b. No later than 60 days after an unexpected event has occurred which has affected the closure plan;
 - c. No later than 30 days after an unexpected event has occurred, if the unexpected event occurs during the partial or final closure period; or
 - d. Within 60 days of the Executive Director's request pursuant to Provision IV.A.4.d., or within 30 days if the change in facility conditions occurs during partial or final closure.
6. The permittee shall notify the Executive Director in writing at least 45 days prior to the date on which he expects to begin final closure of the facility. A copy of the notice shall be submitted to the Texas Water Commission (TWC) District 7 Office.
7. Within 60 days of the completion of final closure, the permittee shall submit to the Executive Director by registered mail, with a copy to the TWC District 7 Office, a certification that the hazardous waste management unit or facility, as applicable, has been closed in accordance with the specifications in the approved closure plan and the terms of this permit. The certification shall be signed by the permittee and by an independent registered professional engineer. Additional documentation supporting the independent registered professional engineer's certification shall be furnished to the Executive Director upon request until he releases the permittee from the financial assurance requirements for closure under 40 CFR 264.143(i).

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[IV.]

B. Hazardous Waste Management Unit Closure Requirements:

1. All tanks, pumps, piping, and any other equipment or structures which have come in contact with waste shall either be decontaminated by removing all waste or disposed of at an authorized facility.
2. All wash water generated during decontamination activities shall be collected and disposed of in accordance with Provision III.B.4.
3. All hard-surfaced areas within the hazardous waste management unit areas shall be decontaminated and the wash water generated shall be collected and disposed of in accordance with Provision III.B.4.
4. Verification of decontamination shall be performed by analyzing wash water for the waste constituents which have been most recently in contact with the particular item being decontaminated.

V. Standard Permit Conditions

The permittee has a duty to comply with the Standard Permit Conditions under Title 31 TAC 305.125. Moreover, the permittee has a duty to comply with the following permit conditions:

- A. In order to continue a permitted activity after the expiration date of the permit the permittee shall submit a new permit application at least 180 days before the expiration date of the effective permit, unless permission for a later date has been granted by the Executive Director. Authorization to continue such activity will terminate upon the effective denial of said application.
- B. The permittee need not comply with the conditions of this permit to the extent and for the duration such noncompliance is authorized in an emergency order issued by the Commission.
- C. For a new unit, the permittee shall not commence storage, processing or disposal of solid waste; and for a unit being modified, the permittee shall not process, store or dispose of solid waste in the modified portion of the unit, until the following requirements have been satisfied:
 1. The permittee has notified the local TWC District Office and submitted to the Executive Director by certified mail or hand delivery a letter signed by the permittee and a Texas registered professional engineer certifying that the facility has been constructed or modified in compliance with the permit. Required certification shall be in the following form:

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[V.C.1.]

This is to certify that the construction of the following facility components authorized or required by TWC Permit No. HW-50269 has been completed, and that construction of said facility component has been performed in accordance with and in compliance with the design and construction specifications of Permit No. HW-50269. (Description of facility units and components with reference to applicable permit provisions), and

2. The Executive Director has inspected the modified or newly constructed unit and finds it is in compliance with the conditions of the permit; or within 15 days of submitting the letter required by Provision V.C.1., the permittee has not received notice from the Executive Director of an intent to inspect, prior inspection is waived and the permittee may commence processing, storage or disposal of solid waste.
- D. The following details shall be included as information which must be reported orally within 24 hours pursuant to Title 31 TAC 305.125(9):
1. Information concerning release of any solid waste that may cause an endangerment to public drinking water supplies.
 2. Any information of a release or discharge of solid waste, or of a fire or explosion from a facility unit, which could threaten the environment or human health outside the facility. The description of the occurrence and its cause shall include the following information:
 - a. name, address, and telephone number of the owner or operator;
 - b. name, address, and telephone number of the facility;
 - c. date, time, and type of incident;
 - d. name and quantity of material(s) involved;
 - e. the extent of injuries, if any;
 - f. an assessment of actual or potential hazards to the environment and human health outside the facility, where this is applicable; and
 - g. estimated quantity and disposition of recovered material that resulted from the incident.

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[V.]

- E. The Executive Director may waive the five-day written notice requirement as specified in Title 31 TAC 305.125(9) in favor of a written report submitted to the Commission within 15 days of the time the permittee becomes aware of the noncompliance or condition.
- F. An annual report must be submitted covering facility activities during the previous calendar year.
- G. Emissions from this facility must not cause or contribute to a condition of "air pollution" as defined in Section 382.003 of the Texas Clean Air Act or violate Section 382.085 of the Texas Clean Air Act. If the Executive Director of the Texas Air Control Board determines that such condition or violation occurs, the permittee shall implement additional abatement measures as necessary to control or prevent the condition or violation.
- H. The provisions of this permit are severable, and if any provision of this permit or the application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this permit shall not be affected thereby.
- I. The permittee shall notify the Commission in writing within 10 days of discovery of any release to the environment of hazardous waste or hazardous constituents that may have occurred from any solid waste management unit at the facility regardless of when the release occurred or may have occurred, and regardless of when waste was placed in any unit. Release of hazardous waste or hazardous waste constituents from any solid waste management unit regardless of when waste was placed in that unit or when the release occurred, will constitute grounds for (1) a major permit amendment or modification pursuant to the Texas Solid Waste Disposal Act, TEXAS HEALTH AND SAFETY CODE, Chapter 361 (Vernon), as necessary to incorporate into the permit appropriate corrective action (2) the adoption by the Commission of a ground water compliance plan; or (3) other action deemed necessary by the Commission. Pursuant to such permit amendment or modification, ground-water compliance plan, or other order or action, the permittee shall then take timely corrective action for such releases.

Within forty-five (45) days of becoming aware of a solid waste management unit (SWMU) not previously addressed in the RCRA Facility Assessment, the permittee shall submit a preliminary assessment. The preliminary assessment shall include information regarding the SWMU to determine if there has been or is currently a release of hazardous waste or hazardous constituents from the unit. Based upon this information, the Executive Director may modify this permit as necessary.

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[V.]

*If the release involves off-site contamination, the Director of the Hazardous Waste Division of Region VI of the U.S. Environmental Protection Agency must be included in all of the required activities specified in this provision.

J. Waste Minimization

The permittee shall certify annually by October 1 for the previous year ending August 31, that the permittee

1. has a program in place to reduce the volume and toxicity of all hazardous wastes which are generated by the permittee's facility operation to the degree determined to be economically practicable;
2. that the proposed method of treatment, storage, or disposal is that practicable method currently available to the permittee which minimizes the present and future threat to human health and the environment. The waste minimization certification is to be included in the operating records; and
3. has surveyed its plant processes and other sources of hazardous waste and has identified those that are listed on the TWC Annual Waste Summary. Within 210 days of the effective date of this permit, the permittee shall submit to the Executive Director a list of hazardous wastes generated, together with a list of Waste Minimization Projects ("WMPs") that it has determined through its waste minimization review program can be implemented within the next five years.

Annually thereafter, the permittee shall submit to the Executive Director, on or before the anniversary date of the permittee's first listing of WMPs, a report setting forth the following information:

- a. The status of each listed WMP as of the date of the report including the quantity of each hazardous waste and the percentage of reduction together with a projection concerning the expected work or resources that can be devoted to each listed WMP during the next twelve months;
- b. If any WMP has been deleted from the list previously submitted, the reason for such deletion; and
- c. A listing of any new or changed WMP that permittee's review program has developed since the last annual report.

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[V.J.3.c.]

The Executive Director may require the permittee to submit a more detailed Status report for a specific WMP if it is unclear to the Executive Director the reasons the permittee has taken a particular action in regard to such WMP.

- K. The permittee shall comply with 40 CFR 266.23(b).
- L. The permittee is required to meet all performance standards in this permit, regardless of whether the permit also contains a specific design or other requirement relating to the performance standard.
- * M. The permittee shall comply with the land disposal restrictions as found in 40 CFR 268 (Fed. Reg. November 7, 1986; June 4, 1987; July 8, 1987; August 17, 1988; June 23, 1989; June 1, 1990 and any subsequent applicable promulgations). Requirements include modifying the permittee's waste analysis plan, as necessary, to include analyses to determine compliance with applicable treatment standards or prohibition levels, pursuant to 40 CFR 268.7(c) and 264.13(a).

The following Provision V.N. is not a part of the TWC permit. It is included as part of the EPA permit, and is to be enforced only by EPA.

- ** N. The Permittee must comply with the requirements of 40 CFR 264 Subpart AA and Subpart BB, as applicable. Within 90 days of the effective date of this modification, the Permittee shall submit to the Director of the Hazardous waste Management Division, EPA, Region 6, a report which must contain, at the minimum, the following information:
 - 1. An equipment list which includes all of the information required under Part 264.1064 (b)(1) for equipment that contains or contacts hazardous waste with organic concentrations of at least 10 percent by weight, and a list of all process vents associated with distillation, fractionation, thin-film evaporation, solvent extraction, or air or steam stripping operations managing hazardous waste with organic concentrations of at least 10 percent by weight.
 - 2. For the process vents listed above, the amount of vent emissions in lb/hr or kg/hr, and in lb/yr or kg/yr.
 - 3. If emissions in Provision V.N.2. of this section exceed the emission limits cited in Part 264.1032 (a)(1), the report must detail the manner in which compliance will be obtained, i.e., by the reduction of total organic emissions to the limits in Part 264.1032 (a)(1), or reduction by means of a control device per Part 264.1032 (a)(2).

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[V.N.]

4. If a closed vent system and control device is installed to comply with the requirements in Part 264.1032 (a)(2), provide the following:
 - a. An implementation schedule that includes dates by which the closed vent system and control device will be installed and in operation (Part 264.1033 (a)(2)).
 - b. The type of control device under Part 264.1033 to be installed (e.g., vapor recovery, flare, etc...).
5. If the Permittee feels any of the requirements of Provision V.N., or of 40 CFR Part 264 Subparts AA and BB, are not applicable to this facility, the Permittee must provide justification for this decision as part of the report.

VI. Incorporated Regulatory Requirements

- A. The following Texas Water Commission regulations are hereby made provisions and conditions of this permit. Issuance of this permit with incorporated rules in no way exempts the permittee from compliance with any other applicable state statute and/or Commission Rule.
 1. 31 Texas Administrative Code (TAC) Chapter 335 Subchapter A;
 2. 31 TAC Chapter 335 Subchapter B;
 3. 31 TAC Chapter 335.152;
 4. 31 TAC Chapters 335.153-335.155;
 5. 31 TAC Chapters 335.177-335.179; and
 6. 31 TAC Chapters 335.221-335.226.
- B. To the extent applicable to the activities authorized by this permit, the following provisions of 40 Code of Federal Regulations Part 264, adopted by reference by 31 TAC Section 335.152, are hereby made provisions and conditions of this permit:
 1. Subpart B -- General Facility Standards;
 2. Subpart C -- Preparedness and Prevention;
 3. Subpart D -- Contingency Plan and Emergency Procedures;
 4. Subpart E -- Manifest System, Recordkeeping, and Reporting;

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[VI.B.]

5. Subpart G -- Closure and Post-closure;
6. Subpart H -- Financial Requirements;
7. Subpart I -- Use and Management of Containers; and
8. Subpart J -- Tank Systems.

VII. Incorporated Application Materials

The permittee shall maintain the following documents at the facility and make them available for inspection by regulatory personnel.

A. Contingency Plan

The permittee shall follow the contingency plan, developed in accordance with 40 CFR Part 264, Subpart D, dated November 1, 1989, and revised July 1, 1989; August 10, 1989 and August 2, 1991, which is hereby approved subject to the terms of this permit and any other orders of the Texas Water Commission. The contingency plan is hereby incorporated into this permit by reference as if set out fully herein. Any and all revisions to the plan shall become provisions and conditions of this permit upon the date of approval by the Commission.

B. Inspection Schedule

The permittee shall follow the inspection schedule, developed in accordance with 40 CFR 264.15, dated November 1, 1989, and revised July 1, 1989 and August 2, 1991, which is hereby approved subject to the terms of this permit and any other orders of the Texas Water Commission. The inspection schedule is hereby incorporated into this permit by reference as if set out fully herein. Any and all revisions to the schedule shall become provisions and conditions of this permit upon the date of approval by the Commission.

C. Closure Plan

Facility closure shall be completed in accordance with the requirements of 31 TAC Section 335.152 and 40 CFR Part 264 Subpart G and the closure plan dated November 1, 1989, and revised July 1, 1989; August 10, 1989 and August 2, 1991, which is hereby approved subject to the terms of this permit and any other orders of the Texas Water Commission. The closure plan is hereby incorporated into this permit by reference as if set out fully herein. Any and all revisions to the plan shall become provisions and conditions of the permit upon the date of approval by the Commission.

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[VII.]

D. Waste Analysis Plan

The permittee shall follow the waste analysis plan developed in accordance with 40 CFR 264.13, dated November 1, 1989, and revised July 1, 1989; August 10, 1989 and August 2, 1991, which is hereby approved subject to the terms of this permit and any other orders of the Texas Water Commission. The waste analysis plan is hereby incorporated into this permit by reference as if set out fully herein. Any and all revisions to the plan shall become provisions and conditions of this permit upon the date of approval by the Commission.

VIII. Standard Permit Conditions Applicable to Off-site Facilities

The following reports shall be submitted:

- A. Manifest discrepancy report: If a significant discrepancy in a manifest is discovered, the permittee must attempt to reconcile the discrepancy. If not resolved within 15 days, the permittee must submit a letter report including a copy of the manifest to the Executive Director.
- B. Unmanifested waste report: Must be submitted to the Executive Director within 15 days of receipt of unmanifested waste.
- C. Monthly summary: A monthly summary must be submitted covering facility activities during the previous month, including product produced from waste and shipped.

IX. Standard Permit Conditions Applicable to Marketers of Hazardous Waste Fuel

- A. Before engaging in the marketing of hazardous waste fuel, the permittee shall notify the U.S. Environmental Protection Agency (EPA) of hazardous waste fuel marketing activities.
- B. A copy of the permittee's notice to EPA shall be maintained in the operating record for three years after all fuel marketing activities have been stopped.
- C. Permittee shall not ship hazardous waste fuel without a written and signed notice from the recipient in the operating record that:
 1. The burner or marketer has notified EPA and identified his waste-as-fuel activities; and
 2. If the recipient is a burner, the burner will burn the hazardous waste fuel only in an industrial furnace or boiler identified in 31 TAC 335.222(b).

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[IX.]

- D. A copy of the notice from each recipient to the permittee shall be maintained in the operating record for three years after the last shipment to the recipient.
- E. Dioxins, F020, F021, F023, F026, F027, and F028 shall not be blended into fuel.
- F. Prior to selecting any waste stream for use in a fuel blend, a representative sample of the waste stream shall be collected and analyzed for heat content using ASTM D240 or D2015. The sample shall not be considered appropriate for fuel blending and the waste stream from which the sample was collected shall not be used in a fuel blend, unless the sample exhibits a total heat content of at least 5,000 BTU/lb. No waste stream with a total PCB content of 50 ppm or greater shall be used in a fuel blend.
- G. Following final blending, i.e. before sale, a representative sample of the resultant hazardous waste mixture shall be collected and analyzed for heat content using ASTM D240 or D2015 and PCB content using SW846-8080. The resultant hazardous waste mixture shall not be labelled or otherwise represented as fuel unless the mixture exhibits the following criteria:
 - a. Total heat content of at least 5,000 BTU/lb; and
 - b. Total PCB content less than 50 ppm.
- H. All sampling and analyses that are performed in order to ensure compliance with Provisions IX.F. and IX.G. above shall be maintained in the facility operating records.
- X. This Section is not used.

XI. Air Quality Provisions

- A. Issuance of this permit does not relieve the permittee from compliance with the Texas Clean Air Act (TCAA) as amended (TEXAS HEALTH AND SAFETY CODE, Chapter 382) or any applicable Rule, Regulation or Order of the Texas Air Control Board (TACB).
- B. All representations with regard to construction plans and operating procedures in the permit application are conditions upon which this permit is issued. The permittee shall not vary from such representations if the change will result in a significant increase in the discharge of any air contaminant, unless prior notification is made to the Texas Water Commission (TWC). The TACB Central Office in Austin and the Harris County Pollution Control Department (HPCPD) shall be notified at the time of such notification to the TWC.

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{XI.}

- C. The appropriate regional office of the TACB and HCPD shall be notified prior to the start of any governmentally required air monitoring of the facility units authorized by this permit in such a manner that a representative of the TACB and HCPD may be present during monitoring.
- D. The facility units covered by this permit shall not be operated unless all associated air pollution abatement equipment which is required to be in place is maintained in good working order and is operating properly during normal facility operations.
- E. A copy of this permit shall be kept at the plant site and made available at the request of personnel from the TACB, TWC, or HCPD.
- F. The permittee shall maintain a duplicate record of a current inventory of materials regulated under this permit at an off-site location.
- G. Containers of hazardous waste or solid waste shall be opened only for the purposes authorized by the terms and conditions of this permit.
- H. The permittee shall install a carbon adsorption system which provides the following:
 - 1. The carbon adsorption system shall at a minimum consist of a carbon absorber with the sampling point at its exit. The absorber exit shall be monitored on a weekly basis to determine breakthrough of organic compounds. If breakthrough is determined to have occurred as specified in Provisions XI.2.2.-3., the absorber shall be replaced by a second absorber or the absorber shall be regenerated immediately.
 - 2. Breakthrough of organic compounds shall be determined by use of a photoionization detector equipped with lamps having an energy level of at least 11.7 eV or an equivalent detector.
 - 3. Breakthrough shall be considered to have occurred when monitoring indicates a concentration of 100 ppm of total hydrocarbons present in the gas stream at the sampling point.
 - 4. Disposal of spent carbon canisters shall not cause or create air emissions.
 - 5. Engineering details and operating conditions of the final carbon bed design shall be provided to the HCPD prior to use of the system.
- I. Ducts, hoses, and connections in the tank truck liquid transfer systems shall be properly maintained to insure leak free conditions.

NAME: NSSI/Recovery Services, Inc.

[XI.]

- J. Within 60 days of October 3, 1990, or sixty (60) days prior to use, whichever is later, the Permittee shall provide to HCPCD diagrams of the scrubber systems, including all manifolds, ductwork, and dampers.
- K. All storage tanks in Building No. 2 containing volatile organic liquid shall be vented to the condenser carbon absorber system.
- L. Storage tank and process vessels in Building No. 1 shall be vented to caustic scrubber prior to the condenser/carbon absorber system, unless there are no particulates or acid gases in the waste stream.
- M. Vapors from tank trucks containing VOC shall be vented into the carbon absorber unit.
- N. Vapors from tank trucks with acid liquids shall be vented to a caustic scrubber system.
- O. The caustic scrubber shall meet the following criteria:
 - 1. The caustic scrubber will be designed by the Permittee.
 - 2. The scrubbing liquid to be used is no less than 0.1% caustic.
 - 3. The minimum pH which will be maintained in each scrubber is 10.
 - 4. The type of packing will be provided after the unit is designed.
- P. The handling of hydrochloric acid (28%) shall not exceed 10% of the total acid handled at this facility. Handling of hydrochloric acid (35%) shall not exceed 7.5% of the total acid handled at this facility.
- Q. Sulfuric acids (98%) shall not exceed 13% of the total acid handled at this facility.
- R. The maximum emission rates from the following sources are:
 - 1. The scrubber
 - (1) VOC: 2.9913 pounds per hour or one ton per year
 - (2) Acid gases: 0.8452 pounds per hour or 0.17 ton per year
 - 2. The absorber
 - (1) VOC: 0.4759 pounds per hour or 0.25 ton per year
 - (2) Acid gases: 0.2527 pounds per hour or 0.30 ton per year

NAME: NSSI/Recovery Services, Inc.

XII. Monitoring of Commercial Hazardous Waste Management Facility Operations

- A. Within the first year after commission action on the modification the facility owner or operator shall provide notice to affected persons of intent to have an independent annual environmental audit of the facility performed. The notice shall be issued in accordance with the following procedure.
1. The notice shall state the names of at least three independent inspectors nominated by the facility owner or operator to perform the environmental audit and shall be published in the newspaper of the largest general circulation that is published in the county in which the facility is located. The facility owner or operator shall not nominate an inspector who is employed or who has been employed by the facility.
 2. The notice shall announce a meeting time and place, to be located near the facility location, be held within 15 days of the published notice in order for the facility to receive comments from and allow for participation by interested affected persons in the selection of the independent inspector. The interested affected persons may either agree to one of the nominated independent inspector or nominate other independent inspector if they do not approve of the nominee list. The selection of the independent inspector shall be agreed to by the facility owner or operator and the interested affected persons no later than 30 days from the date of the meeting. The name of the selected independent inspector shall be submitted to the commission no later than 15 days from the date of selection for the commission's approval. The commission shall approve the independent inspector after it has determined that the independent inspector has the necessary expertise to perform the audit and does not have a conflict of interest with any of the parties involved in the inspector selection.
 3. The published notice may not be smaller than 86.6 square centimeters or 13 square inches with the shortest dimension at least 7.6 centimeters or three inches and shall contain at a minimum, the following information:
 - a. the facility owner's or operator's name;
 - b. the location of the facility;
 - c. the facility permit number;
 - d. the time and date of the scheduled annual environmental audit;
 - e. names of at least three nominated independent inspectors;

NAME: NSSI/Recovery Services, Inc.

[XII.A.3.]

- f. the date and time and location of the selection meeting; and
 - g. the name and telephone number of a facility contact person.
- 4. The facility owner or operator shall provide a copy of the published notice to local jurisdictions where the facility is located.
- 5. The facility owner or operator shall provide the commission with an affidavit including a newspaper tear sheet of the published notice and sworn statement of the editor or publisher certifying that the notice was given as required by this section. Acceptance of the affidavit creates a rebuttable presumption that the applicant has complied with this requirements.
- B. If the facility owner or operator and interested affected persons cannot agree on the selection of an independent inspector within the time frame specified in Provision XII.A.2. the commission shall select an independent inspector. The commission's selection, however, shall not be limited to either the facility owner or operator's nominee list or the interested affected persons' nominee list. The commission shall take steps necessary to assure that the independent inspector or entity selected to perform the audit has the necessary expertise to perform the audit, is not a business competitor of the facility, and does not have a conflict of interest with any of the parties involved in the inspector selection.
- C. The facility owner or operator shall pay the cost of notice required to be provided.
- D. The facility owner operator shall be responsible for the costs of an independent annual environmental audit. The facility owner or operator shall also maintain responsibility for procuring the selected independent inspector. The commission shall not be a party to such procurement nor warrant the workmanship of the selected inspector.
- E. The facility owner or operator shall submit the results of an independent annual environmental audit in writing to the Executive Director.
- F. The scope of the independent annual environmental audit may encompass any and all provisions of environmental permits required for the facility and all relevant statutes and regulations regarding the management of the facility.
- G. The facility is not required to perform the annual independent environmental audit if the facility does not receive any comments from affected persons. If the facility performs the independent audit despite lack of response, the facility must obtain the commission's approval of the selected independent inspector prior to the audit.

NAME: NSSI/Recovery Services, Inc.

[XII.]

- H. An affected person is any person who is a resident of a county of any country adjacent or contiguous to the county in which a hazardous waste management facility is to be located including any person who is doing business or owns land in the county or adjacent or contiguous county and any local government. Such person affected shall also demonstrate to the commission that he has suffered or will suffer actual injury or economic damage.

Attachments

- A -- Legal Description
B -- Site Plan

LEGEND

- 1 ACID BASE NEUTRALIZATION UNIT
- 2 SOLVENT RECOVERY AREA
- 3 CHEMICAL OXIDATION/REDUCTION AREA
- 4 BUILDING NO. 1 CONTAINER STORAGE AREA
- 5 BUILDING NO. 2 CONTAINER STORAGE AREA
- 6 SCHEDULING MEDIA CIRCULATORY AREA
- 7 MULTICATALYTIC SEPARATION AREA
- 8 UNDERGROUND WASTE WATER TANKS (CLOSED)
- 9 SOLIDS CLEANING AREA
- 10 CHEMICAL STABILIZATION AREA
- 11 BUILDING NO. 3 CONTAINER STORAGE AREA
- 12 BLENDING/SEPARATION/STORAGE TANKS
- 13 WASTEWATER TANKS
- 14 REGENERATED STORAGE AREA (CLOSED)
- 15 OUTDOOR CONTAINER STORAGE AREA
- 16 LAB HALL AREA (I THROUGH VI)
- 17 REACTIVE CONTAINER STORAGE AREA

LEGEND

- 2" FIRE HOSE
- ⊗ 20 LB FIRE EXTINGUISHER
- ⊙ FIRE ALARM
- ⊕ TELEPHONE
- ⊖ ABSORBENT
- ⊗ NEUTRALIZER
- ⊘ SCUBA
- ⊙ SAFETY SHOWER
- ⊖ EYEWASH

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

ENTRANCE

Figure 11-2-1
General Facility Layout

Exhibit C3

RCRA PART B PERMIT FOR NSSI

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION VI

1445 ROSS AVENUE, SUITE 1200
DALLAS, TEXAS 75202

April 17, 1989

APR 20 1989

Ms. Janet Greenberg
Project Manager
NSSI/Recovery Services, Inc. Project Team
ENSR Consulting and Engineering
3000 Richmond Avenue
Houston, Texas 77098

Dear Ms. Greenberg:

Your March 23, 1989, letter to Mr. Lee Haze of this Agency, requested some information on permitting requirements for facilities that handle radioactive mixed waste. It is our understanding that your facility has both Part A and B applications on file with the Texas Water Commission.

The State of Texas, through the Texas Water Commission, has applied for approval of some State regulatory revisions. The Environmental Protection Agency has proposed in a February 3, 1989, notice in the Federal Register (54 FR 5500) the approval of these revisions. Included in the application was the State's request to regulate radioactive mixed waste.

EPA will soon publish a final decision on the Texas application in the Federal Register. However, the notice will not be published until a statutory amendment that affects the State's RCRA permitting program is acted upon by the Texas legislature.

We recommend that you continue to work with the Texas Water Commission since they will have the authority to issue the required permit. If this Agency can provide any further assistance, please contact me or have your staff call Ms. Lynn Prince, Regional Authorization Coordinator, at (214) 655-6760.

Sincerely yours,

Guanita Reiter
Chief
RCRA Programs Branch (6H-H)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION VI

1445 ROSS AVENUE, SUITE 1200

DALLAS, TEXAS 75202

APRIL 21, 1989

Ms. Janet Greenberg
Project Manager
NSSI/Recovery Services, Inc. Project Team
ENSR Consulting and Engineering
3000 Richmond Avenue
Houston, Texas 77098

Re: NSSI/Recovery Services, Inc.
Industrial Solid Waste Registration No. 38669
EPA I.D. NO. TXD982560294

Dear Ms. Greenberg:

Thank you for the opportunity to answer your question concerning the subject facility. As you are aware, the State of Texas is authorized to administer the RCRA hazardous waste program; however, Texas is not authorized to regulate the radioactive mixed waste portion of the RCRA program.

Therefore, NSSI/Recovery Services, Inc., is not subject to RCRA regulation of radioactive mixed wastes "...until the State program is revised and authorized to issue RCRA permits for radioactive mixed waste." Once the State of Texas is authorized to regulate radioactive mixed wastes, "[m]ixed waste TSDF's [treatment, storage, or disposal facilities] in States with base program authorization must comply with applicable State requirements and deadlines for obtaining interim status as prescribed in authorized State law.

Texas has made application to receive authorization for the radioactive mixed waste program. The application is currently being reviewed by the U.S. Environmental Protection Agency (EPA). A final decision is expected to be made in a few months. If you have any further questions regarding the effective dates and/or specifics of the new Texas statutes implementing the mixed waste program, you should address your questions to the Texas Water Commission (TWC).

Part A revisions should be sent to TWC, not to EPA. NSSI/Recovery Services, Inc., must update its existing Part A by the deadline specified for obtaining interim status in the Texas law authorizing the radioactive mixed waste program. However, NSSI/Recovery Services, Inc., may submit its revised Part A to TWC before that deadline if it is convenient to do so.

Sincerely yours,

W K Honker

William K. Honker, Chief
RCRA Permits Branch

cc: Susan Ferguson
Texas Water Commission

G-100

TEXAS WATER COMMISSION

B. J. Wynne, III, Chairman
Paul Hopkins, Commissioner
John O. Houchins, Commissioner

Allen Beinke, Executive Director
Michael E. Field, General Counsel
Brenda W. Foster, Chief Clerk

July 24, 1989

Mr. William K. Honker, Chief
RCRA Permits Branch
U. S. Environmental Protection Agency
Region VI - 6H-PT
1445 Ross Avenue
Dallas, Texas 75202-2733

Re: Transmittal of an RCRA Facility Assessment
NSSI/Recovery Service, Inc. - Houston, Texas
Solid Waste Registration No. 38669
EPA I.D. No. TXD 982560294

Dear Mr. Honker:

Consonant with the agreement made between the State of Texas and the U.S. Environmental Protection Agency (EPA) this letter and enclosures constitute the RCRA Facility Assessment (RFA) for NSSI/Recovery Service, Inc. - Houston, Texas. We understand that EPA has committed to a 30-day review and comment period for RFA documents so that the Texas Water Commission can proceed with permitting.

The Preliminary Review (PR), copy enclosed, presents information about all units managing waste materials as well as information about waste materials managed. The PR has been merged into the attached Visual Site Inspection (VSI) report so that, for each unit, the VSI pages and the PR pages are adjacent. The units at the facility are classified into one of the following five categories:

RCRA-Regulated Units

- Storage Tanks 1 through 15
- Acid-Base Neutralization Tank
- Oxidation-Reduction Tank (600 gallons)
- Oxidation-Reduction Tank (400 gallons)
- Reactive Container Storage Area
- Container Storage Area Within Building 1
- Building Two (under construction)
- Ionic Exchange Unit
- Stabilization and Fixation Unit
- Grinder and Screen
- Lab Pack Sorting and Consolidation Area
- Rotex Screen and Hopper System
- Portable Filtration Units

G-101

Mr. William K. Honker, Chief
Page 2

July 24, 1989

RCRA Units Being Closed

- Wastewater Tanks
- Grinder Tanks
- Open-Air Container Storage Area

Mixed Waste Management Unit

- Mixed Waste Compaction and Sorting Area

Solid Waste Management Unit

- Cullet Dumpster

"Other" Units

- Carbon Adsorption Unit
- Vapor Scrubbers

All units on-site are of such design and status as to justify a recommendation of "no further action".

In conclusion there is insufficient evidence to warrant an RFI for any unit on this facility site.

Questions or comments on the RFA should be directed within 30 days from the date of this letter to Alan P. Church, P.E. at AC512/463-8559.

Sincerely,

Ray Henry Austin, P.E.
Minor Brooks Hibbs, Chief
Permits Section
Hazardous and Solid Waste Division

APC:bb

Enclosure: PR and VSI

xc: Robert D. Gallagher, NSSI - Houston. (with VSI)
Shirley Workman, EPA - Dallas
TWC Southeast Region Office - Deer Park (with VSI)
Paul Lewis, TWC Enforcement Section - Austin

FROM

CITY OF HOUSTON

Fire Department/Fire Marshall's Office
410 Bagby • Houston, Texas 77002

JUL 18 1991

3A

***** Acknowledgment of Payment Received *****

This is an acknowledgment that the Permit Office of the Houston Fire Department did receive your application and fee for a Fire Prevention Permit. A Fire Inspector will be assigned to inspect, for approval of your permit, as soon as possible. Please verify the information below:

Requested Type of Permit: ~~CHEMICAL, HAZARDOUS (STORAGE OR USE)~~

Location to be Permitted: 5731 ETHERIDGE ST.

Your Check/Money Order #: 031285

Amount Paid: \$150.00

Property Controlled By: ROBERT D. GALLAGHER

Business Phone Number: (713) 641 0391

If any information is not correct or if you need further information, call the Permit Office (Mon thru Fri, 7:30 AM to 5:00 PM) at 247-3709.

Application Date: 6/27/91 TO:
Section: SE Key Map: 5340
HFD No. 00000 7/15/91 M
Permit Number: 6410391001 CML

NUCLEAR SOURCES & SERVICES, INC.
P. O. BOX 2042
HOUSTON, TEXAS 77254
Attn: ROBERT D. GALLAGHER

FROM

CITY OF HOUSTON

Fire Department/Fire Marshall's Office
410 Bagby • Houston, Texas 77002

JUL 18 1991

4A

***** Acknowledgment of Payment Received *****

This is an acknowledgment that the Permit Office of the Houston Fire Department did receive your application and fee for a Fire Prevention Permit. A Fire Inspector will be assigned to inspect, for approval of your permit, as soon as possible. Please verify the information below:

Requested Type of Permit: ~~FLAMM./COMB. LIQUID STORAGE & USE GEN.~~

Location to be Permitted: 5731 ETHERIDGE ST.

Your Check/Money Order #: 031285

Amount Paid: \$175.00

Property Controlled By: ROBERT D. GALLAGHER

Business Phone Number: (713) 641 0391

If any information is not correct or if you need further information, call the Permit Office (Mon thru Fri, 7:30 AM to 5:00 PM) at 247-3709.

Application Date: 6/27/91 TO:
Section: SE Key Map: 5340
HFD No. 00000 7/15/91 M
Permit Number: 6410391000 CML

NUCLEAR SOURCES & SERVICES, INC.
P. O. BOX 2042
HOUSTON, TEXAS 77254
Attn: ROBERT D. GALLAGHER

MAY 14 1990

DW0550

TEXAS WATER COMMISSION
NOTICE OF REGISTRATION
SOLID WASTE MANAGEMENT

05-08-90

THIS IS NOT A PERMIT AND DOES NOT CONSTITUTE AUTHORIZATION OF ANY WASTE MANAGEMENT ACTIVITIES OR FACILITIES LISTED BELOW. REQUIREMENTS FOR SOLID WASTE MANAGEMENT ARE PROVIDED BY TEXAS ADMINISTRATIVE CODE SECTION 335 OF THE RULES OF THE TEXAS WATER COMMISSION (TWC). CHANGES OR ADDITIONS TO WASTE MANAGEMENT METHODS REFERRED TO IN THIS NOTICE REQUIRE WRITTEN NOTIFICATION TO THE TWC.

DATE OF NOTICE: 03-13-90

REGISTRATION DATE: 12-07-88

REGISTRATION NUMBER: 38669

EPA I.D. NUMBER: TXD982560294

THE REGISTRATION NUMBER PROVIDES ACCESS TO STORED INFORMATION PERTAINING TO YOUR OPERATION. PLEASE REFER TO THAT NUMBER IN ANY CORRESPONDENCE.

COMPANY NAME: NSSI/RECOVERY SERVICES, INC.

P.O. BOX 34042

HOUSTON,

TX 77234

GENERATING SITE LOCATION:

5709-5747 ETHERIDGE

CONTACT PERSON: ROBERT D GALLAGHER

PHONE: (713) 641-0391

NUMBER OF EMPLOYEES: LESS THAN 100

TWC DISTRICT: 07

REGISTRATION STATUS: ACTIVE

REGISTRATION TYPE: GENERATOR/RECEIVER/TRANSPORTER

HAZARDOUS WASTE STATUS:

GENERATOR/TRANSPORTER

1. WASTE GENERATED:

WASTE NUMBER	DESCRIPTION	CLASS	CODE	DISPOSITION
001	WASTEWATER CONTAINING ORGANICS , TRACE METALS, AND OIL	IH	907870	ON-SITE/OFF-SITE
EPA HAZARDOUS WASTE NOS. (REFER TO 40 CFR PART 261 FOR DESCRIPTIONS):				
002	ORGANIC LIQUIDS	IH	916300	ON-SITE
EPA HAZARDOUS WASTE NOS. (REFER TO 40 CFR PART 261 FOR DESCRIPTIONS):				
003	SLUDGES, HAZARDOUS	IH	951850	ON-SITE/OFF-SITE

NOTICE OF REGISTRATION (CONTINUED)
REGISTRATION NUMBER: 38669
COMPANY NAME: NSSI/RECOVERY SERVICES, INC.

EPA HAZARDOUS WASTE NOS. (REFER TO 40 CFR PART 261 FOR DESCRIPTIONS):

004 STILL BOTTOMS, SOLVENT RECOVER IH 950240 ON-SITE/OFF-SITE
Y

EPA HAZARDOUS WASTE NOS. (REFER TO 40 CFR PART 261 FOR DESCRIPTIONS):

005 CONCRETE AND/OR METAL, MISC. C IH 979250 ON-SITE/OFF-SITE
HEMICAL CONTAMINATED

EPA HAZARDOUS WASTE NOS. (REFER TO 40 CFR PART 261 FOR DESCRIPTIONS):

006 TANK BOTTOMS IH 952180 ON-SITE

EPA HAZARDOUS WASTE NOS. (REFER TO 40 CFR PART 261 FOR DESCRIPTIONS):

007 CARBON, ACTIVATED, SPENT IH 981730 ON-SITE/OFF-SITE

EPA HAZARDOUS WASTE NOS. (REFER TO 40 CFR PART 261 FOR DESCRIPTIONS):

008 ION EXCHANGE RESIN IH 949990 ON-SITE/OFF-SITE

EPA HAZARDOUS WASTE NOS. (REFER TO 40 CFR PART 261 FOR DESCRIPTIONS):

009 FILTER WASTES IH 973340 ON-SITE/OFF-SITE

EPA HAZARDOUS WASTE NOS. (REFER TO 40 CFR PART 261 FOR DESCRIPTIONS):

010 DUST, GRINDING IH 973-60 ON-SITE/OFF-SITE

EPA HAZARDOUS WASTE NOS. (REFER TO 40 CFR PART 261 FOR DESCRIPTIONS):

011 TRASH AND DEBRIS I 183780 ON-SITE/OFF-SITE

012 CHEMICAL CONTAMINATED WASTE, L IH 910191 ON-SITE/OFF-SITE
LIQUID

EPA HAZARDOUS WASTE NOS. (REFER TO 40 CFR PART 261 FOR DESCRIPTIONS):

013 CHEMICAL CONTAMINATED WASTE, S IH 986000 ON-SITE/OFF-SITE
OLID

EPA HAZARDOUS WASTE NOS. (REFER TO 40 CFR PART 261 FOR DESCRIPTIONS):

NOTICE OF REGISTRATION (CONTINUED)
REGISTRATION NUMBER: 38669
COMPANY NAME: NSSI/RECOVERY SERVICES, INC.

11. Shipping/Reporting: Pursuant to Section 335 of the Texas Administrative Code of the rules of the TWC pertaining to Hazardous Waste management, issuance of manifests and annual reporting are required for Off-site Storage/Processing/Disposal of the following wastes listed in Part I. All manifested wastes should be reported on the annual waste summary report and submitted to the TWC by the 25th of each January for the prior calendar year.

001	907870	WASTEWATER CONTAINING ORGANICS , TRACE METALS, AND OIL
003	951850	SLUDGES, HAZARDOUS
004	950240	STILL BOTTOMS, SOLVENT RECOVER Y
005	979250	CONCRETE AND/OR METAL, MISC. C HEMICAL CONTAMINATED
007	981730	CARBON, ACTIVATED, SPENT
008	949990	ION EXCHANGE RESIN
009	973340	FILTER WASTES
010	973460	DUST, GRINDING
011	183780	TRASH AND DEBRIS
012	910191	CHEMICAL CONTAMINATED WASTE, L IQUID
013	988000	CHEMICAL CONTAMINATED WASTE, S OLID

III. ON-SITE WASTE MANAGEMENT FACILITIES:

FAC NO.	FACILITY	STATUS
01	TANK (SUB-SURFACE) STORAGE/PROCESSING 1500 GALS. WASTEWATER TANKS	INACTIVE
02	TANK (SURFACE) STORAGE/PROCESSING OF WASTE NUMBER(S) 001 20000 GALS WASTEWATER TANKS	ACTIVE
03	TANK (SURFACE) STORAGE/PROCESSING OF WASTE NUMBER(S) 001	ACTIVE

NOTICE OF REGISTRATION (CONTINUED)
REGISTRATION NUMBER: 38669
COMPANY NAME: NSSI/RECOVERY SERVICES, INC.

- 1300 GALS
NEUTRALIZATION TANK
- 04 TANK (SURFACE) ACTIVE
STORAGE/PROCESSING
OF WASTE NUMBER(S) 001, 002, 003
1000 GALS.
CHEMICAL OXIDATION/REDUCTION TANKS
- 05 TANK (SURFACE) INACTIVE
PROCESSING
OF WASTE NUMBER(S) 002
200 GPD
SOLVENT RECOVERY TANK
PROPOSED FACILITY
- 06 MISCELLANEOUS STORAGE CONTAINERS ACTIVE
PROCESSING
OF WASTE NUMBER(S) 002, 003, 004, 006, 007, 008,
009, 010, 011, 012, 013
1000 GPD
STABILIZATION/FIXATION UNIT (PROCESSING IN CONTAINERS)
- 07 TANK (SURFACE) ACTIVE
STORAGE/PROCESSING
OF WASTE NUMBER(S) 001, 002, 006
29600 GALS
BLENDING/SEPARATION/ STORAGE TANKS
ADDITIONAL 4700 GALLONS CAPACITY PROPOSED
- 08 CONTAINER STORAGE AREA ACTIVE
STORAGE
OF WASTE NUMBER(S) 001, 002, 003, 004, 005, 006,
007, 008, 009, 010, 011, 012,
013
79860 GAL.
BUILDING NO. 1 CONTAINER STORAGE AREA
- 09 MISCELLANEOUS STORAGE CONTAINERS ACTIVE
STORAGE/PROCESSING
OF WASTE NUMBER(S) 007
100 GPD
CARBON ADSORPTION UNIT
- 10 MISCELLANEOUS STORAGE CONTAINERS ACTIVE
STORAGE/PROCESSING
OF WASTE NUMBER(S) 001, 008
5000 GPD
ION EXCHANGE UNIT
- 11 MISCELLANEOUS STORAGE CONTAINERS ACTIVE
STORAGE/PROCESSING
OF WASTE NUMBER(S) 001, 002, 003, 006, 009, 010
5000 GPD
FILTERS

NOTICE OF REGISTRATION (CONTINUED)
REGISTRATION NUMBER: 38669
COMPANY NAME: NSSI/RECOVERY SERVICES, INC.

12	CONTAINER STORAGE AREA
STORAGE
OF WASTE NUMBER(S) 012, 013
500 GALS.
REACTIVE CONTAINER STORAGE AREA	ACTIVE
13	MISCELLANEOUS STORAGE CONTAINERS
STORAGE
OF WASTE NUMBER(S) 011
10000 PPD
DUMPSTER	ACTIVE
14	MISCELLANEOUS STORAGE CONTAINERS
PROCESSING
OF WASTE NUMBER(S) 003, 004, 006, 007, 008, 009,
010, 013
220000 PPM
SOLIDS CLEANING AREA
(PROCESSING AREA)	ACTIVE
16	TANK (SURFACE)
STORAGE
OF WASTE NUMBER(S) 002
128 CU.FT.
GRINDER TANKS	INACTIVE
17	CONTAINER STORAGE AREA
STORAGE
OF WASTE NUMBER(S) 001, 002, 003, 004, 005, 006,
007, 008, 009, 010, 011, 012,
013
29700 GALS
BUILDING NO. 2 CONTAINER STORAGE AREA
PROPOSED FACILITY	INACTIVE
18	CONTAINER STORAGE AREA
STORAGE
OF WASTE NUMBER(S) 012, 013
3120 GALS.	ACTIVE
19	TANK (SURFACE)
STORAGE
OF WASTE NUMBER(S) 002
2000 GAL.
2-GRINDER TANKS OF 1000 GALS. EACH	ACTIVE

UNLESS OTHERWISE STATED ABOVE, FACILITIES ARE LOCATED
AT 5709-5747 ETHERIDGE
COUNTY OF HARRIS

IV. RECORDS.

12345678910

12345678910

12345678910

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•

Exhibit C4

RADIOACTIVE MATERIALS LICENSE FOR NSSI

TEXAS DEPARTMENT OF HEALTH
RADIOACTIVE MATERIAL LICENSE

09411

Pursuant to the Texas Radiation Control Act and Texas Department of Health regulations on radiation, and in reliance on statements and representations heretofore made by the licensee, a license is hereby issued authorizing the licensee to receive, acquire, possess and transfer radioactive material listed below; and to use such radioactive material for the purpose(s) and at the place(s) designated below. This license is subject to all applicable rules, regulations and orders of the Texas Department of Health now or hereafter in effect and to any conditions specified below.

LICENSEE			This license issued pursuant to and in accordance with	
1. Name Nuclear Sources and Services, Inc. DBA NSSI/Recovery Services, Inc. ATTN: Mr. Robert D. Gallagher 2. Address P. O. Box 34042 Houston, Texas 77034			☐ APPLICATION ☒ LETTER ☐	
			Dated: September 29, 1983	
			Signed By: Robert D. Gallagher	
			3. License Number	Amendment Number
			L01811	42
			PREVIOUS AMENDMENTS ARE VOID	
RADIOACTIVE MATERIAL AUTHORIZED			4. Expiration Date	
			April 30, 1995	
5. Radioisotope	6. Form of Material	7. Maximum Activity*	8. Authorized Use	
A. Any radioactive material.	A. Radioactive Waste as defined in Texas Regulations for Control of Radiation (TRCR) 44.2	A. Activities of groups as specified under TRCR 44.5(a) for a Class B Processing Facility not to exceed the following: Group I. 1 Ci Group II. 10 Ci Group III. 100 Ci Group IV. 1000 Ci	A. Receipt from other persons, processing, research and development, and transfer to licensed radioactive waste disposal sites or other licensed recipients.	

☒ CONTINUED ON PAGE 2 IF CHECKED.

CONDITIONS

9. Radioactive material shall be used only at:

Subsite Number
000Location
Houston - 5711 Etheridge (this address shall consist of all properties operated by the licensee within an area bounded on the north by Moline Street, on the south by Joyner Street, on the east by Northdale Street,

* Ci-Curies

mCi-Millicuries

μ Ci-Microcuries

CONDITIONS CONTINUED ON PAGE 3

(2/88)

TEXAS DEPARTMENT OF HEALTH
RADIOACTIVE MATERIAL LICENSE

Page 2 of 13 Pages

26237

Supplementary Sheet

LICENSE NUMBER	AMENDMENT NUMBER
L01811	42

5. Radio-isotope	6. Form of Material	7. Maximum Activity	8. Authorized Use
B. Any radioactive material.	B. Radio-active Waste as defined in TRCR 44.2.	B. Activities of groups as specified under TRCR 44.5(a) for a Class B Storage Facility not to exceed the following: Group I. 2 Ci Group II. 20 Ci Group III. 200 Ci Group IV. 2000 Ci	B. Receipt from other persons, storage, and transfer to licensed radioactive waste disposal sites or other licensed recipients.
C. Any radioactive material	C. Sealed sources received as radioactive waste	C. Total activity not to exceed 2000 Ci	C. Receipt from other persons, storage, processing and transfer to licensed radioactive waste disposal sites or other licensed recipients.
D. Special Nuclear Material	D. Any received as radioactive waste	D. As specified in TRCR 11.2 "Special Nuclear Material in Quantities not Sufficient to Form a Critical Mass"	D. Receipt from other persons, storage, processing and transfer to licensed radioactive waste disposal sites or other licensed recipients.

CONDITIONS CONTINUED ON PAGE 3

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RADIOACTIVE MATERIAL LICENSEPage 3 of 13 Pages

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Supplementary Sheet

LICENSE NUMBER	AMENDMENT NUMBER
L01811	42

CONDITIONS CONTINUED:

9. (continued)

and on the west by Cheswood Street, and is further identified as Block 37, lots 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 17, and 18, and Block 38, lots 4, 5, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, and 18 in Houston, Texas as indicated in Attachment 1, which is attached hereto and is made a part hereof).

10. The licensee shall comply with the provisions of TRCR Parts 11, 12, 13, 21, 22, 41, and 44.
11. The activities authorized by this license shall only be performed by individuals designated by the licensee's Radiation Safety Committee or by persons working under the direct supervision of persons designated by the licensee's Radiation Safety Committee.
12. The individual designated to perform the functions of Radiation Safety Officer (RSO) for activities covered by this license is Robert D. Gallagher.
13. The licensee is authorized to possess special nuclear material only in quantities not to exceed that specified in TRCR 11.2. The total amount of special nuclear material possessed under all licenses issued by this Agency at the licensee's facility described in Condition No. 9 shall not exceed the TRCR 11.2 limits.
14. A. The licensee is authorized to collect and repackage radioactive waste at customer sites throughout Texas and transport the radioactive waste in containers that comply with United States Department of Transportation (USDOT) specifications to the licensee's or other properly licensed facility.

B. Waste processing under this license is limited to that as defined by the TRCR and the following:
 - (1) Receipt and survey in accordance with procedures contained in the application dated September 29, 1983 and letter dated September 14, 1984;

CONDITIONS CONTINUED ON PAGE 4

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TEXAS DEPARTMENT OF HEALTH
RADIOACTIVE MATERIAL LICENSEPage 4 of 13 Pages

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Supplementary Sheet

LICENSE NUMBER	AMENDMENT NUMBER
L01811	42

CONDITIONS CONTINUED:

14. B. (continued)

- (2) Repackaging in accordance with procedures contained in the application dated September 29, 1983;
- (3) Compaction and consolidation in accordance with procedures contained in the application dated September 29, 1983;
- (4) Separation and processing of liquid scintillation media, containers, and other bulk liquid and solid waste into: (a) liquid fractions; (b) solid fractions; and (c) rinses in accordance with procedures contained in the application dated September 29, 1983 and letter dated September 14, 1984.
- (5) Solidification of liquid radioactive waste using media acceptable to low-level waste disposal sites.

15. Empty or processed liquid scintillation vials may be disposed of in accordance with TRCR 21.307 (a) without regard to their radioactivity if: (1) concentrations of carbon-14, hydrogen-3, or iodine-125 do not exceed .05 microcuries per gram; or (2) for any other radionuclide, concentrations which do not exceed TRCR Appendix 21-A, Table II, Column 2 limits.

The determination of concentration shall be made with at least a 100 gram sample collected from each process batch.

16. While on site, waste will remain physically identifiable as radioactive waste and traceable to waste receipt records until shipment for disposal.
17. A. Waste inventory shall be computed in units of, or equivalent to the volume of 55-gallon drums (7.35 cubic feet). When computing the total inventory, any drum or container not equal to the volume of a 55-gallon drum shall be included in the inventory as its 55-gallon drum equivalent (e.g., a 30-gallon container has a volume equal to 30/55 of a 55-gallon drum).
- B. Any container that contains any quantity of radioactive waste shall be counted as a full container in the drum equivalent inventory unless it can be readily verified as empty.

CONDITIONS CONTINUED ON PAGE 5

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RADIOACTIVE MATERIAL LICENSEPage 5 of 13 Pages

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Supplementary Sheet

LICENSE NUMBER	AMENDMENT NUMBER
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CONDITIONS CONTINUED:

17. (continued)

C. By January 15, April 15, July 15 and October 15 of each year the licensee shall submit a written report to the Agency which includes the following information about the preceding calendar quarter:

- (1) The number of drum equivalents and activity on hand at the beginning and end of the quarter;
- (2) The number of drum equivalents and activity received during the quarter;
- (3) The number of drum equivalents and activity processed during the quarter;
- (4) The number of drums or drum equivalents disposed of at a licensed low-level radioactive waste disposal site; and
- (5) Volume and activity of waste disposed of in accordance with TRCR 21.307(a) and the identity of the disposal site (e.g., the name of the municipal landfill, incinerator, etc.) and the date of each disposal.

D. No more than 4000 55-gallon drum equivalents of radioactive waste shall be possessed at any one time.

18. A. The outer surfaces of each container shall be wipe tested for removable contamination upon receipt or repackaging and just prior to transfer. Any container with removable contamination in excess of 2200 dpm/100 cm² (alpha) or 22000 dpm/100 cm² (beta-gamma) shall be decontaminated. Drum storage area floors shall be wipe-tested at least quarterly to confirm that containers are not leaking radioactive materials.

B. Containers shall be visually inspected at least quarterly. Any container showing signs of rusting, physical damage, leaking materials, or other deterioration shall be repackaged as soon as practicable, but not later than ten days.

C. Upon receipt, the surface of each container shall be surveyed individually to assess the external radiation fields present and a record made of the highest surface reading noted.

CONDITIONS CONTINUED ON PAGE 6

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RADIOACTIVE MATERIAL LICENSEPage 6 of 17 Pages

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Supplementary Sheet

LICENSE NUMBER	AMENDMENT NUMBER
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CONDITIONS CONTINUED:

19. Records of all environmental sampling results; visual and physical inspections; radiation surveys; bioassay; personnel monitoring; personnel contamination surveys; radioactive material receipt, transfers, and disposals; management safety audits; biweekly wipe surveys of any restricted and unrestricted areas; area surveys and other records required by TRCR and this license shall be maintained by the licensee, in accordance with the time limits specified by the TRCR, for inspection by the Agency.
20. A. Shipments of radioactive waste by the licensee shall meet the requirements of the U.S. DOT, as specified in Title 49 Code of Federal Regulations and the requirements of the waste disposal site to which they are being shipped.
- B. The licensee is authorized to store any package prepared for shipment containing waste byproduct, source or special nuclear material in truck trailers at the licensee's facility for periods not to exceed ten working days prior to transport to a disposal site.
21. The licensee shall maintain for inspection by the Agency an inventory of all radioactive waste possessed under this license. The inventory shall show the radionuclide, date received, from whom received, amount of activity, physical form, date processed, original and reassigned drum or container number, and the date transferred for disposal. In addition, the licensee shall at least monthly generate a cumulative inventory, by radionuclide, which demonstrates compliance with the appropriate processing group limits of TRCR 44.5.
22. A. The clothing and skin of all employees (including permanent and contract workers) working in a radiation restricted area shall be monitored with radiation detecting instrumentation for contamination prior to departure from the facility. Contamination exceeding 20 dpm/100 cm² (alpha) and/or 1,000 dpm/100 cm² (beta-gamma) shall be removed prior to an individual departing the radiation restricted area.

CONDITIONS CONTINUED ON PAGE 7

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RADIOACTIVE MATERIAL LICENSEPage 7 of 13 Pages

Supplementary Sheet

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LICENSE NUMBER	AMENDMENT NUMBER
L01811	42

CONDITIONS CONTINUED:

22. (continued)

- B. Areas found to possess contamination in excess of 2200 dpm/100 cm² (removable alpha) and/or 22,000 dpm/100 cm² (removable beta-gamma) shall be decontaminated and resurveyed to assure that removable contamination is below the aforementioned limits. The limits do not apply to the contents of properly packaged waste materials, to waste materials during processing, or to the inner surfaces of processing equipment and air handling, sampling, or exhausting equipment.
23. A. Radiation safety training shall be given to radiation workers and radiation safety technicians in accordance with the licensee's letter dated September 14, 1984. All permanent radiation workers shall attend the "Radiation Workers Training Program" within 30 days of employment and shall attend the "Respirator Training Program" prior to working in areas requiring respiratory protection.
- B. Contract or temporary workers working in any radiation restricted area will work only under the direct supervision of a Radiation Safety Technician and shall not work in any radiation restricted area alone.
- C. All female employees who enter any radiation restricted area will be given instruction concerning prenatal radiation exposure.
- D. All training will be documented. Documentation of the training shall be made available for Agency inspection.
24. The licensee shall provide appropriate respiratory protection for persons working in areas where airborne contamination at concentrations above the limits specified in TRCR Appendix 21-A, Table I, Column I is possible. A physical inspection to include wipe testing of the respirator shall be performed before each use, but not less frequently than quarterly. Persons working in those areas shall be tested for proper fit of respirators at least once each year. Records of the physical inspection, fit test and training given to employees shall be maintained for inspection by the Agency.

CONDITIONS CONTINUED ON PAGE 8

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RADIOACTIVE MATERIAL LICENSEPage 8 of 13 Pages

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Supplementary Sheet

LICENSE NUMBER	AMENDMENT NUMBER
L01811	42

CONDITIONS CONTINUED:

25. Respirators made available for use must show no removable alpha contamination in excess of 22 dpm/100 cm², no removable beta-gamma contamination in excess of 220 dpm/100 cm², no fixed alpha contamination in excess of 100 dpm/100 cm², or no fixed beta-gamma contamination in excess of 1,000 dpm/100 cm².
26. Individuals involved in operations which utilize, during any 24-hour period, more than 50 millicuries of iodine-125 (I-125) and/or iodine-131 (I-131) or unvented operations involving 10 millicuries of I-125 and/or I-131 in a noncontained form shall have bioassays performed within one week. If the use of I-125 and/or I-131 is on a continual basis, bioassays shall be performed once every two weeks. The action points listed below shall be observed:
- A. Whenever the thyroid burden at the time of measurement exceeds 0.12 microcuries of I-125 or 0.04 microcuries of I-131, the following actions shall be taken:
- (1) An investigation of the operations involved, including ventilation surveys, shall be carried out immediately to determine the causes of exposure and to evaluate the potential for further exposures.
 - (2) If the investigation indicates a potential for excessive worker exposure, access will be controlled until the source of exposure is discovered and corrected.
 - (3) Corrective actions that will eliminate or lower the potential for further exposures shall be implemented.
 - (4) A repeat bioassay shall be taken within one week of the previous measurement in order to confirm the effectiveness of the corrective action taken.
 - (5) Reports or notification shall be provided as required by TRCR 21.405 and 21.408.
- B. If the thyroid burden at any time exceeds 0.5 microcuries of I-125 or 0.14 microcuries of I-131, the following actions shall be taken:
- (1) Prevent the individual from any further handling of I-125 or I-131 until the thyroid burden is below the above limits.
 - (2) Carry out all steps described above.

CONDITIONS CONTINUED ON PAGE 9

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RADIOACTIVE MATERIAL LICENSEPage 9 of 13 Pages

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Supplementary Sheet

LICENSE NUMBER	AMENDMENT NUMBER
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CONDITIONS CONTINUED:

26. B. (continued)

- (3) As soon as possible, refer the case to appropriate medical consultation for recommendations regarding therapeutic procedures that may be carried out to accelerate removal of radioactive iodine from the body. This should be done within 2-3 hours after exposure when the time of exposure is known so that any prescribed thyroid blocking agent would be effective.
- (4) Carry out repeated measurements at approximately one-week intervals at least until the thyroid burden is less than 0.12 microcuries of I-125 or 0.04 microcuries of I-131.

27. A. Individuals involved in operations which utilize, at any one time, more than 100 millicuries of hydrogen-3 in a noncontained form, ~~other than metallic foil, outside of a glovebox shall have bioassays performed within one week following a single operation and at weekly intervals for continuing operations.~~

B. ~~Hydrogen-3 shall not be used in such a manner as to cause any individual to receive a radiation exposure such that urinary excretion rates exceed 28 microcuries of hydrogen-3 per liter when averaged over a calendar quarter.~~

C. ~~A report of an average concentration in excess of the limit specified in Part B of this condition for any individual shall be filed, in writing, within 30 days of the end of the calendar quarter with the Agency. The report shall contain the results of all urinalysis for the individual during the calendar quarter, the cause of the excessive concentrations, and the corrective steps taken or planned to assure against a recurrence.~~

D. Any single urinalysis which discloses a concentration of greater than 50 microcuries per liter shall be reported, in writing, within seven days of the licensee's receipt of the results.

CONDITIONS CONTINUED ON PAGE 10

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RADIOACTIVE MATERIAL LICENSE

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Supplementary Sheet

LICENSE NUMBER	AMENDMENT NUMBER
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CONDITIONS CONTINUED:

28. A. If air sample results indicate that an airborne release in excess of ten times the limits of TRCR Appendix 21-A, Table I, Column 1 occurred to the restricted area or to any portion of the restricted area, the licensee shall immediately perform bioassays on all individuals who were present. If the bioassay results indicate that the maximum permissible body burden was exceeded for any individual; the individual shall have a whole body count performed to determine the uptake, if appropriate for the radionuclide. Appropriate measures to enhance elimination shall be made in consultation with the licensee's consulting physician.
- B. If any air sample results indicate that an airborne release to the unrestricted area in excess of the limits of TRCR Appendix 21-A, Table II, Column 2 has occurred, the licensee shall take appropriate measures to determine the dose to the maximally exposed member of ~~the public downwind of the plume and notify the Agency in writing within five working days of the sample analysis and the dose assessment.~~
29. ~~Records of bioassays, thyroid counts, whole-body exposures, any dose to employees or members of the public and any corrective actions taken shall be maintained for Agency inspection.~~
30. ~~The licensee shall conduct the radiation survey and area monitoring program as described in Sections 5.2, 5.3, and 5.4 of the document entitled "Operating Procedures for the Radioactive Waste Processing and Storage Facilities at Houston, Harris County" dated September 1983, at the locations indicated in Drawing No. 100-83023-B, "Site Plan - Nuclear Sources and Services Inc." dated August 10, 1983. The monitoring program will be reviewed at least semiannually by the Radiation Safety Committee to assure its adequacy for the size and scope of operations at the facility. A report of its analyses shall be kept for Agency inspection.~~
31. Once each calendar quarter the licensee shall collect three environmental soil samples from the following locations:
- A. South of the NSSI office building, west of 5747 Etheridge, just west of the fence on the east side of Etheridge, on the south side of the driveway, in the low drainage area;

CONDITIONS CONTINUED ON PAGE 11

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LICENSE NUMBER	AMENDMENT NUMBER
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CONDITIONS CONTINUED:

31. (continued)

- B. Southwest of the NSSI office building, just west of the fence on the east side of Etheridge, just south of the main gate drive where the slab drainage exists at the site.
- C. Southwest of the NSSI office building, just west of the fence on the east side of Etheridge, on the south side of the driveway to the drum storage area and waste storage and processing building, in the low drainage area.

32. The RSO and the Radiation Safety Committee shall review the following areas of the radiation safety program at least semiannually:

- A. health physics authority and responsibility;
- B. operating procedures (involving the handling, processing and/or storage of radioactive materials);
- C. audits, inspections, and surveys conducted by the facility RSO (for timeliness and the resolution of any problems);
- D. radiation protection including employee exposure records; bioassay procedures and results; quarterly, semiannual, or annual surveys and inspections; radiological survey and sampling data; and any changes in operating procedures;
- E. radiation safety training;
- F. respiratory protection program;
- G. facility and equipment design including ventilation rates within various portions of the facility, and fire control;
- H. control of airborne radioactive materials;
- I. compliance with applicable federal and state regulations and the conditions of this license; and
- J. the audit of drum inspection and receipt procedures.

A copy of this report shall be maintained for review by the Agency.

- 33. Modifications of existing facilities or construction of a new facility requiring a change in the operating procedures or the use of new radioisotope handling facilities shall be approved by the Agency prior to the initiation of their use on a commercial scale.

CONDITIONS CONTINUED ON PAGE 12

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RADIOACTIVE MATERIAL LICENSEPage 12 of 13 Pages

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Supplementary Sheet

LICENSE NUMBER	AMENDMENT NUMBER
L01811	42

CONDITIONS CONTINUED:

34. A. The licensee shall post and maintain financial security.
- B. Financial security shall be in the form of a preapproved trust agreement with the Agency designated as the beneficiary.
- C. The amount of financial security shall be based on the average number of drum-equivalents of radioactive waste, as determined from a count obtained during the two inspections made during the prior year. The amount of financial security required shall be reviewed on a yearly basis and adjusted to reflect the average number of drums as determined during the two semi-annual inspections. No adjustment shall be made downward unless the total amount of security equals the total amount required by the Agency based on the preceding year's average drum count.
- D. The initial amount of financial security is \$225,000, based upon ~~\$300 per drum-equivalent of radioactive waste counted on-site during the two inspections conducted prior to issuance of Amendment No. 42 of this license.~~ This amount is to be paid as provided in Parts E and F of this condition.
- E. The initial payment to the trust fund shall be in the amount of \$56,250.
- F. Payments to the trust fund shall be made on a semi-annual basis (June 1 and December 1) until the total amount of financial security required is attained. The semi-annual payments shall be in the amount of \$2.00 for every cubic foot of radioactive waste received during the six month period.
- G. In no event shall the amount of the security be less than \$56,250. This amount may be reviewed annually.
35. The licensee shall provide the Agency a Certificate of Insurance which indicates that the requirements of TRCR 44.30(c) have been fulfilled. Should the licensee be unable to obtain such insurance coverage, every six months the licensee shall submit documentation of attempts to obtain the liability insurance and a request for exemption from TRCR 44.30(c).

CONDITIONS CONTINUED ON PAGE 13

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RADIOACTIVE MATERIAL LICENSEPage 13 of 13 Pages

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Supplementary Sheet

LICENSE NUMBER	AMENDMENT NUMBER
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CONDITIONS CONTINUED:

36. The licensee shall notify the Agency in writing or via telephone at least 48 hours in advance of shipping its low-level radioactive waste, including the shipment of TRCR 21.307 (a) waste, to a commercial treatment, storage, or disposal site.
37. All containers of radioactive waste shall be stored within enclosed buildings with the following exceptions:
- A. Containers may be stored outside temporarily (i.e., not to exceed one week) while being received or being prepared for shipment.
 - B. Bulk flammable liquids shall be stored in accordance with local applicable fire safety regulations.
38. For research and development of waste processing techniques, the licensee is authorized to process up to 15 drum equivalents at any one time using new procedures, equipment, facilities, and technology without prior approval from the Agency. All research and development studies must be approved by the Radiation Safety Committee, and a summary report of such activities provided to the Agency at least annually.
39. Except as specifically provided otherwise by this license, the licensee shall possess and use the radioactive material authorized by this license in accordance with statements, representations, and procedures contained in the following:

application dated September 29, 1983,
letter dated September 14, 1984;

The Texas Regulations for Control of Radiation shall prevail over statements contained in the above documents unless such statements are more restrictive than the regulations.

PES:dm

FOR THE TEXAS DEPARTMENT OF HEALTH

G-125

2. August 1990

A handwritten signature in cursive script, appearing to read "Robert Bernstein".
Robert Bernstein
M.D., F.A.C.P.

FEB 13 1989

Texas Department of Health

Robert Bernstein, M.D., F.A.C.P.
Commissioner

1100 West 49th Street
Austin, Texas 78756-3189
(512) 458-7111

Radiation Control
(512) 835-7000

Robert A. MacLean, M.D.
Deputy Commissioner
Professional Services
Hermas L. Miller
Deputy Commissioner
Management and Administration

February 6, 1989

Nuclear Sources and Services, Inc.
Attn: Robert D. Gallagher
P.O. Box 34042
Houston, Texas 77034

Ref: Compliance No. LB81318
License No. 11-1811
Inspection of Dec. 14, 1988
By Arthur Flores
At 5711 Etheridge
Houston, Texas

Dear Mr. Gallagher:

After reviewing the report of the inspection conducted by Mr. Arthur Flores on December 14, 1988, we are pleased to inform you that your radiation protection program, with regard to the records reviewed and procedures observed, appears to be in compliance with the applicable Texas Regulations for Control of Radiation and/or Conditions pertaining to the above referenced License.

Thank you for the cooperation and assistance provided during the inspection.

Sincerely,

Robert L. Green, Jr.
Technical Review and Enforcement Program
Radioactive Material Inspection and
Enforcement Branch
Division of Compliance and Inspection
Bureau of Radiation Control

Exhibit D1

**LIST OF PERMITS, LICENSES, OR AUTHORIZATIONS
PERTAINING TO QUADREX**

List of permits, licenses, or authorizations pertaining to Quadrex					
Type	Number	Issue date	Expiration date	Issued by	
Radioactive Materials License	1354-1	December 4, 1990	November 30, 1995	Florida Dept. of Health and Rehabilitative Services Office of Radiological Control P. O. Box 680069 Orlando, FL 32868-0069	
RCRA - Hazardous Waste Permit	HO 01-169480	September 28, 1990	September 27, 1995	Florida Dept. of Environmental Regulation Northeast District Suite 200, 7825 Baymeadows Way Jacksonville, FL 32256-7577	
EPA Generators Number	FLD 98 071 1071	None specified	None specified	Florida Dept. of Environmental Regulation Northeast District Suite 200, 7825 Baymeadows Way Jacksonville, FL 32256-7577	
FDER Used Oil Registration	50428-UO	July 1, 1991	Renewed annually	Florida Dept. of Environmental Regulation Twin Towers Office Building 2600 Blairstone Road Tallahassee, FL 32301	

Exhibit D2

RCRA HAZARDOUS WASTE PERMIT FOR QUADREX

III PERMITS/NOTIFICATION/REGISTRATION/LICENSE

RCRA Hazardous Waste Permit

Date of Issuance: September 28, 1990
Date of Expiration: September 27, 1995
EPA Permit Number: HO 01-169480
EPA I.D. Number: FLD 980711071

NPDES/Pretreatment

Quadrex does not discharge any material and is not subject to NPDES/Pretreatment permit requirements.

Storm Water Permit

Although a storm water permit is not required at this time, Quadrex is seeking a general permit to ensure compliance with Section 402(p) of the Clean Water Act.

RCRA Notification

EPA was renotified of Quadrex's hazardous waste and used oil marketing activities on May 24, 1991.

FDER Used Oil Registration

Date of Issuance: July 1, 1991
Date of Expiration: Renewed Annually
Registration Number: 50428-UO

Radioactive Materials License

Date of Issuance: December 4, 1990
Date of Expiration: November 30, 1995
License Number: 1354-1

Exhibit D3

RCRA PART B PERMIT FOR QUADREX

Florida Department of Environmental Regulation

Northeast District • Suite 200, 7825 Baymeadows Way • Jacksonville, Florida 32256-7577 • 904-448-4300

Bob Martinez, Governor

Dale Twachmann, Secretary

John Shearer, Assistant Secretary
Brent Frey, Deputy Assistant Secretary

PERMITTEE:

Attention: Mr. Bernhardt C. Warren
Quadrex Environmental Company
1940 Northwest 67th Place
Gainesville, Florida 32606-1649

I.D. Number: FLD 980 711 071
Permit/Certification No. HO 01-169480
Date of Issue: September 28, 1990
Expiration Date: September 27, 1995
County: Alachua
Latitude/Longitude: 29°42'08"N/82°20'51"W
Section/Township/Range: 18/9S/20E
Project: Operation of a tank and a
container storage area and
closure of a secondary container
storage area.

This permit is issued under the provisions of Chapter 403, Florida Statutes, and Florida Administrative Code Rules 17-4 and 17-730. The above-named permittee is hereby authorized to perform the work or operate the facility shown on the application and approved drawing(s), plans, and other documents attached hereto or on file with the Department and made a part hereof and specifically described as follows:

To close a secondary container storage area with dimensions of fifty feet square and maximum storage capacity of 480 fifty-five (55) gallon drums. This storage area is described in Figures 10 and 11 of the closure plan dated August 8, 1990.

To operate the following two (2) hazardous waste storage units at Quadrex Environmental Company, located at 1940 N.W. 67th Place, Gainesville, Florida. The facility is described in Figure 10 of the permit application dated September 1, 1989, and revised Figure 11 dated April 2, 1990:

- A. A container storage area as described in Figure 11 contains three (3) zones to store hazardous waste in containers ranging from $\frac{1}{2}$ gallon to fifty-five (55) gallon drums and other D.O.T. approved containers. The storage area is allowed to store a maximum volume of 72,100 gallons of hazardous waste.
- B. A 3,000 gallon aboveground storage tank, installed on September 1, 1983, is constructed of $\frac{1}{2}$ " carbon steel.

The hazardous wastes and hazardous wastes mixed with low level radioactive waste stored at this facility and their designated hazardous waste codes are as listed in Attachment A.

The Environmental Protection Agency (EPA) has determined that there is no evidence of releases of hazardous wastes or constituents from solid waste management units (SWMUs) at this facility. Therefore, at this time, Section 3004(u) of the Hazardous and Solid Waste Amendments (HSWA) of 1984 does not apply. The only provisions of HSWA which apply to the facility are the Section 3005(h) waste minimization certification and Section 3004(d) Land Disposal Restriction requirements, which have been incorporated into the proposed State permit. Since there are no other provisions of HSWA which affect this facility, the final State permit, if issued, will constitute the full RCRA permit required by DER and EPA.

PERMITTEE:
Quadrex Environmental Company
1940 N.W. 67th Place
Gainesville, Florida 32606-1649

I.D. Number: FLD 980 711-071
Permit/Certification Number: H0 01-169480
Date of Issue: September 28, 1990
Expiration Date: September 27, 1995

Operation of these units will be in accordance with the operation permit application dated September 1, 1989, and the supplemental information dated April 10, 1990, July 6, 1990, July 18, 1990 and August 3, 1990.

PERMITTEE:
Quadrex Environmental Company
1940 N.W. 67th Place
Gainesville, Florida 32606-1649

I.D. Number: FLD 980 711 071
Permit/Certification Number: HO 01-169480
Date of Issue: September 28, 1990
Expiration Date: September 27, 1995

GENERAL CONDITIONS:

1. The terms, conditions, requirements, limitations, and restrictions set forth herein are "Permit Conditions" and as such are binding upon the permittee and enforceable pursuant to the authority of Sections 403.161, 403.727, or 403.859 through 403.861, Florida Statutes. The permittee is hereby placed on notice that the Department will review this permit periodically and may initiate enforcement action for any violation of the "Permit Conditions" by the permittee, its agents, employees, servants or representatives.
2. This permit is valid only for the specific processes and operations applied for and indicated in the approved drawings or exhibits. Any unauthorized deviation from the approved drawings, exhibits, specifications, or conditions of this permit may constitute grounds for revocation and enforcement action by the Department.
3. As provided in Subsections 403.087(6) and 403.722(5), Florida Statutes, the issuance of this permit does not convey any vested rights or any exclusive privileges. Nor does it authorize any injury to public or private property or any invasion of personal rights, nor any infringement of federal, state or local laws or regulations. This permit does not constitute a waiver of or approval of any other Department permit that may be required for other aspects of the total project which are not addressed in the permit.
4. This permit conveys no title to land or water, does not constitute state recognition or acknowledgement of title, and does not constitute authority for the use of submerged lands unless herein provided and the necessary title or leasehold interests have been obtained from the state. Only the Trustees of the Internal Improvement Trust Fund may express state opinion as to title.
5. This permit does not relieve the permittee from liability for harm or injury to human health or welfare, animal, plant or aquatic life or property and penalties therefore caused by the construction or operation of this permitted source, nor does it allow the permittee to cause pollution in contravention of Florida Statutes and Department rules, unless specifically authorized by an order from the Department.
6. The permittee shall at all times properly operate and maintain the facility and systems of treatment and control (and related appurtenances) that are installed or used by the permittee to achieve compliance with the conditions of this permit, as required by Department rules. This provision includes the operation of backup or auxiliary facilities or similar systems when necessary to achieve compliance with the conditions of the permit and when required by Department rules.
7. The permittee, by accepting this permit, specifically agrees to allow authorized Department personnel, upon presentation of credentials or other documents as may be required by law, access to the premises, at reasonable times, where the permitted activity is located or conducted for the purpose of:
 - a. Having access to and copying any records that must be kept under the conditions of the permit;

PERMITTEE:
Quadrex Environmental Company
1940 N.W. 67th Place
Gainesville, Florida 32606-1649

I.D. Number: FLD 980 711 071
Permit/Certification Number: HO 01-169480
Date of Issue: September 28, 1990
Expiration Date: September 27, 1995.

7. (continued)

- b. Inspecting the facility, equipment, practices, or operations regulated or required under this permit; and**
- c. Sampling or monitoring any substances or parameters at any location reasonably necessary to assure compliance with this permit or Department rules.**

Reasonable time may depend on the nature of the concern being investigated..

- 8. If, for any reason, the permittee does not comply with or will be unable to comply with any condition or limitation specified in this permit, the permittee shall immediately notify and provide the Department with the following information:**

- a. a description of and cause of noncompliance; and**
- b. the period of noncompliance, including exact dates and times; or, if not corrected, the anticipated time the noncompliance is expected to continue, and steps being taken to reduce, eliminate, and prevent recurrence of the noncompliance.**

The permittee shall be responsible for any and all damages which may result and may be subject to enforcement action by the Department for penalties or revocation of this permit.

- 9. In accepting this permit, the permittee understands and agrees that all records, notes, monitoring data and other information relating to the construction or operation of this permitted source, which are submitted to the Department, may be used by the Department as evidence in any enforcement case arising under the Florida Statutes or Department rules, except where such use is proscribed by Sections 403.73 and 403.111, Florida Statutes.**
- 10. The permittee agrees to comply with changes in Department rules and Florida Statutes after a reasonable time for compliance, provided, however, the permittee does not waive any other rights granted by Florida Statutes or Department rules.**
- 11. This permit is transferable only upon Department approval in accordance with Florida Administrative Code Rules 17-4.120 and 17-730.300, as applicable. The permittee shall be liable for any noncompliance of the permitted activity until the transfer is approved by the Department.**
- 12. This permit is required to be kept at the work site of the permitted activity during the entire period of construction or operation.**
- 13. This permit also constitutes:**
 - () Determination of Best Available Control Technology (BACT)**
 - () Determination of Prevention of Significant Deterioration (PSD)**
 - () Certification of Compliance with State Water Quality Standards (Section 401, FL 92-500)**
 - () Compliance with New Source Performance Standards**

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Quadrax Environmental Company
1940 N.W. 67th Place
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14. The permittee shall comply with the following monitoring and recordkeeping requirements:
- a. Upon request, the permittee shall furnish all records and plans required under Department rules. The retention period for all records will be extended automatically, unless otherwise stipulated by the Department, during the course of any unresolved enforcement action.
 - b. The permittee shall retain at the facility or other location designated by this permit records of all monitoring information (including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation), copies of all reports required by this permit, and records of all data used to complete the application for this permit. The time period of retention shall be at least three years from the date of the sample, measurement, report or application unless otherwise specified by Department rule.
 - c. Records of monitoring information shall include:
 - the date, exact place, and time of sampling or measurements;
 - the person responsible for performing the sampling or measurements;
 - the date(s) analyses were performed;
 - the person responsible for performing the analyses;
 - the analytical techniques or methods used; and
 - the results of such analyses.
15. When requested by the Department, the permittee shall, within a reasonable period of time furnish any information required by law which is needed to determine compliance with the permit. If the permittee becomes aware that relevant facts were not submitted or were incorrect in the permit application or in any report to the Department, such facts or information shall be submitted or corrected promptly.
16. In the case of a hazardous waste facility permit, the following permit conditions shall also apply:
- a. The permittee will submit the following reports to the Department:
 - (1) **Manifest discrepancy report:** If a significant discrepancy in a manifest is discovered, the permittee must attempt to reconcile the discrepancy. If not resolved within 15 days after receiving the waste, the permittee shall immediately submit a letter report including a copy of the manifest to the Department.
 - (2) **Unmanifested waste report:** Permittee shall submit an unmanifested waste report to the Department within 15 days of receipt of unmanifested waste.
 - (3) **Annual report:** An annual report covering facility activities during the previous calendar year must be submitted in accordance with Florida Administrative Code Rule 17-730.

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16. (continued)

- b. Notification of any noncompliance which may endanger health or the environment, including the release of any hazardous waste that may endanger public drinking water supplies, or the occurrence of a fire or explosion from the facility which could threaten the environment or human health outside the facility, shall be verbally submitted to the Department within 24 hours and a written submission provided within 5 days. The verbal submission within 24 hours shall contain the name, address, I.D. number and telephone number of the facility and owner or operator, the name and quantity of materials involved, the extent of injuries (if any), an assessment of actual or potential hazards, and the estimated quantity and disposition of recovered material. The written submission shall contain the following:
- (1) a description of and cause of noncompliance; and
 - (2) If not corrected, the anticipated time the noncompliance is expected to continue and steps being taken to reduce, eliminate, and prevent recurrence of the noncompliance.
- c. Reports of compliance or noncompliance with, or any progress reports on, requirements contained in any compliance schedule of this permit shall be submitted no later than 14 days following each schedule date.
- d. All reports or information required to be submitted to the Department by a hazardous waste permittee shall be signed by a person authorized to sign a permit application.

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SPECIFIC CONDITIONS:

Part I - General Operating Requirements

1. The permittee shall maintain and operate the facility to minimize the possibility of fire, explosion, or any unplanned sudden or non-sudden release of hazardous waste or constituents to air, soil, or surface water which could threaten human health or the environment. [40 CFR 264.31]
2. The permittee shall notify the Department in writing at least four weeks in advance of the date the permittee expects to receive hazardous waste from a foreign source, in accordance with 40 CFR 264.12. Notice of subsequent shipments of the same waste from the same foreign source in the same calendar year is not required.
3. This permit allows the permittee to store at the facility only those wastes specified in Attachment A. Prior to acceptance of new hazardous wastes, the permittee shall submit to the Department, for approval, a waste analysis of the proposed new waste stream. This analysis must be incorporated in the general waste analysis plan and retained on-site. [40 CFR 264.13]
4. The permittee shall follow the procedures described in the waste analysis plan, Section A-6, Part II of the permit application. [40 CFR 264.13(b)]
5. The permittee shall comply with the security provisions of 40 CFR 264.14(b)(2) and (c).
6. The permittee shall inspect the facility operating, emergency and safety equipment in accordance with the schedule approved in Section A-4.d., Part II of the permit application. The permittee shall remedy any deterioration or malfunction discovered by an inspection in accordance with the requirements of 40 CFR 264.15(c). Changes, additions, or deletions to the schedule must be approved in writing by the Department. The schedule must be maintained as part of the operating record of the facility. [40 CFR 264.15]
7. Facility personnel must successfully complete the approved training program indicated in Section A-4.e., Part II of the permit application within 6 months of employment or assignment to a facility or to a new position at the facility. Verification of this training must be kept with the personnel training records and maintained on-site. Personnel shall not work unsupervised until training has been completed. The training must be reviewed by facility personnel at least annually. [40 CFR 264.16]
8. The permittee shall comply with the general requirements of 40 CFR 264.17(a) and (b), and the location requirements of 40 CFR 264.176 and 264.198.
9. The permittee shall comply with the following conditions concerning preparedness and prevention:
 - a. At a minimum, the permittee shall equip the facility with the equipment described in the contingency plan, Section A-4.b., Part II of the permit application, as required by 40 CFR 264.32.

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9. (continued)

- b. The permittee shall test and maintain the equipment specified in Condition 9.(a) as necessary to assure its proper operation in time of emergency as required by 40 CFR 264.33.
 - c. The permittee shall maintain access to the communications or alarm system as required by 40 CFR 264.34.
 - d. At a minimum, the permittee shall maintain aisle space as shown in Figure 11 of the permit application, as required by 40 CFR 264.35.
 - e. The permittee shall maintain arrangements with state and local authorities as required by 40 CFR 264.37. If state or local officials refuse to enter into preparedness and prevention arrangements with the permittee, the permittee must document this refusal in the operating record.
10. The permittee shall comply with the following conditions concerning the contingency plan:
- a. The permittee shall immediately carry out the provisions of the contingency plan, Section A-4.b., Part II of the permit application and follow the emergency procedures described by 40 CFR 264.56, whenever there is a fire, explosion, or release of hazardous waste or hazardous waste constituents which threatens or could threaten human health or the environment. The permittee shall give proper notification if an emergency situation arises and within fifteen (15) days must submit to the Department a written report which includes all information required in 40 CFR 264.56(j).
 - b. The permittee shall comply with the requirements of 40 CFR 264.53.
 - c. The permittee shall immediately amend the contingency plan and distribute the amended plan to the appropriate agencies if any criteria in 40 CFR 264.54 are met. Amendments to the plan must be approved in writing by the Department.
 - d. The permittee shall comply with the requirements of 40 CFR 264.55, concerning the emergency coordinator.
 - e. The Department of Environmental Regulation's 24-hour emergency telephone number is (904) 488-1320. During normal business hours, the DER District Office may be contacted at (904) 798-4200.
11. The permittee shall comply with the manifest requirements of 40 CFR 264.71, 264.72, and 264.76.
12. The permittee shall maintain a written operating record at the facility which includes the following:
- the description and quantity of each hazardous waste received
 - the location of each hazardous waste within the facility, and the quantity at each location
 - the results of the waste analyses

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12. (continued)

- a summary report and details of incidents that require implementation of the contingency plan
- manifest numbers
- the results of inspections (for 3 years)
- annual certification of waste minimization
- the closure plan and closure cost estimates

These records must be maintained at the facility until completion and certification of closure. [40 CFR 264.73]

- 13.** The permittee shall maintain and operate the facility in accordance with Section D-2, Part I of the permit application (including Figures 8, 9, 10, and 11).
- 14.** The permittee shall install a temporary berm around the compacting area described in Section D-2.c., Part I of the permit application, and immediately implement spill prevention and response measures as described in Section C-13.(b),(c) and (d), Part II of the permit application.
- 15.** The permittee shall maintain compliance with 40 CFR 264, Subpart H - Financial Requirements. All submittals in response to this Specific Condition and Specific Condition IV.4. shall be submitted to:

Financial Coordinator
Hazardous Waste Regulation Section
Department of Environmental Regulation
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

- 16.** All submittals in response to this permit (except Specific Conditions I.15. and IV.4.) shall be submitted in quadruplicate to:

Hazardous Waste Supervisor
Department of Environmental Regulation
3426 Bills Road
Jacksonville, Florida 32207

- 17.** Pursuant to 40 CFR 264.73(b)(9), and Section 3005(h) of RCRA, 42 U.S.C. 6925(h), the permittee must certify, no less often than annually, that:
- a.** The permittee has a program in place to reduce the volume and toxicity of hazardous waste to the degree determined by the permittee to be economically practicable; and
 - b.** The proposed method of treatment, storage or disposal is the most practicable method available to the permittee which minimizes the present and future threat to human health and the environment.
 - c.** The permittee shall also maintain copies of certification in the facility operating record as required by 40 CFR 264.73(b)(9).

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18. The Waste Minimization program required under Specific Condition I.17.a. and b. above should as a minimum address the following topics:
- Identify each hazardous waste stream with the source of generation.
 - Types and amounts of hazardous waste that are generated at the facility.
 - Present and proposed method of treatment, storage or disposal that is available to the permittee.
 - Description of techniques implemented in the past for hazardous waste reduction and their effectiveness.
 - An evaluation of technically and economically feasible hazardous waste reduction techniques.
 - A program and schedule for implementing the selected hazardous waste reduction technique.
19. 40 CFR Part 268 identifies hazardous wastes that are restricted from land disposal and defines those limited circumstances which an otherwise prohibited waste may continue to be placed on or in a land treatment, storage or disposal unit. The permittee shall maintain compliance with the requirements of 40 CFR Part 268. Where the permittee has applied for an extension, waiver or variance under 40 CFR Part 268 the permittee shall comply with all restrictions on land disposal under this Part once the effective date for the waste has been reached pending final approval of such application.
20. A restricted waste identified in 40 CFR Part 268 Subpart C may be placed in a land disposal unit without further treatment unless the requirements of 40 CFR Part 268 Subparts C and/or D are met.
21. The storage of hazardous wastes restricted from land disposal under 40 CFR Part 268 is prohibited unless the requirements of 40 CFR Part 268 Subpart E are met.
22. All submittals modifying major engineering features of the hazardous waste storage areas shall be worded, signed and certified by a qualified, professional engineer registered in the State of Florida in accordance with 17-730.220(5), FAC.

Part II - Containers

- The permittee is allowed to store in the approved storage area only the hazardous wastes listed in Attachment A. Containers must conform to DOT specification and be managed in accordance with the approved operation plan. Containers shall be kept closed except when adding or removing waste and shall be handled in a manner that will not allow the containers to rupture or leak, in accordance with 40 CFR 264.173. If a container holding hazardous waste is not in good condition, or begins to leak, the waste shall be transferred to another container in good condition, in accordance with 40 CFR 264.171.
- The permittee shall use only those containers made of or lined with materials which will not react with and are otherwise compatible with the waste to be stored in them, as indicated in Section B-3, Part II of the permit application.
[40 CFR 264.172]

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3. The permittee shall conduct weekly visual inspections in accordance with Section B-5, Part II of the permit application (the inspection schedule), to detect leakage in the hazardous waste container storage area or its associated loading/unloading zones. [40 CFR 264.174] If, in spite of the weekly inspections, a significant deterioration of the pavement (due to occasional spills) is noted, the need for a resurfacing/seal material shall be reevaluated.
4. The permittee shall store a maximum of 72,100 gallons of waste in containers in sizes ranging from 1/2 gallon to fifty-five gallons or other D.O.T. approved containers, in the container storage area as shown in Figure 11 of the permit application (revised April 2, 1990).
5. The permittee shall notify the Department when the capacity of the container storage area reaches 90 percent, i.e., volume of 64,900 gallons.
6. For storage of drums larger than fifty-five gallons, the permittee shall not place more than four drums per pallet and shall not stack them more than two high.
7. The permittee shall comply with the waste compatibility requirements of 40 CFR 264.177, as indicated in Section B-3, Part II of the permit application.

Part III: Tanks

1. The permittee is allowed to store in the tank only those hazardous wastes specified in Attachment A.
2. The permittee shall store a maximum of 3,000 gallons of waste in the storage tank.
3. The permittee shall notify the Department when the volume of waste stored in the tank reaches ninety-five (95) percent capacity of the tank, i.e., 2,850 gallons.
4. The permittee shall not place ignitable or reactive waste in tank systems unless the waste is stored in such a way that it is protected from any material or conditions that may cause the waste to ignite or react. [40 CFR 264.198(a)]
5. The permittee shall comply with the protective distance requirements for the tank placement as set forth in Tables 2-1 through 2-6 of the National Fire Protection Association's "Flammable and Combustible Liquids Code" (1977 or 1981), as required by 40 CFR 264.198(b).
6. The permittee shall handle incompatible wastes in accordance with Section C-10, Part II, of the permit application and 40 CFR 264.199, by not introducing hazardous waste into unwashed tank systems which previously held incompatible waste or material.
7. For new tank components which may be required by the repair options of 40 CFR 264.196(f), the permittee must submit a written assessment, reviewed and certified by an independent registered professional engineer, which attests to the component's structural integrity. This assessment shall include the requirements of 40 CFR 264.192. As required in 40 CFR 264.192(b), an independent qualified inspector or independent registered professional engineer must inspect the installation.

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8. The permittee shall prevent the release of hazardous waste or hazardous constituents to the environment. The secondary containment system should be maintained according to Sections C-7, Part II of the application and shall comply with the requirements of 40 CFR 264.193, including the requirements set forth below:
- a. All new components shall have secondary containment as required by parts (b) and (c) of this condition prior to being put into service.
 - b. The secondary containment system shall meet the requirements of 40 CFR 264.193 and shall be:
 - (1) Updated to prevent any migration of wastes or accumulated liquid to the soil, groundwater or surface waters.
 - (2) Capable of detecting and collecting releases and run-on until the collected material is removed.
 - (3) Lined with materials compatible with the waste to be stored and have sufficient structural strength to sustain the stresses induced by a failure of the primary containment system as well as other stresses which may be induced by the environment.
 - (4) Placed on a foundation or base capable of providing support to the secondary containment system.
 - (5) Provided with leak detection equipment designed and operated to detect failure of either the primary or secondary containment structures or the presence of any release within 24 hours.
 - (6) Sloped or otherwise designed and operated to drain or remove liquids resulting from leaks, spills, or precipitation.
 - (7) Designed and operated, with the exception of double walled tank containment, to contain 100% of the capacity of the largest tank within its boundary and also contain the precipitation due to a 25-year, 24-hour rainfall event, if run-on control is not provided.
 - c. Ancillary equipment shall be provided with secondary containment, except as provided for in 40 CFR 264.193(f).
9. The permittee shall, as part of the general operating requirements of 40 CFR 264.194:
- a. Not place hazardous wastes or treatment reagents in a tank system if the possibility exists that this may cause the tank system to fail.
 - b. Use appropriate controls and practices to prevent spills and overflows, and
 - c. Comply with the requirements of 40 CFR 264.196 if a leak or spill occurs.

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10. The permittee shall inspect the tank system in accordance with Section C-11, Part II of the permit application and as required by 40 CFR 264.195. These requirements include:
 - a. Developing and following a schedule and procedure for inspecting overfilling controls, and
 - b. Inspecting at least once each operating day the aboveground portions of the tank system, data from leak detection or monitoring equipment, and the construction materials and area immediately surrounding the tank.
 - c. The results of the inspections in (a) and (b), of this condition shall be maintained in the operating record of the facility.
11. The permittee shall follow the procedures outlined in Section C-11, Part II, of the permit application, when a tank system or secondary containment system produces a leak or spill, or is determined to be unfit for use. These requirements include, as they are made applicable by 40 CFR 264.196:
 - a. Cessation of use; prevention of flow or addition of waste.
 - b. Removal of waste from the tank system or secondary containment system.
 - c. Containment of visible releases to the environment.
 - d. Notifications, reports.
 - e. Provision of secondary containment, repair or closure, and
 - f. Certification of major repairs.

Part IV - Closure

1. The permittee shall comply with the following conditions concerning closure:
 - a. The permittee shall close the facility as required by 40 CFR 264.111, and in accordance with the closure plan in Section B-6, C-12, and K, Part II of the permit application.
 - b. The permittee shall amend the closure plan in accordance with 40 CFR 264.112(b) whenever necessary.
 - c. In accordance with 40 CFR 264.112(d)(1), the permittee shall notify the Department at least forty-five (45) days prior to the date he expects to begin closure and submit a complete closure permit application.
[17-730.260(1), FAC]
 - d. Within 90 days after receiving the final volume of hazardous waste, the permittee shall treat or remove all hazardous waste from the site in accordance with the schedule specified in the closure plan, Sections B-6, C-12 and K, Part II, of the permit application, and in accordance with 40 CFR 264.113(a).

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1. (continued)

- e. The permittee shall decontaminate and/or dispose of all facility equipment as required by 40 CFR 264.114, 264.197, and the closure plan, Sections B-6, C-12, and K, Part II of the permit application.
2. Within ninety (90) days of the issuance of the permit, the permittee shall close the secondary storage area in accordance with the closure plan dated August 8, 1990 and 40 CFR 264.111.
3. Within thirty (30) days from completion of any closure, the permittee shall submit to the Department by certified mail or hand delivery, a certification signed by the permittee and an independent professional engineer registered in the State of Florida that the facility has been closed in accordance with the permit and specifications of the closure plan. [17-730.220(5) FAC]
4. In addition to the requirements of Specific Condition I.15., the permittee shall revise the closure cost estimate required by 40 CFR 264.142 whenever there is:
 - a change in disposal cost due to changes in the regulations, or
 - a change in the disposal facility.

Part V - Permit Modification/Renewal

1. The Department may modify, revoke and reissue, or terminate for cause, this permit in accordance with the provisions of 17-730.290, FAC. The filing of a request for a permit modification, revocation and reissuance, or termination, or the notification of planned changes or anticipated noncompliance on the part of the permittee does not stay the applicability or enforceability of any permit condition. The permittee may submit any subsequent revisions to the Department for departmental approval. Should these revisions constitute a major modification to the permit, the permittee shall meet the requirements of 17-730.290, FAC.
2. This permit may be reopened if additional information becomes available indicating that the provisions of Section 3004(u) of the Hazardous and Solid Waste Amendments (HSWA) of 1984 apply to this facility. At that time, this permit may be modified to address the requirements of Section 3004(u) of HSWA if the State has been authorized for the provisions, or alternately, the Environmental Protection Agency (EPA) would issued a separate federal permit addressing Section 3004(u) requirements.

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3. Prior to 135 days before the expiration of this permit, the permittee shall submit a complete application for renewal of the permit on forms and in a manner prescribed by the Department, unless the facility is to be closed prior to the expiration date of this permit per the requirements of FAC 17-730.300(1).

Executed in Jacksonville, Florida.

STATE OF FLORIDA DEPARTMENT
OF ENVIRONMENTAL REGULATION

Ernest E. Frey, P.E.
Deputy Assistant Secretary

Northeast District
3426 Bills Road
Jacksonville, Florida 32207

ATTACHMENT A

<u>Name</u>	<u>Hazardous Waste Code Number</u>
1,1 Dichloroethane	U076
1,2 Dichloroethane	U077
1,1,1-Trichloroethane	F001/F002/U226
1,1,2-Trichloroethane	F002/U227
1,1,2-Trichlorotrifluoroethane	F001
1,2-Dichlorobenzene	F002/U070
1,4-Dioxane	U108/D001
2-butenal	U053
2-ethoxyethanol(ethylene glycol monoethyl ether)	F005/U359
2-Nitropropane	F005/U171
Acetaldehyde	U001
Acetone	F003/U002
Acetonitrile	U003
Acetophenone	U004
Aniline	U012
Benzene	F005/U019
n-Butyl alcohol	F003/U031
Carbon Disulfide	F005/P022
Carbon Tetrachloride	F001/U211
Chlorobenzene	F002/U037
Chloroform	U044
m-Cresol	F004/U052
o-Cresol	F004/U052
p-Cresol	F004/U052
Cumene	U055
Cyclohexane	U056
Cyclohexanone	F003/U057
o-Dichlorobenzene	U070
m-Dichlorobenzene	U071
p-Dichlorobenzene	U072
Dichloroisopropyl ether	U027
Dipropylamine	U110
Ethanol	D001
Ethyl Acetate	F003/U112
Ethyl Benzene	F003
Ethyl Ether	F003/U117
Ethylene glycol	D001
Formaldehyde	U122
Furan	U124
Heptane	D001
Hexane	D001
Isoamyl alcohol	D001
Isobutyl alcohol	F005/U140
Isocetane/2,2,4-Trimethylpentane	D001
Methane, bromo-	U029
Methane, dibromo	U068
Methane, trichloro	U044
Methanol	F003/U154
Methylene Chloride	F002/U080
Methyl Ethyl Ketone	F005/U159
Methyl Isobutyl Ketone	F003/U161
Methy Pyrrole	D001

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Mineral Spirits	D001
Naphthalene	U165
Nitrobenzene	F004/U169
Nonane	D001
Octane	D001
Propanol	D001
Pentane	D001
Propane, 1,2-dichloro	U083
2-Propenal	P003
Propylene glycol	D001
Pyridine	F005/P075/U196
Tetrahydrofuran	U213
1,1,2,2-Tetrachloroethane	U209
1,1,1,2-Tetrachloroethane	U208
Tetrachloroethylene	F001/F002/U210
Toluene	F005/U220
o-Toluidine	U328
m-Toluidine	D001
p-Toluidine	U353
Trichloroethylene	F001/F002/U228
Trichlorofluoromethane	F002/U121
Trichloromethane	U044/D001
m-Xylene	F003/U239
o-Xylene	F003/U239
p-Xylene	F003/U239
Unlisted Ignitable Waste	D001
Spent Solvents	F001
Spent Solvents	F002
Spent Solvents	F003
Spent Solvents	F004
Spent Solvents	F005
Arsenic	D004
Barium	D005
Cadmium	D006
Chromium	D007
Lead	D008
Mercury	D009
Selenium	D010
Silver	D011
Endrin	D012
Lindane	D013
Methoxychlor	D014
Toxaphene	D015
2,4-D	D016
2,4,5-TP Silvex	D017
Benzene	D018
Carbon Tetrachloride	D019
Chlordane	D020
Chlorobenzene	D021
Chloroform	D022
O-Cresol	D023
M-Cresol	D024
P-Cresol	D025
Cresol	D026

Attachment A
Page three

1,4 Dichlorobenzene	D027
1,2 Dichloroethane	D028
1,1 Dichloroethylene	D029
2,4 Dinitrotoluene	D030
Heptachlor	D031
Hexachlorobenzene	D032
Hexachlorobutadiene	D033
Hexachloroethane	D034
Methylethylketone	D035
Nitrobenzene	D036
Pentachlorophenol	D037
Pyridine	D038
Tetrachloroethylene	D039
Trichloroethylene	D040
2,4,5 Trichlorophenol	D041
2,4,6 Trichlorophenol	D042
Vinylchloride	D043

Exhibit D4

RADIOACTIVE MATERIALS LICENSE FOR QUADREX

STATE OF FLORIDA
DEPARTMENT OF HEALTH AND REHABILITATIVE SERVICES
OFFICE OF RADIATION CONTROL

911120-1088

RADIOACTIVE MATERIALS LICENSE

Page 1 of 8 Pages
AMENDMENT NO. 28

Pursuant to Chapter 404, Florida Statutes, and Chapter 10D-91, Florida Administrative Code, and in reliance on statements and representations heretofore made by the licensee designated below, a license is hereby issued authorizing such licensee to receive, acquire, possess and transfer the radioactive material(s) designated below and to use such radioactive material(s) for the purpose(s) and at the place(s) designated below. This license is subject to all applicable rules, regulations and orders of the State of Florida, Department of Health and Rehabilitative Services now or hereafter in effect and to any conditions specified below.

Licensee	With reference to correspondence dated 11/15/91, State of Florida Radioactive Materials 3. License Number: 1354-1 is hereby amended in its entirety to read as follows:
1. Name: QUADREX ENVIRONMENTAL COMPANY	
2. Address: 1940 N.W. 67th Place Gainesville, FL 32606	4. Expiration date: November 30, 1995
	5. Category: 4C

- | 6. Radioactive material
(element and mass number) | 7. Chemical and/or physical form | 8. Maximum quantity licensee
may possess at any one time |
|--|---|---|
| A. Any radioactive material with an atomic number 1 through 83. | A. Any sealed source that has been approved for distribution by the U.S. Nuclear Regulatory Commission or an Agreement State. | A. 250 microcuries total; no single source to exceed 10 microcuries each. |
| B. Any radioactive material with an atomic number 84 through 95. | B. Any sealed source that has been approved for distribution by the U.S. Nuclear Regulatory Commission or an Agreement State. | B. 250 microcuries total; no single source to exceed 10 microcuries each. |
| C. Carbon 14 | C. Liquid scintillation materials. | C. See Condition 15, below. |
| D. Hydrogen 3 | D. Liquid scintillation materials. | D. See Condition 15, below. |

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STATE OF FLORIDA
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RADIOACTIVE MATERIALS LICENSE
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License Number 1354-1
AMENDMENT NO. 28
(4C) (K95)

6. Radioactive material
(element and mass
number)	7. Chemical and/or
physical form	8. Maximum quantity
licensee may
possess at any
one time
E. Iodine 125
Chromium 51
Iron 59
Sulfur 35
Phosphorus 32
Calcium 45
Sodium 22
Cobalt 57
Zinc 65
Rubidium 86
Gallium 67
Indium 111
Chlorine 36
Mercury 203
Iodine 131
Selenium 75
Germanium 68
Cadium 109
Cerium 141
Scandium 46
Copper 64
Gold 195
Technetium 99
Gadolinium 153
Tin 119
Tin 113
Phosphorus 33	E. Liquid scintillation
materials.	E. See Condition 15,
below.
F. Radon 222 and its
daughter products.	F. Liquid scintillation
material contained
in radon detection
kits only.	F. See Condition 15,
below.

9. Authorized Use.

- A. and B. To be used as calibration or reference standards.
- C. through F. Liquid scintillation materials shall be received, processed, stored and disposed of in accordance with Condition 15 of this license.

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STATE OF FLORIDA
DEPARTMENT OF HEALTH AND REHABILITATIVE SERVICES
OFFICE OF RADIATION CONTROL

RADIOACTIVE MATERIALS LICENSE
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License Number 1354-1
AMENDMENT NO. 28
(4C) (K95)

CONDITIONS

10. A. The authorized place of receipt, storage, use and processing shall be the licensee's facility located at 1940 N.W. 67th Place, Gainesville, Florida 32606.

B. Liquid scintillation fluids may be transported to Oldover Corporation's rotary kiln located at Green Cove Springs, Florida, where they are mixed with the kiln's fuel.
11. Failure to comply with the provisions of this license is a felony of the third degree pursuant to section 404.161, Florida Statutes. Also, violations may warrant an administrative fine of up to \$1,000.00 per violation per day, pursuant to section 404.162, Florida Statutes.
12. A. Licensed material shall be used by or under the supervision of and in the physical presence, at the license facility listed in Item 2, above, of Raymond Thomas, Joseph Owens, Bernhardt Warren, Jack Flaacke, Raymond Whittle, David Gardner, Orin Pelto, Thomas Owens, or Russell Pendleton.

B. The Radiation Safety Officer is Bernhardt C. Warren.
13. The licensee shall comply with the provisions of Chapter 10D-91, Florida Administrative Code, Part X, "Notices, Instructions and Reports to Workers; Inspections" and Part IV, "Standards for Protection Against Radiation."
14. Sealed sources described in Items 6, 7, 8 and 9, Subitems A and B containing licensed material shall not be opened.
15. A. Receipt, possession, storage, processing and disposal of licensed material described in Items 6, 7, 8 and 9, Subitems C and D must satisfy the following:
 1. Be received and processed in concentrations no greater than 0.05 microcuries per gram of medium;
 2. Be transported for disposal to Oldover's Corporation rotary kiln located at Green Cove Springs, Florida in concentrations no greater than 0.05 microcuries per gram of medium.

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STATE OF FLORIDA
DEPARTMENT OF HEALTH AND REHABILITATIVE SERVICES
OFFICE OF RADIATION CONTROL

RADIOACTIVE MATERIALS LICENSE
SUPPLEMENTARY SHEET

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License Number 1354-1
AMENDMENT NO. 28
(4C) (K95)

15. A. 3. The total activity processed and transported to Oldover's Corporation rotary kiln located in Green Cove Springs, Florida shall not exceed 19.9 curies in a calendar year; and
4. Be received, processed, stored and disposed of in accordance with correspondence described in Condition 22.
- B. Receipt, possession, storage, processing and disposal of licensed material described in Items 6, 7, 8 and 9, Subitems E and F must satisfy the following:
1. Be received and processed in concentrations no greater than 0.05 microcuries per gram of medium;
2. Be transported for disposal to Oldover's Corporation rotary kiln located at Green Cove Springs, Florida, in concentrations no greater than 0.002 microcuries per gram of medium.
3. The total activity processed and transported to Oldover's Corporation rotary kiln located in Green Cove Springs, Florida shall not exceed 100 millicuries in a calendar year; and
4. Be received, possessed, stored, processed and disposed of in accordance with correspondence described in Condition 22.
16. Licensed material described in Items 6, 7, 8 and 9, Subitem C through F, shall not be stored at the licensee's facility located at the address in Item 2, above, for a period greater than 180 days from the date of receipt. The licensee must maintain records of receipt and disposal, including dates, activities and isotopes for inspection by the Department of Health and Rehabilitative Services.
17. Licensed material shall be received, stored and processed in such a manner as to preclude use or access by unauthorized personnel.
18. The licensee shall notify the Department of Health and Rehabilitative Services within 48 hours of customers who submit radioactive materials not in conformance with Condition 15. This 48 hour notification may be made by telephone. The notification shall include the generator's name, address, license number, isotopes, concentrations or activities, and date and description of the materials submitted. This notification shall be made in writing to the Department of Health and Rehabilitative Services within 30 days of the date the materials are submitted to the licensee.

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STATE OF FLORIDA
DEPARTMENT OF HEALTH AND REHABILITATIVE SERVICES
OFFICE OF RADIATION CONTROL

RADIOACTIVE MATERIALS LICENSE
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License Number 1354-1
AMENDMENT NO. 28
(4C) (K95)

19. The licensee shall notify the Office of Radiation Control at least 48 hours in advance of shipping its low-level radioactive waste to a commercial treatment, storage or disposal facility. Notification shall consist of either calling (407) 297-2095 or writing the Office of Radiation Control, Department of Health and Rehabilitative Services, Post Office Box 680069, Orlando, Florida 32868-0069.
20. Individuals involved in operations which utilize, at any one time or over a three month period, radioiodine in an unsealed form that exceeds the activities specified in Table 1 of the U. S. Nuclear Regulatory Commission's Regulatory Guide 8.20 shall have bioassays performed at the following frequency and follow the corresponding actions:
- A. (I) A bioassay shall be taken within 72 hours of initial use of radioiodine and every 2 weeks thereafter. When work with radioiodine is on an infrequent basis (less frequent than every 2 weeks), a bioassay shall be taken within 10 days of the last day of use.
- (II) The licensee shall take the corresponding actions according to the action levels listed below:
- (a) If the thyroid burden at the time of measurement exceeds 0.12 microcurie of iodine 125 or 0.04 microcurie of iodine 131, the following actions shall be taken:
- (1) An investigation of the operations involved, including air and other facility surveys, shall be carried out to determine the causes of exposure and to evaluate the potential for further exposures.
 - (2) If the investigation indicates that further work in the area might result in exposure of a worker to concentrations that would cause the limiting intakes established in Section 10D-91.404, F.A.C., to be exceeded, the licensee shall restrict the worker from further exposure until the source of exposure is discovered and corrected.
 - (3) Corrective actions that will eliminate or lower the potential for further exposures shall be implemented.

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STATE OF FLORIDA
DEPARTMENT OF HEALTH AND REHABILITATIVE SERVICES
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License Number 1354-1
AMENDMENT NO. 28
(4C) (K95)

20. A. (II) (a) (4) A repeat bioassay shall be taken within 2 weeks of the previous measurement and shall be evaluated within 24 hours after the measurement in order to confirm the presence of internal radioiodine and to obtain an estimate of its effective half-life for use in estimating dose commitment.
- (5) Notification reports must be provided as required by Sections 10D-91.426, and 10D-91.428, F.A.C., or as required by conditions of the license pursuant to Section 10D-91.408, F.A.C.
- (b) If the thyroid burden at any time exceeds 0.5 microcurie of iodine 125 or 0.14 microcurie of iodine 131, the following actions shall be taken:
- (1) Carry out all steps described in A.(II)(a) of this condition.
- (2) As soon as possible, refer the case to appropriate medical consultation for recommendations regarding therapeutic procedures that may be carried out to accelerate removal of radioactive iodine from the body.
- (3) Carry out repeated measurements at approximately 1-week intervals at least until the thyroid burden is less than 0.12 microcurie of iodine 125 or 0.04 microcurie of iodine 131.
- B. (I) Bioassays may be performed quarterly, if the following conditions are satisfied:
- (a) The average thyroid burden for each individual working in a given area for which bioassays were performed pursuant to Item A.(I), above, was less than 0.12 microcurie of iodine 125, less than 0.04 microcurie of iodine 131 and less than the corresponding proportionate amount of a mixture of these nuclides during the initial 3 month period.

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STATE OF FLORIDA
DEPARTMENT OF HEALTH AND REHABILITATIVE SERVICES
OFFICE OF RADIATION CONTROL

RADIOACTIVE MATERIALS LICENSE
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License Number 1354-1
AMENDMENT NO. 28
(4C) (K95)

20. B. (I) (b) If measurements of the concentration of radioiodine in air are required as a condition of the license, the quarterly average concentration does not exceed 25 percent of the value for iodine 125, iodine 131 or a proportionate amount of a mixture of these nuclides specified in Table I, Column I of Section 10D-91.429, F.A.C.
- (c) The working conditions during the 3 month period with respect to the potential for exposure are representative of working conditions during the period in which the quarterly bioassay frequency is employed, and there is no reasonable expectation that the criteria given in B.(I)(a) and B.(I)(b) will be exceeded.
- (d) Bioassays shall be randomly distributed over the quarter and will be done within one week after a procedure involving the handling of iodine 125 or iodine 131 to provide a representative assessment of exposure conditions.
- (II) If the thyroid burden exceeds 0.12 microcurie of iodine 125 or 0.04 microcurie of iodine 131, the following actions shall be taken:
- (a) Carry out all steps as described in A.(II)(a) and A.(II)(b) of this condition.
- (b) Reinstitute bioassays every 2 weeks for at least the next three months before reestablishing quarterly bioassays.
21. The licensee shall not transfer possession and/or control of radioactive material, or products containing radioactive material as a contaminant except:
- A. By transfer to a specifically licensed recipient; or
- B. As provided otherwise by specific provision of this license pursuant to the requirements of the "Florida Control of Radiation Hazard Regulations", Chapter 10D-91, Florida Administrative Code.
22. A. Except as specifically provided otherwise by this license, the licensee shall possess and use licensed material described in items 6, 7, 8, and 9 of this license in accordance with state-ments, representations and procedures contained in the licensee's application dated August 27, 1987, signed by Susan E. McDonough, Radiation Safety Officer, and correspondence dated:

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STATE OF FLORIDA
DEPARTMENT OF HEALTH AND REHABILITATIVE SERVICES
OFFICE OF RADIATION CONTROL

RADIOACTIVE MATERIALS LICENSE
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License Number 1354-1
AMENDMENT NO. 28
(4C) (K95)

22. A. (Continued)

December 11, 1989, signed by Bernhardt C. Warren, Radiation
Safety Officer;
January 16, 1990;
April 6, 1990;
April 13, 1990;
April 13, 1990;
November 15, 1990, all signed by Bernhardt C. Warren, Vice
President, Waste Management & Regulatory Services; and
November 15, 1991. signed by Bernhardt C. Warren, Radiation
Safety Officer.

- B. The licensee shall comply with all applicable requirements of
Chapter 10D-91, Florida Administrative Code, and these regulations
shall supersede the licensee's statements in applications or
correspondence, unless the statements are more restrictive than
the regulations.

For the Office of Radiation Control

Date December 3, 1991

Licensee - White
Central Files - Canary
U.S.N.R.C. - Pink
Office - Canary
Field Files - Pink

J. Daniel Nash
Public Health Physicist Manager

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Exhibit D5

FDER USED OIL REGISTRATION FOR QUADREX

Please refer to the instructions for filling this form. The information requested here is required by law (Section 801 of the Resource Conservation and Recovery Act).

Notification of Regulated Waste Activity

United States Environmental Protection Agency

Date Received
(For Official Use Only)

I. Installation's EPA ID Number (Mark X in the appropriate box)

☐ A First Notification

☒ B Subsequent Notification
(complete item C)

C. Installation's EPA ID Number

F L D 9 8 0 7 1 1 0 7 1

II. Name of Installation (Include company and specific site name)

Q U A D R E X E N V I R O N M E N T A L C O M P A N Y

III. Location of Installation (Physical address not P.O. Box or Route Number)

S T R E E T

1 9 4 0 N W 6 7 t h P L A C E

Street (continued)

C i t y o r T o w n

G A I N E S V I L L E

S t a t e

F L

Z I P C o d e

3 2 6 0 6 -

C o u n t y C o d e

C o u n t y N a m e

A L A C H U A

IV. Installation Mailing Address (See Instructions)

S t r e e t o r P . O . B o x

P O B O X 4 1 0 0

C i t y o r T o w n

G A I N E S V I L L E

S t a t e

F L

Z I P C o d e

3 2 6 1 3 -

V. Installation Contact (Person to be contacted regarding waste activities here)

N a m e (l a s t)

F L E E T W O O D

D E N N I S

J o b T i t l e

M G R R E G C O M P L I A

9 0 4 - 3 7 3 - 6 0 6 6

VI. Installation Contact Address (See Instructions)

C o n t a c t A d d r e s s

S t r e e t o r P . O . B o x

C i t y o r T o w n

S t a t e

Z I P C o d e

VII. Ownership (See Instructions)

A. Name of Installation's Legal Owner

P U B L I C C O N O R M D U D E Y P R E S I D E N T

S t r e e t , P . O . B o x o r R o u t e N u m b e r

S A M E

C i t y o r T o w n

S t a t e

Z I P C o d e

E. Phone Number (area code and number)

9 0 4 - 3 7 3 - 6 0 6 6

B. Land Type

P

C. Owner Type

P

D. Change of Owner

Indicator

Yes No *

(Date Changed)

Month Day Year

Note: Mail completed form to the appropriate EPA Regional or State Office. (See Section III of the booklet for addresses.)

Florida Department of Environmental Regulation

Twin Towers Office Bldg. • 2600 Blair Stone Road • Tallahassee, Florida 32399-2400

Lawton Chiles, Governor

Carol M. Browner, Secretary

Ben C. Warren
Quadrex Corporation
P.O. Box 4100
Gainesville, FL 32613

July 20, 1991

BE IT KNOWN THAT
Quadrex Corporation
IS HEREBY REGISTERED AS A USED OIL
COLLECTION FACILITY

in compliance with Chapter 17-710, Florida Administrative Code (F.A.C.).

The Department of Environmental Regulation hereby issues
registration number 50428-UO on July 1, 1991.

This registration will expire June 30, 1992.

This certificate documents receipt of your annual registration
and annual report. It shall be displayed in a prominent place
at your facility. This certificate and your cancelled check
are your receipts.

Betsy Galocy
Used Oil Recycling Manager
Hazardous Waste Reduction & Management Section

Exhibit E1

LIST OF PERMITS, LICENSES, OR AUTHORIZATIONS PERTAINING TO RAMP

List of permits, licenses, or authorizations pertaining to RAMP				
Type	Number	Issue date	Expiration date	Issued by
Radioactive Materials License	Colo. 523-01	August 2, 1990	November 30, 1992	Colorado Dept. of Public Health Radiation Control Division 4210 East 11th Avenue Denver, CO 80220
TSD Type A - Interim Status	Application submitted	January 26, 1988		Colorado Dept. Public Health Waste Management Division
EPA Generators Number	COD 98 071 8985	None specified	None specified	Colorado Dept. Public Health Waste Management Division

Exhibit E2

RADIOACTIVE MATERIALS LICENSE FOR RAMP

STATE OF COLORADO
DEPARTMENT OF PUBLIC HEALTH

RADIOACTIVE MATERIALS LICENSE

Pursuant to the Radiation Control Act Title 25, Article 11, CRS 1989, Replacement Volume, as amended, and the Radiation Control Regulations, Part 3, and in reliance on statements and representations heretofore made by the licensee designated below; a license is hereby issued authorizing such licensee to transfer, receive, possess and use the radioactive material(s) designated below; and to use such radioactive material(s) for the purpose(s) and at the place(s) designated below. This license is subject to all applicable rules, regulations, and orders now or hereafter in effect of the Colorado Department of Health and to any conditions specified below.

Licensee		3. In accordance with the letter dated November 6, 1991 license number Colo. 523-01 is amended in its entirety.
1. Name: Ramp Industries, Inc.		
2. Address: 1127 West 46th Avenue Denver, Colorado 80211		4. Expiration date: November 30, 1992
		5. Reference number: -
6. Radioactive materials (element and mass no.)	7. Chemical and/or physical form	8. Maximum quantity licensee may possess at any one time
A. Any radioactive material with Atomic Nos. 3-88, inclusive, with a half-life of 120 days or less, except as specified below.	A. Any	A. 250 Curies
B. Any radioactive material with Atomic Nos. 89, 90, 94, 95, 96, and 100 with a half-life of 120 days or less, except as specified below.	B. Any	B. 20 millicuries
C. Any radioactive material with Atomic Nos. 4-88, inclusive, with a half-life of more than 120 days, except as specified below.	C. Sealed Sources, Plated Sources, or Foils	C. 3 Curies

STATE OF COLORADO
DEPARTMENT OF PUBLIC HEALTHRADIOACTIVE MATERIALS LICENSELicense Number Colo. 523-01
(Expiration Date: November 30, 1992)
Amendment No. 12

6. Radioactive materials (element and mass no.)	7. Chemical and/or physical form	8. Maximum quantity licensee may possess at any one time
D. Any radioactive material with Atomic Nos. 3-89 inclusive, and 91, with a half-life of more than 120 days, except as specified below.	D. Any	D. 3 Curies
E. Any radioactive material having atomic nos. 93, 95, 96, 97, 98, and 99 with a half-life greater than 120 days.	E. Any	E. 20 microcuries
F. Special nuclear material	F. Any	F. 10 grams
G. Source Material	G. Any	G. 250 kilograms
H. Natural and Depleted Uranium	H. Any	H. 500 kilograms
I. Hydrogen 3	I. Any	I. 10 curies
J. Hydrogen 3	J. Sealed Sources, foils, and exit signs	J. 150 curies
K. Carbon 14	K. Any	K. 500 millicuries
L. Cobalt 57	L. Any	L. 200 millicuries
M. Cobalt 60	M. Sealed Sources	M. 10 curies
N. Nickel 63	N. Sealed Sources	N. 2 curies
O. Zinc 65	O. Sealed Sources plated sources or foils	O. 100 millicuries

STATE OF COLORADO
DEPARTMENT OF PUBLIC HEALTH

RADIOACTIVE MATERIALS LICENSE

License Number Colo. 523-01
(Expiration Date: November 30, 1992)
Amendment No. 12

6. Radioactive materials (element and mass no.)	7. Chemical and/or physical form	8. Maximum quantity licensee may possess at any one time
P. Strontium 90	P. Sealed Sources	P. 3 curies
Q. Cadmium 109	Q. Sealed Sources	Q. 100 millicuries
R. Silver 110m	R. Sealed Sources plated sources or foils	R. 50 millicuries
S. Iodine 129	S. Sealed Sources	S. 10 millicuries
T. Cesium 137	T. Sealed Sources	T. 5 curies
U. Promethium 147	U. Sealed Sources	U. 10 curies
V. Gadolinium 153	V. Sealed Sources	V. 3 curies
W. Polonium 210	W. Sealed Sources plated sources or foils	W. 500 millicuries
X. Lead 210	X. Sealed Sources plated sources or foils	X. 350 millicuries
Y. Radium 226	Y. Any	Y. 100 millicuries
Z. Radium 226	Z. Sealed Sources	Z. 900 millicuries
AA. Americium 241	AA. Sealed Sources plated sources or foils	AA. 500 millicuries
BB. Cesium 137	BB. Sealed Sources	BB. 1 source, not to exceed 1.2 curies

STATE OF COLORADO
DEPARTMENT OF PUBLIC HEALTH

RADIOACTIVE MATERIALS LICENSE

License Number Colo. 523-01
(Expiration Date: November 30, 1992)
Amendment No. 12

CONDITIONS

- 9.A. The licensee may receive, pick-up, transport, store, solidify, subject to absorption and/or compaction, consolidate, package, and repackage radioactive material authorized in Items 6.A., 6.C., 6.D., 6.G., 6.H., 6.I., 6.K., 6.L., and 6.Y. as waste, in approved Department of Transportation (D.O.T.) shipping containers. Disposal of waste shall be made by transfer to authorized recipients.
- B. Radioactive material authorized in Items 6.B., 6.E., and 6.F. shall be received, solidified, packaged, and transferred to authorized recipients for disposal. Prior approval must be granted by the Radiation Control Division for any processing of special nuclear material.
- C. Radioactive material authorized in Items 6.J., 6.M. through 6.X., 6.Z., and 6.AA. shall be received, packaged, and transferred to authorized recipients for disposal.
- D. Radioactive material authorized in Item 6.BB. shall be used for survey instrument calibration.
10. Radioactive material shall be used only at 1031, 1107, and 1127 West 46th Avenue, Denver, Colorado, 80211.
11. The licensee shall comply with the provisions of the State of Colorado Rules and Regulations Pertaining to Radiation Control, Part 10, "Notices, Instructions and Reports to Workers; Inspections" and Part 4, "Standards for Protection Against Radiation".
12. Radioactive material shall be used by, or under the supervision of John E. Lucas, Ray Allen, Gregory D. Smith, or Jack F. Patterson.
- 13.A. The designated Radiation Safety Officer is John E. Lucas.
B. The designated Alternate Radiation Safety Officer is Ray Allen.
14. Radioactive material authorized by Item 6. of this license shall be stored and used in a manner that will preclude use by unauthorized personnel.
15. A total volume of 6375 cubic feet or 850 55-gallon drums of radioactive material may be possessed by RAMP Industries, Inc. This volume includes processed waste, unprocessed waste, waste in storage for decay, regulated scintillation fluids, and all other radioactive materials.

STATE OF COLORADO
DEPARTMENT OF PUBLIC HEALTHRADIOACTIVE MATERIALS LICENSELicense Number Colo. 523-01
(Expiration Date: November 30, 1992)
Amendment No. 12

16. No radioactive waste may be received for which there is no current disposal option.
17. Any radioactive waste must be returned to the generator if:
 - A. it is determined to be a mixed waste which cannot be stored for decay to background; or
 - B. it is not acceptable at a commercial low level waste disposal site.
18. The licensee is authorized to perform tests for leakage and/or contamination upon sealed sources containing radioactive material and upon devices which contain such sealed sources.
- 19.A. (1) Radioactive material authorized in Item 6.BB. shall be tested for leakage and/or contamination at intervals not to exceed six (6) months.

(2) In the absence of a certificate from a transferor indicating that a test has been made within six months prior to the transfer, a sealed source received from another person shall not be put into use until tested.
- B. The test shall be capable of detecting the presence of 0.005 microcurie of radioactive material on the test sample. The test sample shall be taken from the sealed source or from the surfaces of the device in which the sealed source is permanently mounted or stored on which one might expect contamination to accumulate. Records of leak test results shall be kept in units of microcuries and maintained for inspection by the Department.
- C. If the test reveals the presence of 0.005 microcurie or more of removable contamination, the licensee shall immediately withdraw the sealed source from use and shall cause it to be decontaminated and repaired or to be disposed of in accordance with Department regulations. A report shall be filed within 5 days of the test with the Director, Radiation Control Division, Colorado Department of Health, 4210 East 11th Avenue, Denver, Colorado 80220, describing the equipment involved, the test results, and the corrective action taken.
- D. Tests for leakage and/or contamination shall be performed by the licensee or by other persons specifically authorized by the U.S. Nuclear Regulatory Commission or an Agreement State to perform such services.
20. Sealed sources containing radioactive material shall not be opened.
- 21.A. Radioactive material authorized in Item 6.A. shall not be stored for a period exceeding 42 months.

STATE OF COLORADO
DEPARTMENT OF PUBLIC HEALTH

RADIOACTIVE MATERIALS LICENSE

License Number Colo. 523-01
(Expiration Date: November 30, 1992)
Amendment No. 12

- 21.B. (1) Radioactive material authorized in Items 6.B. through 6.H. and Items 6.N. through 6.O. (except Iridium 192 sealed sources) shall not be in the licensee's possession for a period greater than twenty-four (24) months from the date of pick-up or receipt.
- (2) Sealed sources containing Iridium 192 shall not be in the licensee's possession for a period greater than thirty-six (36) months from the date of pick-up or receipt.
- C. The licensee may also hold unsealed radioactive material for in-storage decay for a period of thirty-six (36) months from the date of receipt or 10 half-lives of the longest-lived radioactive material, whichever is shorter.
- 22.A. Individuals involved in operations which utilize, at any one time, more than 50 millicuries of I-125 and/or I-131 or unvented laboratory operations involving 10 mCi of I-125 and/or I-131 in a noncontained form shall have bioassays performed within one week following a single operation. Records of the bioassays shall be maintained for inspection by the Department and the action points listed below shall be observed.
- B. Whenever the thyroid burden at the time of measurement exceeds 0.12 microcuries of I-125 or 0.04 microcuries of I-131, the following actions shall be taken:
- (1) An investigation of the operations involved, including ventilation surveys shall be carried out to determine the causes of exposure and to evaluate the potential for further exposures.
- (2) If the investigation indicates that further work in the area might result in exposure of a worker to concentrations that are excessive, the licensee shall restrict the worker from further exposure until the source of exposure is discovered and corrected.
- (3) Corrective actions that will eliminate or lower the potential for further exposures shall be implemented.
- (4) A repeat bioassay shall be taken within 1 week of the previous measurement in order to confirm the effectiveness of the corrective action taken or to verify internal radioiodines present.
- (5) Reports or notification shall be provided as required by RH 4.29 and 4.34 of the State of Colorado Rules and Regulations Pertaining to Radiation Control.

STATE OF COLORADO
DEPARTMENT OF PUBLIC HEALTH

RADIOACTIVE MATERIALS LICENSE

License Number Colo. 523-01
Expiration Date: November 30, 1992)
Amendment No. 12

22.C. If the thyroid burden at any time exceeds 0.5 microcuries of I-125 or 0.14 microcuries of I-131, the following actions shall be taken:

(1) Prevent the individual from any further handling of I-125 or I-131 until the thyroid burden is below the above limits.

(2) As soon as possible, refer the case to appropriate medical consultation for recommendations regarding therapeutic procedures that may be carried out to accelerate removal of radioactive iodine from the body. This should be done within 2-3 hours after exposure when the time of exposure is known so that any prescribed thyroid blocking agent would be effective.

(3) Carry out repeated measurements at approximately 1-week intervals at least until the thyroid burden is less than 0.12 microcuries of I-125 or 0.04 microcuries of I-131.

23.A. Individuals involved in operations which utilize, at any one time, more than 100 millicuries of Hydrogen 3 in a non-contained form, other than metallic foil, shall have bioassays performed within one week following a single operation and at weekly intervals for continuing operations. Records of the bioassays shall be maintained for inspection by the Department and the action points listed below shall be observed.

B. (1) Tritium shall not be used in such a manner as to cause any individual to receive a radiation exposure such that urinary excretion rates exceed 28 microcuries of tritium per liter when averaged over a calendar quarter.

(2) Urinalysis shall be performed at weekly intervals on all individuals who work in the restricted areas of facilities in which tritium is used. If the average concentration of tritium in urine for any single individual during a calendar quarter is less than 10 microcuries per liter, urinalysis may be performed on that individual at monthly intervals for the following calendar quarter and may continue at monthly intervals so long as the average concentration in the calendar quarter remains below 10 microcuries per liter. The urine specimen shall be collected on the same day of the week insofar as possible.

(3) A report of an average concentration in excess of the limit specified in B. (1) above for any individual shall be filed, in writing, within thirty (30) days of the end of the calendar quarter with the Director, Radiation Control Division, Colorado Department of Health, 4210 East 11th Avenue, Denver, Colorado 80220. The report shall contain the results of all urinalyses for the individual during the calendar quarter, the cause of the excessive concentrations, and the corrective steps taken or planned to assure against a recurrence.

(4) Any single urinalysis which discloses a concentration of greater than 50 microcuries per liter shall be reported, in writing, within seven (7) days of the licensee's receipt of the results, to the Director, Radiation Control Division, Colorado Department of Health, 4210 East 11th Avenue, Denver, Colorado 80220.

STATE OF COLORADO
DEPARTMENT OF PUBLIC HEALTH
RADIOACTIVE MATERIALS LICENSE

License Number Colo. 523-01
(Expiration Date: November 30, 1992)
Amendment No. 12

- 24.A. The licensee may transport radioactive material or deliver radioactive material to a carrier for transport, in accordance with the provisions of RH 17.5 of the State of Colorado Rules and Regulations Pertaining to Radiation Control, "Transportation of Licensed Material".
- B. The licensee is authorized to transport radioactive material for eventual transfer to persons licensed by the U.S. Nuclear Regulatory Commission or an Agreement State to perform radioactive waste disposal services, and that are transported in accordance with RH 17.5 of the State of Colorado Rules and Regulations Pertaining to Radiation Control.
- C. The transportation of Colorado radioactive materials shall be subject to all applicable regulations of the Colorado Public Utilities Commission, Colorado Department of Highways, Colorado Department of Public Safety, Colorado Department of Revenue (Port of Entry), U.S. Department of Transportation, and other agencies of the United States having jurisdiction. When the U.S. Department of Transportation Regulations (Title 49, Chapter I, Code of Federal Regulations) are not applicable to shipments by land of Colorado radioactive material by reason of the fact that the transportation does not occur in interstate or foreign commerce, the licensee must be in compliance with the requirements relating to packaging of the radioactive material, marking and labeling of the package, placarding of the transport vehicle, and accident reporting set forth in the regulations of the U.S. Department of Transportation.
- 25.A. The licensee shall maintain in force a surety pursuant to RH 3.9.5.1 of the Regulations for the decommissioning and decontamination at the site and buildings at the storage area. This surety is subject to yearly review for adequacy by the Department.
- B. The decommissioning and decontamination surety shall be maintained sufficient to fully comply with all conditions of this License, the Regulations, and 6 CCR 1007-1. The Surety Agreement entered into between the licensee and the State is hereby incorporated by reference as a condition of the license.
- C. As of April 30, 1992, a surety of \$11,654.37 must be on deposit for RAMP Industries in a trust account with Central Bank National Association.
- D. As of June 30, 1991 a surety of \$92,588.56 must be on deposit with the Department for RAMP Industries.
- D. Additions to the surety account in the amount of \$5,000.00 shall be made by RAMP Industries on a quarterly basis.

STATE OF COLORADO
DEPARTMENT OF PUBLIC HEALTHRADIOACTIVE MATERIALS LICENSELicense Number Colo. 523-01
(Expiration Date: November 30, 1992)
Amendment No. 12

26. The transportation of radioactive materials within the DOT Specification 20WC packaging shall be in accordance with the limitations and requirements specified in the DOT-E 9581 exemption.
27. Within three months of the issuance of this license or amendment the licensee must furnish this Division evidence of the licensee's ability to lawfully dispose of the Radium source(s) possessed by the licensee. The evidence must include the name and address of the company/licensee to which the source(s) would be sent for disposal during the period of time this license is valid. The evidence must also include the ability of the receiving company/licensee to receive such source(s). The ability to dispose of the Radium source(s), and documents supporting that ability, must be maintained by the licensee until lawful disposal of the Radium source(s) has been completed.
28. All low-level radioactive waste, which was generated outside the Rocky Mountain Compact Region and was imported into the Compact Region by Ramp Industries, Inc., shall be removed from the Compact Region prior to January 1, 1993.
29. Prior to the use of licensed materials outside the State of Colorado the licensee shall comply with the applicable provisions of 10 CFR 150.20 or if the use shall take place in an Agreement State the licensee shall comply with the applicable provisions of that State's reciprocity requirements.
30. Except as specifically provided otherwise by this license, the licensee shall possess and use radioactive materials described in Items 6., 7., and 8. of this license in accordance with statements, representations, and procedures contained in:
- A. The applications and attachments dated October 28, 1987; November 25, 1987 (mR services); and
 - B. The license correspondence and attachments dated November 15, 1982; June 8, 1983; November 6, 1984; December 10, 1985; February 16, 1988; and February 17, 1988; March 9, 1990; March 15, 1990; April 5, 1990; August 2, 1990; August 22, 1990; January 31, 1991; March 14, 1991; November 6, 1991; December 10, 1991; December 19, 1991; January 9, 1992; and February 28, 1992; and
 - C. The Ramp Industries Contingency Plan (received November 27, 1987).

The State of Colorado Rules and Regulations Pertaining to Radiation Control shall govern the licensee's statements in applications or letters, unless the statements are more restrictive than the regulations.

FOR THE COLORADO DEPARTMENT OF HEALTH

Date May 22, 1992
OR-RH-18By W. J. Lamb

Exhibit E3

RCRA PART A PERMIT FOR RAMP

FORM 1 GENERAL		U.S. ENVIRONMENTAL PROTECTION AGENCY GENERAL INFORMATION Consolidated Permits Program (Read the "General Instructions" before starting.)		I. EPA I.D. NUMBER FICOD98071898S	
II. POLLUTANT CHARACTERISTICS		GENERAL INSTRUCTIONS If a preprinted label has been provided, affix it in the designated space. Review the information carefully; if any of it is incorrect, or through it and enter the correct data in appropriate fill-in area below. Also, if any the preprinted data is absent (the area to left of the label space lists the information that should appear), please provide it in proper fill-in area(s) below. If the label is complete and correct, you need not complete items I, III, V, and VI (except VI-B which must be completed regardless). Complete items if no label has been provided. Refer the instructions for detailed item descriptions and for the legal authorizations under which this data is collected.			
III. FACILITY NAME V. FACILITY MAILING ADDRESS VI. FACILITY LOCATION		PLEASE PLACE LABEL IN THIS SPACE			

INSTRUCTIONS: Complete A through J to determine whether you need to submit any permit application forms to the EPA. If you answer "yes" to any questions, you must submit this form and the supplemental form listed in the parenthesis following the question. Mark "X" in the box in the third column if the supplemental form is attached. If you answer "no" to each question, you need not submit any of these forms. You may answer "no" if your activity is excluded from permit requirements; see Section C of the instructions. See also, Section D of the instructions for definitions of bold-faced terms.

SPECIFIC QUESTIONS	MARK "X"			SPECIFIC QUESTIONS	MARK "X"		
	YES	NO	ATTACHED		YES	NO	ATTACHED
A. Is this facility a publicly owned treatment works which results in a discharge to waters of the U.S.? (FORM 2A)	X			B. Does or will this facility (either existing or proposed) include a concentrated animal feeding operation or aquatic animal production facility which results in a discharge to waters of the U.S.? (FORM 2B)		X	
C. Is this a facility which currently results in discharges to waters of the U.S. other than those described in A or B above? (FORM 2C)	X			D. Is this a proposed facility (other than those described in A or B above) which will result in a discharge to waters of the U.S.? (FORM 2D)		X	
E. Does or will this facility treat, store, or dispose of hazardous wastes? (FORM 3)	X			F. Do you or will you inject at this facility industrial or municipal effluent below the lowermost stratum containing, within one quarter mile of the well bore, underground sources of drinking water? (FORM 4)		X	
G. Do you or will you inject at this facility any produced water or other fluids which are brought to the surface in connection with conventional oil or natural gas production, inject fluids used for enhanced recovery of oil or natural gas, or inject fluids for storage of liquid hydrocarbons? (FORM 4)	X			H. Do you or will you inject at this facility fluids for special processes such as mining of sulfur by the Frasch process, solution mining of minerals, in situ combustion of fossil fuel, or recovery of geothermal energy? (FORM 4)		X	
I. Is this facility a proposed stationary source which is one of the 28 industrial categories listed in the instructions and which will potentially emit 100 tons per year of any air pollutant regulated under the Clean Air Act and may affect or be located in an attainment area? (FORM 5)	X			J. Is this facility a proposed stationary source which is NOT one of the 28 industrial categories listed in the instructions and which will potentially emit 250 tons per year of any air pollutant regulated under the Clean Air Act and may affect or be located in an attainment area? (FORM 5)			

III. NAME OF FACILITY 1 RAMP INDUSTRIES INCORPORATED	
IV. FACILITY CONTACT A. NAME & TITLE (last, first, & title) 2 LUCAS JOHN E. MANAGER B. PHONE (area code & no.) 303 480 1509	
V. FACILITY MAILING ADDRESS A. STREET OR P.O. BOX 3 1127 WEST 46th AVE. B. CITY OR TOWN 4 DENVER C. STATE CO D. ZIP CODE 80211	
VI. FACILITY LOCATION A. STREET, ROUTE NO. OR OTHER SPECIFIC IDENTIFIER 5 1127 WEST 46th AVE. B. COUNTY NAME DENVER C. CITY OR TOWN 6 DENVER D. STATE CO E. ZIP CODE 80211 F. COUNTY CODE (if known)	

CONTINUED FROM THE FRONT

VII. SIC CODES (4-digit, in order of priority)

A. FIRST		B. SECOND	
7	9 9 9 9 (specify) Non-Classifiable	7	(specify)
C. THIRD		D. FOURTH	
(specify)	(specify)	(specify)	(specify)

VIII. OPERATOR INFORMATION

A. NAME		B. Is the name listed in Item VIII-A also the owner?	
8 RAMP INDUSTRIES INCORPORATED		☒ YES ☐ NO	
C. STATUS OF OPERATOR (Enter the appropriate letter into the answer box; if "Other", specify.)		D. PHONE (area code & no.)	
F = FEDERAL M = PUBLIC (other than federal or state) S = STATE O = OTHER (specify) P = PRIVATE		3 0 3 4 8 0 1 4 8 1	
E. STREET OR P.O. BOX			
1 1 2 7 W E S T 4 6 t h A V E N U E			
F. CITY OR TOWN		G. STATE	H. ZIP CODE
3 D E N V E R		C O	8 0 2 1 1
		IX. INDIAN LAND	
		Is the facility located on Indian lands? ☐ YES ☐ NO	

X. EXISTING ENVIRONMENTAL PERMITS

A. NPDES (Discharges to Surface Water)		D. PSD (Air Emissions from Proposed Sources)	
9 I N I	9 I P I		
B. UIC (Underground Injection of Fluids)		E. OTHER (specify)	
9 I U I	9 I	(specify)	
C. RCRA (Hazardous Wastes)		E. OTHER (specify)	
9 I R I	9 I I	S E E A T T A C H M E N T S	

MAP

Attach to this application a topographic map of the area extending to at least one mile beyond property boundaries. The map must show the outline of the facility, the location of each of its existing and proposed intake and discharge structures, each of its hazardous waste treatment, storage, or disposal facilities, and each well where it injects fluids underground. Include all springs, rivers and other surface water bodies in the map area. See instructions for precise requirements.

XII. NATURE OF BUSINESS (provide a brief description)

See Attachments

XIII. CERTIFICATION (see instructions)

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this application and all attachments and that, based on my inquiry of those persons immediately responsible for obtaining the information contained in the application, I believe that the information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

A. NAME & OFFICIAL TITLE (type or print)		B. SIGNATURE	C. DATE SIGNED
Daniel E. Caulk President		David E. Caulk President	1-26-88

COMMENTS FOR OFFICIAL USE ONLY

C	
---	--

FORM 3	EPA	U.S. ENVIRONMENTAL PROTECTION AGENCY HAZARDOUS WASTE PERMIT APPLICATION Consolidated Permits Program (This information is required under Section 3005 of RCRA.)	I. EPA I.D. NUMBER <div style="border: 1px solid black; padding: 2px;"> FIC 0 D 9 8 0 7 1 8 9 8 5 1 </div>
RCRA			
FOR OFFICIAL USE ONLY			
APPLICATION APPROVED	DATE RECEIVED (yr. mo. & day)	COMMENTS	

II. FIRST OR REVISED APPLICATION

Place an "X" in the appropriate box in A or B below (mark one box only) to indicate whether this is the first application you are submitting for your facility or revised application. If this is your first application and you already know your facility's EPA I.D. Number, or if this is a revised application, enter your facility's EPA I.D. Number in Item I above.

A. FIRST APPLICATION (place an "X" below and provide the appropriate date)

- ☒ 1. EXISTING FACILITY (See instructions for definition of "existing" facility. Complete item below.)

- ☐ 2. NEW FACILITY (Complete item below.)

FOR EXISTING FACILITIES, PROVIDE THE DATE (yr., mo., & day) OPERATION BEGAN OR THE DATE CONSTRUCTION COMMENCED (use the boxes to the left)

FOR NEW FACILITY PROVIDE THE DATE (yr., mo., & day) OPERATION BEGAN OR IS EXPECTED TO BEG

B. REVISED APPLICATION (place an "X" below and complete item 1 above)

- ☐ 1. FACILITY HAS INTERIM STATUS

- ☐ 2. FACILITY HAS A RCRA PERMIT

III. PROCESSES - CODES AND DESIGN CAPACITIES

A. PROCESS CODE - Enter the code from the list of process codes below that best describes each process to be used at the facility. Ten lines are provided for entering codes. If more lines are needed, enter the code(s) in the space provided. If a process will be used that is not included in the list of codes below, the describe the process (including its design capacity) in the space provided on the form (Item III-C).

B. PROCESS DESIGN CAPACITY - For each code entered in column A enter the capacity of the process.

1. AMOUNT - Enter the amount.

2. UNIT OF MEASURE - For each amount entered in column B(1), enter the code from the list of unit measure codes below that describes the unit of measure used. Only the units or measure that are listed below should be used.

PROCESS	PRO- CESS CODE	APPROPRIATE UNITS OF MEASURE FOR PROCESS DESIGN CAPACITY	PROCESS	PRO- CESS CODE	APPROPRIATE UNITS OF MEASURE FOR PROCESS DESIGN CAPACITY
Storage:			Treatment:		
CONTAINER (barrel, drum, etc.)	501	GALLONS OR LITERS	TANK	T01	GALLONS PER DAY OR LITERS PER DAY
TANK	502	GALLONS OR LITERS	SURFACE IMPOUNDMENT	T02	GALLONS PER DAY OR LITERS PER DAY
WASTE PILE	503	CUBIC YARDS OR CUBIC METERS	INCINERATOR	T03	TONS PER HOUR OR METRIC TONS PER HOUR; GALLONS PER HOUR OR LITERS PER HOUR
SURFACE IMPOUNDMENT	504	GALLONS OR LITERS	OTHER (Use for physical, chemical, thermal or biological treatment processes not occurring in tanks, surface impoundments or inciner- ators. Describe the processes in the space provided; (Item III-C).)	T04	GALLONS PER DAY OR LITERS PER DAY
Disposal:					
INJECTION WELL	D79	GALLONS OR LITERS			
LANDFILL	D80	ACRE-FEET (the volume that would cover one acre to a depth of one foot); OR HECTARE-METER			
LAND APPLICATION	D81	ACRES OR HECTARES			
OCEAN DISPOSAL	D82	GALLONS PER DAY OR LITERS PER DAY			
SURFACE IMPOUNDMENT	D83	GALLONS OR LITERS			
UNIT OF MEASURE	CODE	UNIT OF MEASURE	UNIT OF MEASURE	CODE	UNIT OF MEASURE
GALLONS	G	LITERS PER DAY	V	ACRE-FEET	
LITERS	L	TONS PER HOUR	D	HECTARE-METER	
CUBIC YARDS	Y	METRIC TONS PER HOUR	W	ACRES	
CUBIC METERS	C	GALLONS PER HOUR	E	HECTARES	
GALLONS PER DAY	U	LITERS PER HOUR	H		

EXAMPLE FOR COMPLETING ITEM III (shown in line numbers X-1 and X-2 below): A facility has two storage tanks, one tank can hold 200 gallons and other can hold 400 gallons. The facility also has an incinerator that can burn up to 20 gallons per hour.

1	C	DUP	FAC C	11	12	13	14	15	16	17	18	19
LINE NUMBER	A. PRO- CESS CODE (from list above)	B. PROCESS DESIGN CAPACITY		FOR OFFICIAL USE ONLY	LINE NUMBER	A. PRO- CESS CODE (from list above)	B. PROCESS DESIGN CAPACITY		FOR OFFICIAL USE ONLY			
		1. AMOUNT (specify)	2. UNIT OF MEAS- URE (enter code)				1. AMOUNT	2. UNIT OF MEAS- URE (enter code)				
X-1	S 0 2	600	G		5							
X-2	T 0 3	20	E		6							
1	S 0 1	96	G		7							
2	S 0 1	750	G		8							
3	T 0 1	262.5	G		9							
4					10							

III. PROCESSES (continued) C. SPACE FOR ADDITIONAL PROCESS CODES OR FOR DESCRIBING OTHER PROCESSES (code "T04"). FOR EACH PROCESS ENTERED HERE INCLUDE DESIGN CAPACITY.

SEE ATTACHMENTS

IV. DESCRIPTION OF HAZARDOUS WASTES

- A. EPA HAZARDOUS WASTE NUMBER — Enter the four-digit number from 40 CFR, Support D for each listed hazardous waste you will handle. If you handle hazardous wastes which are not listed in 40 CFR, Support D, enter the four-digit number(s) from 40 CFR, Support C that describes the characteristics and/or the toxic contaminants of those hazardous wastes.
- B. ESTIMATED ANNUAL QUANTITY — For each listed waste entered in column A estimate the quantity of that waste that will be handled on an annual basis. For each characteristic or toxic contaminant entered in column A estimate the total annual quantity of all the non-listed waste(s) that will be handled which possess that characteristic or contaminant.
- C. UNIT OF MEASURE — For each quantity entered in column B enter the unit of measure code. Units of measure which must be used and the appropriate codes are:

ENGLISH UNIT OF MEASURE	CODE	METRIC UNIT OF MEASURE	CODE
POUNDS	P	KILOGRAMS	K
TONS	T	METRIC TONS	M

If facility records use any other unit of measure for quantity, the units of measure must be converted into one of the required units of measure taking into account the appropriate density or specific gravity of the waste.

D. PROCESSES

1. PROCESS CODES:

For listed hazardous waste: For each listed hazardous waste entered in column A select the code(s) from the list of process codes contained in Item III to indicate how the waste will be stored, treated, and/or disposed of at the facility.

For non-listed hazardous wastes: For each characteristic or toxic contaminant entered in column A, select the code(s) from the list of process codes contained in Item III to indicate all the processes that will be used to store, treat, and/or dispose of all the non-listed hazardous wastes that possess that characteristic or toxic contaminant.

Note: Four spaces are provided for entering process codes. If more are needed: (1) Enter the first three as described above; (2) Enter "000" in the extreme right box of Item IV-D(1); and (3) Enter in the space provided on page 4, the line number and the additional code(s).

2. PROCESS DESCRIPTION: If a code is not listed for a process that will be used, describe the process in the space provided on the form.

NOTE: HAZARDOUS WASTES DESCRIBED BY MORE THAN ONE EPA HAZARDOUS WASTE NUMBER — Hazardous wastes that can be described by more than one EPA Hazardous Waste Number shall be described on the form as follows:

- Select one of the EPA Hazardous Waste Numbers and enter it in column A. On the same line complete columns B, C, and D by estimating the total annual quantity of the waste and describing all the processes to be used to treat, store, and/or dispose of the waste.
- In column A of the next line enter the other EPA Hazardous Waste Number that can be used to describe the waste. In column D(2) on that line enter "included with above" and make no other entries on that line.
- Repeat step 2 for each other EPA Hazardous Waste Number that can be used to describe the hazardous waste.

EXAMPLE FOR COMPLETING ITEM IV (shown in line numbers X-1, X-2, X-3, and X-4 below) — A facility will treat and dispose of an estimated 900 pounds per year of chrome shavings from leather tanning and finishing operation. In addition, the facility will treat and dispose of three non-listed wastes. Two wastes are corrosive only and there will be an estimated 200 pounds per year of each waste. The other waste is corrosive and ignitable and there will be an estimated 100 pounds per year of that waste. Treatment will be in an incinerator and disposal will be in a landfill.

LINE NO.	A. EPA HAZARDOUS WASTE NO. (enter code)	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE (enter code)	D. PROCESSES	
				1. PROCESS CODES (enter)	2. PROCESS DESCRIPTION (If a code is not entered in D(1))
X-1	K 0 5 4	900	P	T 0 3 D 8 0	
X-2	D 0 0 2	400	P	T 0 3 D 8 0	
X-3	D 0 0 1	100	P	T 0 3 D 8 0	
X-4	D 0 0 2				included with above

EPA I.D. NUMBER (enter from page 1)										FOR OFFICIAL USE ONLY									
W 0 0 0 0 0 7 1 0 0 0 5										W 1 2 1 2 D U P									
IV. DESCRIPTION OF HAZARDOUS WASTES (continued)																			
LINE NO.	A. EPA HAZARD. WASTE NO. (enter code)	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE (enter code)	D. PROCESSES															
				1. PROCESS CODES (enter)								2. PROCESS DESCRIPTION (if a code is not entered in D(1))							
1	F 0 0 0 3	20,000	G	S 0 1															
2	F 0 0 0 5	Included in above	G	S 0 1															
3	D 0 0 0 1	Included in above	G	S 0 1															
4																			
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26																			

IV. DESCRIPTION OF HAZARDOUS WASTES (continued)

E. USE THIS SPACE TO LIST ADDITIONAL PROCESS CODES FROM ITEM D(1) ON PAGE 3.

EPA I.D. NO. (enter from page 1)

F C 01 D 19 8 0 17 1 8 19 8 5 6

V. FACILITY DRAWING

All existing facilities must include in the space provided on page 5 a scale drawing of the facility (see instructions for more detail).

VI. PHOTOGRAPHS

All existing facilities must include photographs (aerial or ground-level) that clearly delineate all existing structures; existing storage, treatment and disposal areas; and sites of future storage, treatment or disposal areas (see instructions for more detail).

VII. FACILITY GEOGRAPHIC LOCATION

LATITUDE (degrees, minutes, & seconds)

LONGITUDE (degrees, minutes, & seconds)

39 46 49 N

105 00 00 W

VIII. FACILITY OWNER

☐ A. If the facility owner is also the facility operator as listed in Section VIII on Form 1, "General Information", place an "X" in the box to the left and skip to Section IX below.

☐ B. If the facility owner is not the facility operator as listed in Section VIII on Form 1, complete the following items:

1. NAME OF FACILITY'S LEGAL OWNER

2. PHONE NO. (area code & no.)

E DMD Industries Inc

303-480-1500

3. STREET OR P.O. BOX

4. CITY OR TOWN

5. ST.

6. ZIP CODE

F 1127 West 46th Avenue

G Denver

CO

80211

IX. OWNER CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

A. NAME (print or type)

Daniel E. Caulk

B. SIGNATURE

Daniel E. Caulk President

C. DATE SIGNED

1-26-88

X. OPERATOR CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

A. NAME (print or type)

Daniel E. Caulk

B. SIGNATURE

Daniel E. Caulk President

C. DATE SIGNED

1-26-88

Exhibit E4

HAZARDOUS WASTES ACCEPTABLE FOR RECEIPT AT RAMP

1.3 EPA Waste Codes Accepted

The RAMP facility receives RCRA waste in the following EPA waste codes:

- D001 Wastes meeting ignitability criteria per Section 251.21.
- F003 Spent nonhalogenated solvents (xylene, acetone, ethyl acetate, ethyl benzene, ethyl ether, methyl isobutyl ketone, n-butyl alcohol, cyclohexanone, and methanol) and still bottoms from their recovery.
- F005 Spent nonhalogenated solvents (toluene, methyl ethyl ketone, carbon disulfide, isobutanol, and pyridine) and still bottoms from recovery.

Exhibit F1

**LIST OF PERMITS, LICENSES, OR AUTHORIZATIONS
PERTAINING TO ENVIROCARE**

List of permits, licenses, or authorizations pertaining to Envirocare				
Type	Number	Issue date	Expiration date	Issued by
Radioactive Materials License	UT 2300249	August 1989	February 28, 1996	Utah Dept. of Environmental Quality Division of Radiation Control
TSD Type B ~ Hazardous Waste Permit	UTD 98 259 8898	November 30, 1990	November 30, 2000	Utah Dept. of Environmental Quality Division of Solid & Hazardous Waste
EPA Generators Number	UTD 98 259 8898	March 3, 1989	NA	Utah Dept. of Environmental Quality Division of Solid & Hazardous Waste

Exhibit F2

RADIOACTIVE MATERIALS FOR LICENSE FOR ENVIROCARE

UTAH DEPARTMENT OF ENVIRONMENTAL QUALITY
DIVISION OF RADIATION CONTROL
RADIOACTIVE MATERIAL LICENSE

Pursuant to Section 19-3-104 of the Utah Code Annotated 1953, and the Utah Department of Environmental Quality Rules for the Control of Ionizing Radiation, and in reliance of statements and representations heretofore made by the licensee designated below, a license is hereby issued authorizing such licensee to transfer, receive, possess and use the radioactive material designated below; and to use such radioactive material for the purpose(s) and at the place(s) designated below. This license is subject to all applicable rules, and orders now or hereafter in effect and to any conditions specified below.

LICENSEE		
1. Name	Envirocare of Utah, Inc.	) 3. License Number
		) UT 2300249
		) Amendment #11, in its entirety
2. Address	215 South State Street	) 4. Expiration Date
	Suite 1160	) February 28, 1996
	Salt Lake City, Utah 84111	) 5. License Category 4-a

6. Radioactive Material (Element and Mass Number)	7. Chemical and/or Physical Form	8. Maximum Concentration In Waste for Disposal
A. Silver-110m	A. Volumetric bulky materials or structural debris	A. 5.6E+02 pCi/g
B. Americium-241	B. Volumetric bulky materials or structural debris	B. 2.3E+02 pCi/g
C. Americium-243	C. Volumetric bulky materials or structural debris	C. 1.7E+03 pCi/g
D. Beryllium-7	D. Volumetric bulky materials or structural debris	D. 3.8E+04 pCi/g
E. Calcium-45	E. Volumetric bulky materials or structural debris	E. 4.0E+08 pCi/g
F. Cadmium-109	F. Volumetric bulky materials or structural debris	F. 4.6E+04 pCi/g
G. Cobalt-56	G. Volumetric bulky materials or structural debris	G. 3.6E+02 pCi/g
H. Cobalt-57	H. Volumetric bulky materials or structural debris	H. 1.9E+04 pCi/g

UTAH DIVISION OF RADIATION CONTROL
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6. Radioactive Material (Element and Mass Number)	7. Chemical and/or Physical Form	8. Maximum Concentration In Waste for Disposal
I. Cobalt-58	I. Volumetric bulky materials or structural debris	I. 1.6E+03 pCi/g
J. Cobalt-60	J. Volumetric bulky materials or structural debris	J. 3.6E+02 pCi/g
K. Chromium-51	K. Volumetric bulky materials or structural debris	K. 6.8E+04 pCi/g
L. Cesium-134	L. Volumetric bulky materials or structural debris	L. 1.2E+03 pCi/g
M. Cesium-137	M. Volumetric bulky materials or structural debris	M. 5.6E+02 pCi/g
N. Europium-152	N. Volumetric bulky materials or structural debris	N. 1.7E+03 pCi/g
O. Europium-154	O. Volumetric bulky materials or structural debris	O. 1.4E+03 pCi/g
P. Iron-55	P. Volumetric bulky materials or structural debris	P. 1.8E+06 pCi/g
Q. Mercury-203	Q. Volumetric bulky materials or structural debris	Q. 1.0E+04 pCi/g
R. Potassium-40	R. Volumetric bulky materials or structural debris	R. 1.0E+04 pCi/g
S. Iridium-192	S. Volumetric bulky materials or structural debris	S. 2.5E+03 pCi/g
T. Manganese-54	T. Volumetric bulky materials or structural debris	T. 5.6E+03 pCi/g

G-205

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6. Radioactive Material (Element and Mass Number)	7. Chemical and/or Physical Form	8. Maximum Concentration In Waste for Disposal
U. Niobium-94	U. Volumetric bulky materials or structural debris	U. 1.6E+02 pCi/g
V. Nickel-59	V. Volumetric bulky materials or structural debris	V. 7.0E+02 pCi/g
W. Nickel-63	W. Volumetric bulky materials or structural debris	W. 2.0E+06 pCi/g
X. Lead-210	X. Volumetric bulky materials or structural debris	X. 2.3E+05 pCi/g*
Y. Polonium-210	Y. Volumetric bulky materials or structural debris	Y. 2.0E+04 pCi/g
Z. Radium-226	Z. Volumetric bulky materials or structural debris	Z. 2.0E+03 pCi/g*
AA. Radium-228	AA. Volumetric bulky materials or structural debris	AA. 1.8E+03 pCi/g
BB. Radium-228 1 year	BB. Volumetric bulky materials or structural debris	BB. 1.2E+03 pCi/g*
CC. Radium-228 5 years	CC. Volumetric bulky materials or structural debris	CC. 6.7E+02 pCi/g*
DD. Radium-228 10 years	DD. Volumetric bulky materials or structural debris	DD. 5.6E+02 pCi/g*
EE. Ruthenium-106	EE. Volumetric bulky materials or structural debris	EE. 1.9E+04 pCi/g*
FF. Antimony-124	FF. Volumetric bulky materials or structural debris	FF. 7.9E+02 pCi/g

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6. Radioactive Material (Element and Mass Number)	7. Chemical and/or Physical Form	8. Maximum Concentration In Waste for Disposal
GG. Antimony-125	GG. Volumetric bulky materials or structural debris	GG. 5.3E+03 pCi/g
HH. Tin-113	HH. Volumetric bulky materials or structural debris	HH. 7.3E+05 pCi/g
II. Strontium-90	II. Volumetric bulky materials or structural debris	II. 2.0E+04 pCi/g
JJ. Thorium-230	JJ. Volumetric bulky materials or structural debris	JJ. 1.5E+04 pCi/g
KK. Thorium-232	KK. Volumetric bulky materials or structural debris	KK. 6.8E+02 pCi/g*
LL. Uranium-234	LL. Volumetric bulky materials or structural debris	LL. 3.7E+04 pCi/g
MM. Uranium-235	MM. Volumetric bulky materials or structural debris	MM. 7.7E+02 pCi/g
NN. Uranium-236	NN. Volumetric bulky materials or structural debris	NN. 3.6E+04 pCi/g
OO. Uranium-238	OO. Volumetric bulky materials or structural debris	OO. 2.8E+04 pCi/g
PP. Uranium-natural	PP. Volumetric bulky materials or structural debris	PP. 1.8E+04 pCi/g
QQ. Uranium-depleted	QQ. Volumetric bulky materials or structural debris	QQ. 1.1E+05 pCi/g
RR. Zinc-65	RR. Volumetric bulky materials or structural debris	RR. 1.1E+04 pCi/g

* Daughters are assumed to be present at same concentrations in equilibrium.

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9. AUTHORIZED USE

Radioactive material as radioactive waste may be received, stored and disposed of by land burial. The licensee shall not accept low-level radioactive waste generated outside the region comprised of the party states to the Northwest Interstate Compact on Low-Level Radioactive Waste Management ("Compact") namely Alaska, Hawaii, Idaho, Montana, Oregon, Utah and Washington, unless the provisions of Articles IV and V of the Compact are met. Prior to receiving any such shipments, the licensee shall submit to the Utah Division of Radiation Control documentation evidencing compliance with these Compact provisions.

CONDITIONS

10. Licensed material shall be used at the licensee's facility located in Section 32 of Township 1 South and Range 11 West, Tooele County, Utah.
11. The licensee shall not possess at any time, more than 300,000 cubic yards of radioactive waste material which is not disposed of in accordance with the finished design requirements. This includes all wastes in storage or active processing.
12. Pursuant to R447-12-54(1), the licensee is granted as exemption to R447-25-9, as it relates to land ownership and assumption of ownership.
13. The maximum quantity of special nuclear material which the licensee may possess, undisposed of, at any one time shall not exceed 350 grams of U-235.
14. Licensed material specified in Item 6.A through 6.RR shall not be placed in a disposal cell unless it has been determined that the concentration of radionuclides is appropriately homogeneous within the physical form of the waste. This does not pertain to structural debris superficially contaminated with licensed materials.
15. A. If a mixture of radionuclides a, b, and c are present in the waste in the concentrations C_a , C_b , and C_c and if the applicable maximum waste concentrations from Item 8 of this license are MWC_a , MWC_b , and MWC_c respectively, then the concentration in the waste shall be limited so that the following relationship exists.

$$\frac{C_a}{MWC_a} + \frac{C_b}{MWC_b} + \frac{C_c}{MWC_c} \leq 1$$

- B. If a single radionuclide is present in the waste, the concentration shall not exceed the applicable value found in Item 8 of this license.

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16. A. The licensee may receive for treatment, storage, and disposal any radioactive waste as authorized by this license that contains hazardous constituents as permitted by the "RCRA Hazardous Waste Operations Permit" issued by the Executive Secretary, Utah Solid and Hazardous Waste Committee and "HWSA Permit" issued by the U.S. Environmental Protection Agency.
- B. The licensee shall dispose of these wastes in the "mixed waste" disposal embankment only.
17. Sealed sources as defined in R447-12-3(64) shall not be accepted for disposal.
18. Radioactive waste containing liquid, shall not be accepted for disposal except as provided by the Ground Water Discharge Permit, number UGW 450005, issued by the Executive Secretary of the Utah Water Quality Board.
19. The licensee shall comply with the provisions of Chapter R447-18, "Notices, Instructions and Reports to Workers by Licensees or Registrants, Inspections" and Chapter R447-15, "Standards for Protection Against Radiation".
20. The licensee may transport licensed material or deliver licensed material to a carrier for transport in accordance with the provisions of R447-19-100 "Transportation".
21. Written procedures shall be maintained and available at the disposal facility for operations involving radioactive materials. The procedures shall incorporate operating instructions and appropriate safety precautions for the work. The employee training program shall include detailed review of the operating procedures applicable to the employee's assignments. The requirement for written procedures shall include establishment of procedures for conduct of the radiation safety and environmental monitoring programs, including analytical procedures and instrument calibration requirements. Written procedures and subsequent changes to the procedure shall be reviewed and approved by the Corporate Radiation Safety Officer and the Project Manager. At least annually, all procedures shall be reviewed to assure continued applicability.
22. The Corporation Radiation Safety Officer shall perform and document weekly inspections of the facility and report any findings of non-compliance, affecting radiological safety, to the Project Manager. Items for inspection include: operating procedures, license requirements and safety practices.
23. The licensee shall conduct contamination surveys in accordance with Table 7.2 of the license amendment application dated September 20, 1990.
24. The licensee shall conduct a bioassay and occupational airborne radioactive contamination monitoring program in accordance with Section 7.4.8.3 of the license amendment application dated September 20, 1990.

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25. The use of respirators shall be controlled by a respiratory protection program as stipulated in R447-15-103.
26. The licensee shall calibrate air sampling equipment at intervals not to exceed six months.
27. The operational environmental monitoring program shall be conducted in accordance with Section 4.5, Table 4.7 and Figure 4.6 of the license amendment application dated September 20, 1990.
28. Vehicles, facilities, equipment or other items for unrestricted use shall not be released from the licensee's control if contamination measurements exceed the following limits:

Nuclide ^a	Column I Average ^{b,c,d}	Column II Maximum ^{b,d,f}	Column III Removable ^{b,d,f}
U-nat, U-235, U-238, and associated decay products	5,000 dpm alpha/ 100 cm ²	15,000 dpm alpha/ 100 cm ²	1,000 dpm alpha/ 100 cm ²
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100 dpm/100 cm ²	300 dpm/100 cm ²	20 dpm/100 cm ²
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000 dpm/100 cm ²	3,000 dpm/100 cm ²	200 dpm/100 cm ²
Beta-gamma emitters (nuclides with decay modes other than alpha emissions or spontaneous fission) except Sr-90 and other noted above.	5,000 dpm beta, gamma/100 cm ²	15,000 dpm beta- gamma/100 cm ²	1,000 dpm beta- gamma/100 cm ²

- a. Where surface contamination by both alpha- and beta-gamma emitting nuclides exists, the limits established for alpha- and beta-gamma emitting nuclides should apply independently.
- b. As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.
- c. Measurements of average contaminant should not be averaged over more than one square meter. For objects of less surface area, the average should be derived for each such object.
- d. The maximum contamination level applies to an area of not more than 100 cm².
- e. The amount of removable radioactive material per 100 cm² of surface area should be determined by wiping the area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.
- f. The average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters shall not exceed 0.2 mrad/hr at 1 cm and 1.0 mrad/hr at 1 cm, respectively, measured through not more than 7 milligrams per square centimeter of total absorber.

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29. A quarterly report shall be prepared by the Corporate Radiation Safety Officer for the Project Manager and Company President evaluating employee exposures, effluent releases and environmental data to determine:
 - A. If there are any upward trends in personnel exposures for identifiable categories of workers or types of operations or in effluent releases;
 - B. If exposures and effluents might be lowered under the concept of maintaining exposures and effluents as low as reasonably achievable; and
 - C. If equipment for exposure and effluent control is being properly used and maintained.
30. In accordance with R447-25-33, the licensee shall submit annual reports to the Division of Radiation Control by the end of the first calendar quarter of each year for the preceding year. The reports shall include:
 - A. Specification of the quantity of each of the principal contaminants released to unrestricted areas in liquid and in airborne effluents during the preceding year.
 - B. The results of the environmental monitoring program;
 - C. A summary of licensee disposal unit survey and maintenance activities; and
 - D. A summary of the volume, radioisotopes and their activities for materials disposed of.
31. Except as provided by this condition, the licensee shall maintain the results of sampling, analyses, surveys, and instrument calibration, reports on inspections and audits, employee training records as well as any related reviews, investigations and corrective actions, for five (5) years. The licensee shall maintain personnel exposure records in accordance with R447-15-401.
32. Operations shall be conducted by or under the supervision of Vernon E. Andrews, Corporate Radiation Safety Officer, or other individuals designated by the Corporate Radiation Safety Officer upon successful completion of the licensee's training program.
33. The licensee shall staff the operations of the facility in accordance with the organization chart (Figure 8.1) of the license amendment application dated September 20, 1990.
34. The licensee staff shall meet the qualifications as described in Section 8.2 and shall have the responsibilities as described in Section 8.1.2 of the license amendment application dated September 20, 1990.

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35. The licensee shall not initiate disposal operations in newly excavated areas until the Division of Radiation Control has inspected and approved the cell/embankment liner.
36. The licensee shall provide "as built drawings" of the facility, at intervals not to exceed six (6) months. Drawings shall be submitted by February 1 and August 1 of each year. The drawings shall show conditions on the site as they existed no earlier than thirty (30) days prior to the submittal of the drawings to the Division of Radiation Control. Drawings submitted as, "as built drawings" will be marked as such, and will be marked in the same place on each drawing. Record drawings showing approved future designs, final or finished conditions at the site may be included in the "as built drawings", but shall be marked as "record drawings".
37. Radioactive waste which have been off loaded shall be placed in the appropriate disposal embankment and stored in a manner approved by the Division of Radiation Control.
38. For the purpose of this license, debris is defined as any radioactive waste for disposal other than soils. Compactible debris is defined as: (A) having a gradation that will pass through a four inch (4") grizzly and; (B) as having a density greater than seventy pounds per cubic foot dry weight in accordance with ASHTO T-99. Contaminated materials, other than soil, not meeting these criteria are defined as noncompactible debris.
39. The licensee shall place bulk radioactive materials in twelve inch (12") uncompacted lifts.
40. In-place bulk radioactive waste shall be compacted at a moisture content of zero percent (0%) to three percent (3%) of optimum as determined by the Standard Proctor Method ASTM D-698.
41. The licensee shall compact each lift to not less than ninety percent (90%) of optimum density as determined by Standard Proctor Method ASTM D-698. Sampling points for compaction testing shall include locations immediately adjacent to debris when debris is included in the lift.
42. All debris shall be less than ten inches (10") in at least one (1) dimension, and no longer than eight feet (8') in any dimension.
43. The final 24 inches of the radioactive waste material embankment, within the side slopes and the top surface, shall be free of debris.
44. A lift or any portion of a lift shall be limited to less than ten percent (10%) by volume of noncompactible debris and the debris shall be uniformly distributed throughout the lift. However, noncompactible debris in the form of concrete, stone or solid metal may be placed in the lift up to twenty-five percent (25%) by volume, of the total lift if uniformly distributed throughout the lift.

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45. The licensee shall excavate the disposal cell liner, consisting of native materials, to a depth of twenty-four inches (24") and replace it with imported clay in six inch (6") uncompacted lifts. Each lift shall be compacted to not less than ninety-five percent (95%) optimum density as determined by ASTM D-698 and field permeability of 1.0×10^{-7} cm/sec.
46. The licensee shall not place, compactible nor non-compactible debris, in the first lift.
47. The disposal cell liner and radon barrier shall be constructed with a moisture content of zero percent (0%) to three percent (3%) of optimum moisture as determined by Standard Proctor Method ASTM D-698.
48. The licensee shall compact the radon barrier to not less than 95 percent of optimum density as determined by Standard Proctor Method ASTM D-698 and a field permeability of 1.0×10^{-7} cm/sec.
49. The licensee shall record, at the time of acceptance, the date and time of day that any lift or portion of a lift has been accepted by the licensee as finished in accordance with all specifications and license conditions.
50. The licensee shall use rock filter zone and rock erosion barrier that has been sized and graded in accordance with Section 3.1.1.2 and 9.2.5 of the license amendment application dated September 20, 1990.
51. The licensee shall test rock erosion barrier and filter zone rock in accordance with the provisions found in Section 9 of the license amendment application dated September 20, 1990.
52. The licensee shall utilize a manifest ("Radioactive Waste Shipment and Disposal Record," Envirocare Form E-100) containing the information required in R447-15-311(2) and (3) including:
 - A. Specification of any solidification agents utilized;
 - B. Identification of wastes containing more than 0.1% by weight of chelating agents. Chelating agents means amine polycarboxylic acids, hydroxyl-carboxylic acids, gluconic acids and polycarboxylic acids;
 - C. An estimate of the weight percentage of any chelating agents in waste.
53. The licensee shall not accept radioactive waste for storage and disposal unless the licensee has received a complete "Radioactive Waste Shipment and Disposal Record" (Form #E-100) from the shipper.
54. The licensee shall maintain copies of complete manifests or equivalent documentation until the Division of Radiation Control authorizes their disposition.

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55. The licensee shall immediately notify the Division of Radiation Control or the Division's on-site representative of any waste shipment where a violation of applicable regulations or license conditions has been found.
56. The licensee shall require anyone who transfers radioactive waste to the facility comply with the requirements in R447-15-311(4)(a) through (h).
57. The licensee shall acknowledge receipt of the waste within one (1) week of receipt by returning a signed copy of the manifest or equivalent documentation to the shipper. The shipper to be notified is the licensee who last possessed the waste and transferred the waste to the licensee. The returned copy of the manifest or equivalent documentation shall indicate any discrepancies between materials listed on the manifest and materials received.
58. The licensee shall notify the shipper (i.e., the generator, the collector, or processor) and the Division of Radiation Control when any shipment or part of a shipment has not arrived within 60 days after the advance manifest was received.
59. The licensee shall maintain a record for each shipment of waste disposed of at the site. As a minimum, the record shall include:
 - A. The date of disposal of the waste;
 - B. The location of waste in the disposal site;
 - C. The condition of the waste packages received;
 - D. Any discrepancy between the waste listed on the shipment manifest or shipping papers and the waste received in the shipment.
 - E. A description of any evidence of leaking or damaged packages or radiation or contamination in excess of applicable regulatory limits; and
 - D. A description of any repackaging operations of any of the waste packages in the shipment.
60. In accordance with R447-25-31 the licensee shall maintain a Utah Division of Radiation Control Surety (Trust) Agreement adequate to fund the decommissioning and reclamation of the grounds, equipment and facilities. These costs, identified in Section 10 of the license amendment application dated September 20, 1990, shall be reviewed and updated annually and a report submitted to the Utah Division of Radiation Control within 60 days after July 1, of each year. The survey arrangement shall be updated as necessary to reflect decommissioning and reclamation costs.

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51. Truck, railcar, waste hauling and other earth moving equipment washdown (decontamination) facilities, including evaporation ponds, shall be controlled and fenced to prevent intrusion.
52. All burial embankments and waste storage areas, including immediately adjacent drainage structures, shall be controlled areas, surrounded by a six foot (6') high, chain link fence, topped with twisted selvedge. All permanent fence shall be chain link, six feet (6') high, topped with three strand barbed wire, top tension wire and twisted selvedge.
53. The licensee shall fulfill and maintain compliance with all conditions and shall meet all compliance schedules stipulated in the Ground Water Discharge Permit, number UGW 450005, issued by the Executive Secretary of the Utah Water Quality Board.
54. One (1) year prior to the anticipated closure of the site, the licensee shall submit a final version of the site closure, decontamination and decommissioning plan. As part of this plan, the licensee shall demonstrate by measurements and/or modeling that concentrations of radioactive materials which may be released to the general environment, after site closure, will not result in an annual dose exceeding 25 millirems to the whole body, 75 millirems to the thyroid, and 25 millirems to any other organ of any member of the public.
55. Except as specifically provided otherwise by this license, the licensee shall possess and use radioactive material described in Item 6, 7, and 8 of this license and conduct site operations in accordance with statements, representations, operating procedures, and disposal criteria, heretofore made by the licensee or his authorized representative in application for and subsequent to issuance of Utah Radioactive Material License No. UT 2300249 and amendments thereto.

March 16, 1992

Date

Larry F. Anderson
Larry F. Anderson, Executive Secretary, Utah Radiation Control Board

Exhibit F3

RCRA PERMIT FOR ENVIROCARE

STATE OF UTAH PLAN APPROVAL

Permittee:

Envirocare of Utah, Inc.

Tooele County, Utah

EPA Identification Number UTD982598898

Pursuant to the Utah Solid and Hazardous Waste Act, (the Act), 26-14-1, et. seq., Utah Code Annotated 1953, as amended and the Utah Administrative Code (UAC) (R450-1 through R450-13 and R450-50) as adopted by the Utah Solid and Hazardous Waste Committee, (the Committee), a plan approval (herein after called "permit") is issued to Envirocare of Utah, Inc. (hereafter called the "Permittee"), to operate a hazardous waste treatment and storage facility in Tooele County, Utah, at latitude 40° 41' 000" North and longitude 113° 06' 030" West. The U.S. Environmental Protection Agency (U.S. EPA) has authorized the Executive Secretary to issue such a permit under Section 3006(b) of the Resource Conservation and Recovery Act (RCRA).

The Permittee must comply with all the terms and conditions of this permit. The permit consists of the conditions contained herein (including the portions of the application attached and incorporated by reference), and the applicable portions of R450-1 through R450-13, R450-50, and R450-101 contained in the permit. Applicable rules are those which are in effect on the date of issuance of this permit.

This permit is based on the premise that the information submitted in the application dated July 22, 1987 as modified by subsequent amendments dated April 25, 1988 and July 25, 1989 (hereafter referred to as the application), is accurate and that the facility will be operated as specified in the referenced portions of the application, except as modified by the conditions herein. Portions of the application are attached and incorporated herein by reference, wherever noted, as part of this permit. Any inaccuracies or misrepresentations found in the application may be grounds for the termination or modification of this permit (see R450-3-9.). The Permittee must inform the Executive Secretary of any deviation from, or changes in the information in the application which would affect the Permittee's ability to comply with the applicable regulations or permit conditions.

This permit is effective as of November 30, 1990 and shall remain in effect until November 30, 2000, unless revoked and reissued (R450-3-9.1(a)(b)(c)) or terminated (R450-3-9.2.), or continued in accordance with R450-3-5(d).

Signature: *Dennis R. Downs*

Date: 11/30/90

Dennis R. Downs
Executive Secretary
Utah Solid and Hazardous Wastes Committee

NOTE TO ENVIROCARE'S PART B PERMIT CERTIFICATE:

The Envirocare site is licensed by the Utah Bureau of Radiation Control for disposal of radioactive waste. The site is also licensed by the Utah Bureau of Radiation Control and permitted by the Utah Bureau of Solid and Hazardous Waste for disposal of "mixed" (hazardous/radioactive) waste.

Any one wishing to visit the site should contact the Permittee to make arrangements for a site tour and to determine that all safety requirements are met prior to entering the site.

Inspectors who will have extensive contact with the site should contact both the Utah Bureau of Radiation Control and the Utah Bureau of Solid and Hazardous Waste to determine that all safety requirements i.e. safety equipment, safety training, and/or physical, are met prior to entering the site.

Exhibit F4

HAZARDOUS WASTES ACCEPTABLE FOR DISPOSAL AT ENVIROCARE

**APPROVED HAZARDOUS WASTE NUMBERS
ENVIROCARE OF UTAH, INC.**

**APPROVED HAZARDOUS WASTE NUMBERS
ENVIROCARE OF UTAH, INC.**

RCRA Wastes

EPA Waste No.		Hazard Code
D001	Ignitability	(I)
D002	Corrosivity	(C)
D003	Reactivity	(R)
D004	Arsenic	(E)
D005	Barium	(E)
D006	Cadmium	(E)
D007	Chromium	(E)
D008	Lead	(E)
D009	Mercury	(E)
D010	Selenium	(E)
D011	Silver	(E)
D012	Endrin	(E)
	(1,2,3,4,10,10-hexachloro-1,7,epoxy-1,4,4a,5,6,7,8,8a-0 octahydro-1,4, endo, endo-5,8-dimeth-ano-naphthalene)	
D013	Lindane	(E)
	(1,2,3,4,5,6, hexa-chloro-cyclohexane, gamma isomer)	
D014	Methoxychlor	(E)
	(1,1,1-Trichloro-2,2-bis(p-methoxyphenyl)ethane)	
D015	Toxaphene	(E)
	(C ₁₀ H ₁₀ Cl ₈ , technical chlorinated camphene, 67-69 percent chlorine)	
D016	2,4-D	(E)
	(2,4 dichlorophenoxyacetic acid)	
D017	2,4,5-TP Silvex	(E)
	(2,4,5-trichloro-phenoxypropionic acid)	
D018	Benzene	(I)
D019	Carbon Tetrachloride	(C)
D020	Chlordane	(R)
D021	Chlorobenzene	(E)
D022	Chloroform	(E)
D023	o-Cresol	(E)
D024	m-Cresol	(E)
D025	p-Cresol	(E)
D026	Cresol	(E)
D027	1,4-Dichlorobenzene	(E)
D028	1,2-Dichloroethane	(E)
D029	1,1-Dichloroethylene	(E)
D030	2,4-Dinitrotoluene	(R)
D031	Heptachlor (and its epoxide)	(E)
D032	Hexachlorobenzene	(E)
D033	Hexachlorobutadiene	(E)
D034	Hexachloroethane	(E)
D035	Methyl Ethyl Ketone	(E)
D036	Nitrobenzene	(E)
D037	Pentachlorophenol	(E)
D038	Pyridine	(E)
D039	Tetrachloroethylene	(E)
D040	Trichloroethylene	(R)
D041	2,4,5-Trichlorophenol	(E)
D042	2,4,6-Trichlorophenol	(E)
D043	Vinyl Chloride	(E)

**APPROVED HAZARDOUS WASTE NUMBERS
ENVIROCARE OF UTAH, INC.
(continued)**

HAZARDOUS WASTE FROM NON-SPECIFIC SOURCES:

F001 The following spent halogenated solvents used in degreasing:

Tetrachloroethylene, trichloroethylene, methylene chloride, 1,1,1-trichloroethane, carbon tetrachloride, and chlorinated fluorocarbons; all spent solvent mixtures/blends used in degreasing containing, before use, a total of ten percent or more (by volume) of one or more of the above halogenated solvents or those solvents listed in F002, F004 and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.

F002 The following spent halogenated solvents:

Tetrachloroethylene, methylene chloride, trichloroethylene, 1,1,1-trichloroethane, chlorobenzene, 1,1,2-trichloro-1,2,2-trifluoroethane, ortho-dichlorobenzene, trichlorofluoromethane, and 1,1,2-trichloroethane; and all spent solvent mixtures/blends containing, before use, a total of one or more of the above halogenated solvents or those listed in F001, F004, or F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.

F003 The following spent non-halogenated solvents:

Xylene, acetone, ethyl acetate, ethyl benzene, ethyl ether, methyl isobutyl ketone, n-butyl alcohol, cyclohexanone, and methanol; all spent solvent mixtures/blends containing, before use, only the above non-halogenated solvents; and all spent solvent mixtures/blends containing, before use, one or more of the above non-halogenated solvents, and, a total of ten percent or more (by volume) of one or more of those solvents listed in F001, F004, and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.

F004 The following spent non-halogenated solvents:

Cresols and cresylic acid, nitrobenzene; all spent solvent mixtures/blends containing, before use, a total of ten percent or more (by volume) of one or more of the above non-halogenated solvents or those solvents listed in F001, F002, and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.

F005 The following spent non-halogenated solvents:

Toluene, methyl ethyl ketone, carbon disulfide, isobutanol, and pyridine; benzene, 2-ethoxyethanol, and 2-nitropropane; all spent solvent mixtures/blends containing, before use, a total of ten percent or more (by volume) of one or more of the above non-halogenated solvents or those solvents listed in F001, F002, or F004; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.

**APPROVED HAZARDOUS WASTE NUMBERS
ENVIROCARE OF UTAH, INC.
(continued)**

HAZARDOUS WASTE FROM NON-SPECIFIC SOURCES (continued):

- F006 Waste-water treatment sludges from electroplating operations except from the following processed: (1) Sulfuric acid anodizing for aluminum; (2) tin plating on carbon steel; (3) zinc plating (segregated basis on carbon steel; (4) aluminum or zinc-aluminum plating on carbon steel; (5) cleaning/stripping associated with tin, zinc and aluminum plating on carbon steel; and (6) chemical etching and milling of aluminum.
- F007 Spent cyanide plating bath solutions from electroplating operations.
- F008 Plating bath residues from the bottom of plating baths from electroplating operations where cyanides are used in the process.
- F009 Spent stripping and cleaning bath solutions from electroplating operations where cyanides are used in the process.
- F010 Quenching bath residues from oil baths from metal heat treating operations where cyanides are used in the process.
- F011 Spent cyanide solutions from salt bath pot cleaning from metal heat treating operations.
- F012 Quenching waste water treatment sludges from metal heat treating operations where cyanides are used in the process.
- F019 Waste-water treatment sludges from the chemical conversion coating of aluminum.
- F028 Residues resulting from the incineration or thermal treatment of soil contaminated with EPA Hazardous Waste Nos. F020, F021, F022, F023, F026 and F027.

HAZARDOUS WASTE FROM SPECIFIC SOURCES:

- K011 Bottom stream from the wastewater stripper in the production of acrylonitrile.
- K013 Bottom stream from the acetonitrile column in the production of acrylonitrile.
- K050 Heat Exchanger Bundle Cleaning Sludge from the petroleum refining industry.
- K051 API separator sludge from the petroleum refining industry.
- K052 Tank bottoms (lead) from the petroleum refining industry.

APPROVED HAZARDOUS WASTE NUMBERS
ENVIROCARE OF UTAH, INC.
(continued)

HAZARDOUS WASTE FROM SPECIFIC SOURCES (continued):

K061 Emission control dust/sludge from the primary production of steel in electric furnaces.

K069 Emission control dust/sludge from the secondary lead smelting.

DISCARDED COMMERCIAL CHEMICAL PRODUCTS, OFF-SPECIFICATION SPECIES, CONTAINER RESIDUES, AND SPILL RESIDUES THEREOF:

P003	Acrolein	H
P004	Aldrin	H
P010	Arsenic Acid	H
P011	Arsenic Pentoxide	H
P012	Arsenic Trioxide	H
P013	Barium Cyanide	H
P015	Beryllium Dust	H
P021	Calcium Cyanide	H
P022	Carbon Disulfide	H
P024	p-Chloroaniline	H
P027	3-Chloropropionitrile	H
P029	Copper Cyanide	H
P030	Cyanides (soluble cyanide salts), n.o.s.	H
P037	Dieldrin	H
P046	alpha, alpha-Dimethylphenethylamine	H
P047	4,6-Dinitro-2-Methylphenol	H
P048	2,4-Dinitrophenol	H
P050	Endosulfan	H
P051	Endrin	H
P056	Fluorene	H
P059	Heptachlor	H
P060	Isodrin	H
P074	Nickel Cyanide	H
P077	p-Nitroaniline	H
P082	N-Nitrosodimethylamine	H
P098	Potassium Cyanide	H
P099	Potassium Silver Cyanide	H
P104	Silver Cyanide	H
P106	Sodium Cyanide	H
P107	Strontium Sulfide	H
P113	Thallium (III) Oxide	H
P114	Thallium Selenite	H
P115	Thallium (I) Sulphate	H
P119	Ammonium Vanadate	H
P120	Vanadium (V) Oxide	H
P121	Zinc Cyanide	H
P122	Zinc Phosphide (>10%)	H
P123	Toxaphene	H

APPROVED HAZARDOUS WASTE NUMBERS
 ENVIROCARE OF UTAH, INC.
 (continued)

COMMERCIAL INTERMEDIATES, PRODUCTS:	CHEMICAL OR	PRODUCTS, OFF-SPECIFICATION	MANUFACTURING COMMERCIAL CHEMICAL
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U002	Acetone	I
U004	Acetophenone	T
U007	Acrylamide	T
U009	Acrylonitrile	T
U012	Aniline	I, T
U018	Benzo(a)anthracene	T
U019	Benzene	T
U021	Benzidine	T
U022	Benzo(a)pyrene	T
U027	Bis(2-chloroisopropyl)ether	T
U028	Bis(2-Ethylhexyl) Phthalate	T
U029	Bromomethane	T
U030	4-Bromophenyl Phenyl Ether	T
U031	n-Butyl Alcohol	I
U032	Calcium Chromate	T
U036	Chlordane	T
U037	Chlorobenzene	T
U039	4-Chloro-3-methyl Phenol	T
U042	2-Chloroethylvinyl Ether	T
U043	Vinyl Chloride	T
U044	Chloroform	T
U045	Chloromethane	T
U047	2-Chloronaphthalene	T
U048	2-Chlorophenol	T
U050	Chrysene	T
U052	Cresols/Cresylic Acid	T
U056	Cyclohexane	I
U057	Cyclohexanone	I
U060	DDD	T
U061	DDT	T
U062	Diallate	T
U063	Dibenz(a,h)anthracene	T
U066	1,2-Dibromo-3-Chloropropane	T
U067	1,2-Dibromoethane	T
U068	Dibromomethane	T
U069	Di-n-Butylphthalate	T
U070	o-Dichlorobenzene	T
U071	m-Dichlorobenzene	T
U072	p-Dichlorobenzene	T
U073	3-3'-Dichlorobenzidine	T
U074	1,4-Dichloro-2-Butene	I, T
U075	Dichlorodifluoroethane	T
U076	1,1-Dichloroethane	T
U077	1,2-Dichloroethane	T
U078	1,1-Dichloroethylene	T
U079	1,2-Dichloroethylene	T
U080	Methylene Chloride	T
U081	2,4-Dichlorophenol	T
U082	2,6-Dichlorophenol	T
U083	1,2-Dichloropropane	T
U084	1,3-Dichloropropene	T
U088	Diethylphthalate	T
U093	Dimethylaminoazobenzene	T

APPROVED HAZARDOUS WASTE NUMBERS
ENVIROCARE OF UTAH, INC.
(continued)

COMMERCIAL CHEMICAL PRODUCTS, MANUFACTURING CHEMICAL
INTERMEDIATES, OR OFF-SPECIFICATION COMMERCIAL CHEMICAL PRODUCTS
(continued):

U094	7,12-Dimethylbenz(a)anthracene	T
U095	3,3'-Dimethylbenzidine	T
U101	2,4-Dimethylphenol	T
U102	Dimethylphthalate	T
U105	2,4-Dinitrotoluene	T
U106	2,6-Dinitrotoluene	T
U107	Di-n-Octyl Phthalate	T
U109	1,2-Diphenylhydrazine	T
U112	Ethyl Acetate	I
U117	Ethyl Ether	I
U119	Ethyl Methanesulfonate	T
U120	Fluoranthene	T
U121	Trichlorofluoromethane	T
U127	Hexachlorobenzene	T
U128	Hexachlorobutadiene	T
U129	Lindane (Hexachlorocyclohexane)	T
U130	Hexachlorocyclopentadiene	T
U131	Hexachloroethane	T
U132	Hexachlorophene	T
U135	Hydrogen Sulfide	T
U137	Indeno(1,2,3-cd)pyrene	T
U138	Iodomethane	T
U140	Isobutyl Alcohol	I,T
U142	Kepone	T
U144	Lead Acetate	T
U145	Lead Phosphate	T
U146	Lead Subacetate	T
U151	Mercury	T
U154	Methanol	I
U157	3-Methylcholanthrene	T
U158	4,4'-Methylene Bis(2-Chloroaniline)	T
U159	Methyl Ethyl Ketone	I,T
U161	Methyl Isobutyl Ketone	I
U165	Naphthalene	T
U167	1-Naphthalenamine	T
U168	2-Naphthalenamine	T
U169	Nitrobenzene	I,T
U170	4-Nitrophenol	T
U171	2-Nitropropane	I,T
U172	N-Nitroso-di-n-butylamine	T
U179	N-Nitrosopiperidine	T
U182	Paraldehyde	T
U183	Pentachlorobenzene	T
U184	Pentachloroethane	T
U185	Pentachloronitrobenzene	T
U187	Phenacetin	T
U188	Phenol	T
U191	2-Picoline	T
U192	Pronamide	T
U196	Pyridine	T
U204	Selenium Dioxide	T
U205	Selenium Sulfide	T
U207	1,2,4,5-Tetrachlorobenzene	T

APPROVED HAZARDOUS WASTE NUMBERS
ENVIROCARE OF UTAH, INC.
(continued)

COMMERCIAL CHEMICAL PRODUCTS, MANUFACTURING CHEMICAL
INTERMEDIATES, OR OFF-SPECIFICATION COMMERCIAL CHEMICAL PRODUCTS
(continued):

U208	1,1,1,2-Tetrachloroethane	T
U209	1,1,2,2-Tetrachloroethane	T
U210	Tetrachloroethylene	T
U211	Carbon Tetrachloride	T
U212	2,3,4,6-Tetrachlorophenol	T
U214	Thallium (I) Acetate	T
U215	Thallium (II) Carbonate	T
U216	Thallium (I) Chloride	T
U217	Thallium (I) Nitrate	T
U220	Toluene	T
U225	Bromoform	T
U226	1,1,1-Trichloroethane	T
U227	2-Ethoxyethanol	T
U228	Trichloroethylene	T
U230	2,4,5-Trichlorophenol	T
U231	2,4,6-Trichlorophenol	T
U232	2,4,5-TP	T
U233	2,4,5-TP Silvex	T
U235	Tris(2,3-Dibromopropyl) Phosphate	T
U237	Uracil Mustard	T
U239	Xylene	I
U240	2,4-Dichlorophenoxyacetic acid	T
U242	Pentachlorophenol	T
U243	Hexachloropropene	T
U247	Methoxychlor	T
U249	Zinc Phosphide (<10%)	T
U359	1,1,2-Trichloroethane	T

Other Wastes

- o Chemical Waste from the Envirocare Laboratory: Laboratory waste which can be landfilled on site will be disposed of at Envirocare. Other wastes will be sent off-site for hazardous waste management.
- o On-site Generated Waste: Wastes generated at the facility can generally be characterized adequately as to the composition of the waste.

(Note: Non-radioactive hazardous wastes must not be mixed with radioactive wastes to avoid or circumvent the land disposal restrictions.)

Exhibit G

ACCEPTANCE LIMITS AND CRITERIA FOR CONTAMINATED OILS AT SEG

WASTE ACCEPTANCE POLICY

PURPOSE: The purpose of this policy is to provide a uniform plan and procedure for the acceptance of low level radioactive waste for processing.

POLICY: SEG will accept waste which meets our waste acceptance criteria, can be safely processed, and meets the SEG license criteria. Waste which does not meet the general acceptance criteria may be accepted after evaluation and approval of the pertinent waste information provided on a Non-standard Waste Acceptance Form (NWAFF).

ACCEPTANCE OF NORMAL WASTE:

Normal waste is defined as any radioactive waste which meets the waste acceptance criteria listed below:

1. Low Level Waste Acceptance Criteria
2. Oil Acceptance Criteria
3. Metal Acceptance Criteria
4. TRU (Transuranic) Criteria
5. Liquid Waste/Bldg 3 Criteria (to be added later)

Waste which meets these criteria will be accepted if SEG has sufficient "financially assured storage space", if its licensed radionuclide inventory will not be exceeded, and can be processed within the allowed license time frame. Other business and/or process related factors may cause otherwise acceptable waste to be refused or delayed.

RESPONSIBILITIES:

REGULATORY SERVICES: Shall be responsible for the following:

1. Assist in determining that the material would meet DOT and burial site criteria.
2. Accepting the advanced waste shipment notification and assuring that the proposed shipment complies with the SEG Waste Acceptance Criteria.
3. Determining that the proposed shipment can be stored on "financially assured storage space".
4. Determining that the proposed shipment will not cause SEG to exceed its licensed radionuclide concentrations on any license.

BEAR CREEK AND GALLAHER OPERATIONS DEPARTMENT: Shall be responsible for the following:

1. Providing the Regulatory Service Department with regular information regarding the storage space available.
2. Determining that the proposed shipment will not cause any fence-line dose to be exceeded when stored awaiting processing.
3. Determining how the waste can be safely processed.
4. If the waste is approved using the NWAf form, the operations department will provide information to the sales department regarding the method of processing, the estimated manpower, and the equipment required to process the waste. In addition, a processing schedule shall be provided.

DATA SYSTEMS: Shall be responsible for the following:

1. Providing a weekly radionuclide inventory and/or updates to the inventory when requested.

ACCEPTANCE OF NON-STANDARD WASTE:

SEG may accept waste which does not meet our standard waste acceptance criteria using the following procedure:

SALES DEPARTMENT: The customer service department shall work with the customer to determine and document the following information on the Non-Standard Waste Acceptance Form (NWAf):

1. Generator's company name & facility
2. Contact name and phone number
3. Waste description
4. Radionuclide and activity information
5. Size, weight and volume data
6. Biological activity
7. Special characteristics
8. Desired date of shipment
9. Method of shipment

10. Planned packaging
11. Special disposal instructions
12. Amount of free-standing water
13. Material requiring quick processing

NOTE: Operations to generate cost figures for additional processes required. This cost figure shall be on a separate page.

After completing the NWAFF and depending on the waste type, the Customer Service Department shall work with the appropriate manager to determine the acceptability of the waste form. The appropriate manager shall indicate his agreement in writing on the NWAFF. He should consider the following:

1. Can the waste be processed in a time period which meets our license condition,
2. Can the waste be safely processed in the planned manner,

Pricing for Non-Standard waste shall be developed by the Marketing Manager with the assistance of the appropriate manager.

When the appropriate Processing Manager approves the waste for processing, then the Customer Service Department shall obtain the written approval of the Manager of Regulatory Services, or his designee, concerning the acceptability of the waste meeting our license and permit requirements. Factors to be considered by the Manager of Regulatory Services will include:

1. Can the waste be safely shipped, received, and effectively processed for burial,
2. Can the radionuclide concentrations be accepted without exceeding our license permit limitations,
3. Can the waste be processed in a manner which meets our ALARA and safety plan objectives,

After the NWAFF has been completed and the appropriate signatures have been obtained, a copy of the NWAFF shall be provided to the following:

1. Cognizant Production Manager
2. Regulatory Services Department
3. Incoming Shipment Coordinator
4. Customer Service Department
5. Invoicing Department
6. Fax copy of completed form to the client and document to the files.

Package Volume Determination:

55-Gallon Drums - 7.5 cf

Other Containers - Based on External Dimensions

Physical and Chemical Composition - No gases, biological materials, chelating agents, hazardous chemicals, pyrophorics, nor explosives. Solid wastes must not contain any significant free standing liquids. SEG will only accept waste materials which are acceptable at the destination burial ground.

Contact SEG for special materials which require processing for them to become acceptable at the destination burial ground.

FILTERS - Activity less than 0.1 uCi/cc of those isotopes with half-life greater than five years. Please call an SEG representative for activity levels greater than 0.1 uCi/cc.

ASBESTOS WASTE - All asbestos will be properly manifested, identifying number of bags, boxes, etc. Containers are to be properly identified (Labeled) on the primary containers as well as the secondary or individual containers. SEG does not have an abatement program, therefore, material should be sized and packaged to allow repackaging for compact on without breaching the primary container (i.e.. double plastic wrapping).

CONDENSER TUBES - Tubes to be relatively straight (some curvature is permissible) and the tubes are not to be pinched closed or grooved during removal. Interior buildup of scale to be less than 2% of the total weight of the tube. Condenser tubes to be removed in such a manner that will not grind contamination into the tube; that will segregate the stainless steel tubes from the brass tubing; that the inside of the tubes are dry or will be drained prior to loading. In addition, if any beveled ends exist, the beveled ends to be loaded toward the front of the container.

11/92

SEG ACCEPTANCE LIMITS FOR CONTAMINATED OILS

NOTE: This is a general guideline used for interfacing analytical results in client's oil with SEG's acceptance criteria for oil. SEG's acceptance criteria is based upon EPA regulations contained in 40 CFR 261/266, Tennessee Valley Authority requirements and the State of Tennessee regulations, where appropriate.

TYPE OF ANALYSIS

SEG ACCEPTANCE CRITERIA

1. Toxicity Characteristic (TCLP)

Heavy Metals (40 CFR 261.24)

Arsenic	< 5.00 mg/l
Barium	< 100.00 mg/l
Cadmium	< 1.00 mg/l
Chromium	< 5.00 mg/l
Lead	< 5.00 mg/l
Mercury	< 0.2 mg/l
Selenium	< 1.00 mg/l
Silver	< 5.00 mg/l

Organics

See list of 31 organic compounds and their respective regulatory levels listed under 40 CFR 261.24. Any compound which cannot be certified by the generator to be absent from the oil must be tested for under TCLP standards.

2. Total Halogens (TOX)	Equal to or less than 1000 ppm -
(ASTM Method D808-81)	Unless rebutted *

- * EPA has specified 1000 ppm total halogens as the level at which they presume mixing with spent halogenated solvents has occurred. The oil can contain up to 4000 ppm total halogens if the presumption of mixing can be successfully rebutted. To successfully rebut the mixing presumption, you must be able to show that the oil contains less than 100 ppm of any individual halogenated solvent listed as an F001 or F002 waste and certify that there has been no additional mixing of hazardous constituents with the oil. Additional volatile organic analysis (EPA method 8240) would be required to analyze for these individual halogenated compounds.

3. Polychlorinated Biphenyls < 2.00 ppm

Limits based upon request by the Tennessee Valley Authority and EPA regulations contained in 40 CFR 761.

4. Flashpoint Equal to or greater than 140°F

5. Viscosity Less than 3000 ssu

6. Solids Content Less than 10% by volume

7. Aqueous Liquid Content Less than 10% by volume

8. Radiological Analyses:

A. Maximum total concentration of radionuclides less than 1E-4 (uCi/ml) averaged over truckload lot.

B. Uranium at less than 1E-5 (uCi/ml) averaged over truckload lot.

C. No other alpha emitters comprising >10% of the total amount in a single container (prior arrangements/rad. license).

9. Maximum Individual Isotope Activities

A. H-3 1.9 microci/gallon or 0.5 nanoci/ml

B. C-14 0.1 microci/gallon or 0.026 nanoci/ml

C. Tc-99 0.4 microci/gallon or 0.1 nanoci/ml

D. I-129 0.01 microci/gallon or 0.0026 nanoci/ml

NOTE: Oil which exceeds any of the above radiological limits will require prior approval by SEG. SEG will review these requests on a case-by-case basis.

ATTACHMENT 2
TO SEG'S RADIOACTIVE WASTE SERVICES AGREEMENT
BURNING OF RADIOACTIVE OILS

PART 2. 1 SEG RADIOACTIVELY CONTAMINATED OIL ACCEPTANCE CRITERIA

SEG standard oil pricing is based upon oil acceptable for burning with the following specifications:

1. Oil with grades less than 40 weight.
2. Specific oil history should be identified if possible.
3. Solids content less than 10% by volume.
4. Aqueous liquid content less than 10% by volume.
5. Certified to be free of listed and characteristic hazardous waste as defined by RCRA or the Toxic Substances Control Act (TSCA). Oil which contains detectable levels of PCB's (2 ppm or greater) as regulated by the Toxic Substance Control Act (TSCA) would not be acceptable by SEG.
6. Shipped in leak-tight containers.
7. Maximum Radionuclide concentration less than 1×10^{-4} uCi/ml with Uranium at $< 1 \times 10^{-5}$ uCi/ml both averaged over a truckload lot and with no other significant alpha emitters comprising >10% of the total amount of any single container may be taken, but prior notification and approval is required.

Normal oils and heating oils, including kerosene, hydraulic oil, diesel, and other flammable oils are acceptable if they are not listed hazardous wastes or characteristic wastes. Alcohol or gasolines or highly flammable solvents that comprise <1% of total are acceptable. Call a SEG representative for pricing on alcohols, gasolines, and highly flammable solvents that exceed 1%. If you have questions about your specific oil mixture, contact your SEG representative for a determination.

SEG can also analyze your oils and provide you with necessary certification for suspect oils. Analytical costs vary, depending upon extent and nature of the analysis. Contact an SEG representative for details. SEG will work with you to determine what is required to qualify your oil for disposal. Radioactive or commingled oils which cannot be burned will be solidified and buried according to the regulations at the time. In addition, a waste burial allocation will be required for any nuclear power plant oil or sludge which cannot be burned and must be solidified and buried.

Surcharges over and above the price for burning oils may be applied for higher solid content or nonflammable liquids, or any oils that may require solidification for burial or oils that require certification to allow burial. SEG will perform additional tasks on a time and material basis with labor charged at 3.0 times direct salary and other costs billed at cost plus 20%.

ATTACHMENT 2
SEG'S RADIOACTIVE WASTE SERVICES AGREEMENT
BURNING OF RADIOACTIVE OILS

PART 2.2 DISCUSSION OF SEG OIL ACCEPTANCE CRITERIA

1. **OIL VISCOSITY:** The viscosity of the oil is important since we are planning to burn the oil in a specific burner. SEG's original guidance on oil viscosity was to specify a grade of 40 or less. A second way of looking at our acceptance criteria is that SEG will accept oil that has a viscosity of 3000 ssu units or less. Alternately, we will accept oil which has a viscosity of 3000 ssu units or less when the oil is diluted with kerosene in a ratio of 1 part kerosene to 2 parts oil. As you can see from this discussion, SEG accepts oil with a wide range of viscosities. If the oil will flow when poured, SEG will probably be able to prepare it for burning. When you have a question on your oil's grade or viscosity, send a sample to SEG for analysis and acceptance. SEG will also take grease if it can be dissolved with kerosene to meet our viscosity requirements. In the case of grease, the charge will be made on the basis of the diluted volume.

2. **ANALYSIS SERVICE:** At the request of the customer, SEG will perform necessary analyses of the oil to determine that it meets our license criteria. The client can ship oil samples to SEG and SEG will analyze the oil for a fee as determined by SEG's Radioactive Waste Services Agreement (Attachment 3 - Burning Radioactive Contaminated Oil.). Results of sampling will be provided to the customer. The analyses that may be required will depend on the history of the oil. Some of the typical tests that might be used and the approximate prices associated with those tests (without markup) are attached. Reference Attachment 3 for SEG's fee for pass through services.

3. **OIL SHIPPING CONTAINERS:** SEG will provide "double containment with absorbent" shipping boxes to the customer. These containers are generally of two types. The first type is an approximate 4'x4'x6' LSA container loaded with internal 79 gallon drum overpacks. The client's 55-gallon drums can then be contained inside of the 79 gallon drums. Absorbent is added around outer 79-gallon drums. The second type container supplied by SEG is more appropriate for those customers that wish to ship oil to SEG in bulk. This container is a double containment sea-land container with absorbent, a sea land container with a full drip pan inside of the container for possible spill. The approximate oil carrying capacity of the box is 210 gallons (4 each 55-gallon drums) and of the sea land is 2500 gallons. Transportation of the containers from SEG to the customer and return will be done at the rates quoted in the fee schedule (see Attachment 3).

4. **SOLIDIFICATION SERVICES:** Oil which contains unacceptable contents for burning will be returned to the customer or at the customers option, be solidified by SEG. Oil which must be solidified will be processed for an extra charge in accordance with Attachment 3. This charge should be less than twice the charge of SEG's standard oil burning fee schedule rate, plus the cost of any sampling and laboratory analysis costs and transportation charges to disposal. SEG will solidify the oil using approved procedures for the selected burial grounds, package the solidified oil, arrange for transportation, and pay for burial. The customer will provide a waste allocation and a burial permit for the selected burial ground.
5. **WASTE EXPORT PERMIT:** SEG will take the lead and arrange for a permit to export solidified oil from the Southeast Compact Region with the assistance of the customer required.
6. **TITLE AND POSSESSION OF WASTE:** SEG will take title and possession of the oil when it is delivered at our facility. SEG will be responsible for all burial ground fines and violations which relate to the packaging, method of solidification, quality of the solidified material, or other violations which SEG was directly responsible for. The utility will be responsible for the accuracy and certification of the oil, as being non-hazardous under RCRA and TSCA regulations.
7. **RADIONUCLIDE CONCENTRATION:** Oil with concentrations of radionuclides equal to or less than 1×10^{-4} microcuries per ml for fission products and 1×10^{-5} microcuries per ml for uranium when averaged over the entire batch or shipment and with no other significant alpha emitters comprising >10% of the total amount of the activity may be taken. If higher oil concentrations apply, contact SEG for permission to ship the oil.
8. **TRANSPORTATION SERVICES:** SEG will provide transportation in accordance with Attachment 3 (SEG's Radioactive Waste Services Agreement). The charges are summarized on the applicable fee schedule titled - Transportation.
9. **OIL DISPOSAL FEES:** SEG will burn and/or solidify radioactive oil on a per gallon basis based upon Attachment 3. The Attachment is based upon a per gallon price plus the cost of transportation and any sampling and laboratory analysis costs. A discount is usually provided to those clients that provide substantial DAW business to SEG (drums, boxes or sea lands).
10. **SEG LIMITS:** SEG will work with our client to quickly remove oils from their site to SEG for processing. The total of all oil backlogged at utilities exceeds on the short term the capacity of SEG to receive all of this oil at the same time. SEG will work with our client to schedule the burning of their oils or transfer of their oils to SEG's site for our backlog purposes.

ATTACHMENT 2
TO SEG'S RADIOACTIVE WASTE SERVICES AGREEMENT
BURNING OF RADIOACTIVE OILS

PART 2.3 SUMMARY OF HAZARDOUS WASTE REGULATIONS RELATED TO OIL ACCEPTANCE CRITERIA

GENERAL STATEMENT

SEG is NOT a hazardous waste treatment, storage, or disposal facility. Therefore, SEG is NOT permitted to receive, accept, store, or process any client's regulated listed or characteristic hazardous waste.

In regard to specific regulations on used oil, SEG will accept non-hazardous oil as defined in the Resource Conservation Recovery Act (RCRA) 40 CFR, part 261. This part sets specific constituents/properties and the allowable levels. Additionally, used oil which contains PCBs as regulated by the Toxic Substance Control Act (TSCA), 40 CFR, part 761, would not be acceptable by SEG.

The term "hazardous" means that the material is regulated as such by a governing authority and has no reference to whether or not the material is "dangerous". For example, kerosene is dangerous but it is not hazardous since it is not defined as such by regulations. Furthermore, a waste is not necessarily "hazardous" by regulation even if tests show that the waste contains materials typically regulated as hazardous; it often depends on how the waste was generated. Thus, it is literally possible to have two identical containers of waste with one regulated as hazardous and the other not.

The discussion below is not intended to make the issue more complex than it obviously is; rather, its purpose is to provide SEG clients with the maximum flexibility allowed by law for the shipment to SEG of oil and similar materials contaminated with radioactive material. None of the comments below are special license or permit conditions at SEG. Rather, they are restatements of the current RCRA regulations as of February 1, 1988.

DEFINITION OF NONHAZARDOUS "OIL"

The following nonhazardous material may be accepted in pure form or as mixtures with each other or as mixtures with other nonhazardous (by regulation) materials; motor oil, hydraulic oil, transmission and power steering fluids, lubricating oils, kerosene, turpentine, most cutting oils, diesel fuel, and similar nonhazardous materials. Any such similar liquid material having a flash point above 140°F (60°C) and which is not listed or otherwise hazardous by regulation is acceptable. Generally, scintillation fluids are not accepted unless one of the exemptions below is met.

CHARACTERISTICALLY HAZARDOUS MATERIALS

IGNITABLE - Liquid materials not otherwise hazardous except for the characteristic of ignitability (flash point less than 140°F) are acceptable if the generator unintentionally or accidentally mixes it with the nonhazardous materials listed above. Thus, gasoline, mineral spirits, or other similar ignitable material mixed with oil is acceptable if the mixture flash point is greater than 140°F. However, a container of pure gasoline, mineral spirits, or other similar ignitable material (FP less than 140°F) is not acceptable at SEG.

CORROSIVE, REACTIVE, TOXIC CHARACTERISTIC (TC) - Oil containing a material which would cause it to exhibit one or more of these characteristics (e.g., a toxic characteristic metal such as hexavalent chromium or lead), as defined by regulation, is not acceptable. Oil containing small quantities of hazardous constituents is acceptable if the final mixture does not exhibit the characteristic and is also not a listed waste.

OIL CONTAMINATED WITH EMPTY-CONTAINER RESIDUES

The release left in "empty" containers as defined by regulation are not hazardous. Therefore, oils contaminated by such residues may be accepted as long as they do not exhibit a characteristic of a hazardous waste. An example is the toluene residue in an "empty" container. Even though toluene is a listed constituent, it is not regulated as hazardous under these conditions. Furthermore, a nonhazardous waste stored in that container and which becomes contaminated with the toluene residue does not become a hazardous waste even though it now contains a constituent which is regulated as a "listed" waste under certain conditions. It is important that the regulatory definition of "empty" be met; simply "emptying" a container may not qualify the container as "empty", especially with acute hazardous wastes, which require triple rinsing to qualify as "empty".

SPECIAL RULES FOR HALOGENATED SOLVENTS (F001-F002)

Mixtures of hazardous waste and used oil ordinarily are classified as hazardous waste. However, both used oil and hazardous halogenated solvents are frequently generated by the same facility, and some incidental contamination is inevitable. Therefore, some specific rules exist for halogenated solvents in used oil.

Any used oil containing more than 1,000 ppm and up to 4,000 ppm of total halogens is presumed to be a hazardous waste because it was mixed with halogenated hazardous waste. Persons may rebut this presumption by demonstrating that the used oil does not contain significant concentrations of halogenated hazardous constituents. Some possible examples of rebuttal are:

1. Show that the used oil contains less than 100 ppm of any individual hazardous halogenated component listed as a hazardous spent solvent.
2. Show that the hazardous constituents could have been added or formed during use of the oil.

There are possible other rebuttable presumptions depending on the circumstances specific to individual cases. If you have any questions regarding the acceptability of your used oil, contact you SEG representative.

ACCEPTABILITY OF OTHER HAZARDOUS WASTES

Any listed or characteristic hazardous waste not exempt above is, most likely, not acceptable to SEG. In summary, to determine if used oil may or may not be accepted by SEG, many factors such as the generating process, mixing characteristics, etc., may to be reviewed to determine acceptance. Please contact your SEG representative.

METAL ACCEPTANCE

1. Size Maximum is a piece or a combination of pieces
 that can be placed in a 20 foot sealand.
- Weight Maximum weight of a single piece is 20,000.
2. Rad Level Average contact reading without any shielding.

- A. Shield Material 0 - 50 mr/hr
- B. Volume Reduction for Burial 51 - 200 mr/hr

Note: Any material >200 requires prior permission from SEG, and no single piece to exceed 1000 MR on contact. The standard Radwaste surcharge shall apply.

Special Nuclear Materials* (U233-U235) .1 gm/cf
Transuranic* (Including Pu241) <1 nanoci/gm
Activated Metal 0.1 mr/hr on contact
Ra 226 (DOE only) <10 nanoci/gram
Ra 226 (Commercial) requires special permission.

- * Subject to pre-verification approval. Materials which are not metal will be billed by the appropriate rate. Asbestos materials require special permission.

APPENDIX H

**OPEN LITERATURE CITATIONS FOR
SELECTED MIXED WASTE TREATMENT TECHNOLOGIES**

APPENDIX H

OPEN LITERATURE CITATIONS FOR SELECTED MIXED WASTE TREATMENT TECHNOLOGIES

A search of the open literature publications from October 1990 to June 1992 for waste treatment technologies resulted in 902 citations. The data bases searched included: Biotechnology Abstracts, DOE Energy, Enviroline, Federal Register, Federal Research in Progress, National Technical Information Service, Pollution Abstracts, and Environmental Bibliography. The search included mixed, hazardous, and low-level radioactive waste and treatment categories listed in Tables 5.2 and 5.3 of Sect. 5, The Treatability of Mixed Waste. The treatment categories and number of citations are summarized below:

Incineration	299 citations;
Thermal Recovery	9 citations;
Vitrification	234 citations;
Solidification	173 citations;
Stabilization	139 citations;
Acid Leaching	10 citations;
Chemical Treatment	13 citations;
Neutralization	25 citations.

Examples of the citations, which are arranged chronologically according to treatment category along with annotated abstracts and citation information, are presented in this appendix. The entire citation database can be obtained by submitting a request and a blank 3.5 in. floppy disk (1.4 Mb size) to:

OAK RIDGE NATIONAL LABORATORY
Attention: Dr. J. A. Klein
Nuclear Waste Studies and Applications
P.O. Box 2008, MS 6495
Oak Ridge, Tennessee 37831-9984
Telephone No. (615) 574-6823

Although grouped according to major treatment category, many citations will include information about other treatment technologies. Thus, in lieu of an index, reading of the citations (or a computer search) is recommended in order to make greater use of the citation data. (Because of their length, generally only titles and citation information are included for Federal Register citations.)

A previously conducted search for the 1987 to 1990 time period resulted in 412 citations. This database is also available on request from Dr. Klein, arranged according to treatment categories.

INCINERATION

10/7/25 (Item 25 from file: 103)

03253282 JPN-91-011202; EDB-92-016039

Title: Overall reaction rate analysis of ion-exchange resins incineration by fluidized bed

Author(s): Kinoshita, Koki; Hirata, Masaru; Yahata, Taneaki (Japan Atomic Energy Research Inst., Oarai, Ibaraki (Japan). Oarai Research Establishment)

Source: Journal of Nuclear Science and Technology (Tokyo) (Japan) v 28:8.

Coden: JNSTA ISSN: 0022-3131

Publication Date: Aug 1991 p 739-747

Language: In English

Abstract: A kinetic study on the incineration of ion-exchange resins was conducted using fluidized bed. In the experiment, cation or anion exchange resins with known quantities were fed into the fluidized bed maintained at a constant temperature from 550 to 750degC. The apparent reaction rate constants k_{ap} could be evaluated by the time for completion of combustion derived from the continuous measurement of CO_2 concentration in the off-gas. It was confirmed that the reaction of the ion-exchange resins proceeded with the shrinking particle model forming no solid product layer and the rate of disappearance of the resins could be expressed by the surface chemical reaction. Most preferable conditions for incinerating the ion-exchange resins were found to be about 650degC for temperature and more than $4.91 \times 10^{-2} m \cdot s^{-1}$ for the air velocities at fluidized bed u_B . Also, k_{ap} for cation and anion exchange resins were found to be 1.25×10^{-2} and $1.51 \times 10^{-2} s \cdot s^{-1}$, respectively, at 650degC and u_B of $5.45 \times 10^{-2} m \cdot s^{-1}$. (author).

10/7/26 (Item 26 from file: 103)

03252039 NTS-92-008675; EDB-92-014796

Title: Safety in the ARIES-III D- sup 3 He tokamak reactor design

Author(s)/Editor(s): Herring, J.S.; Dolan, T.J.

Corporate Source: EG and G Idaho, Inc., Idaho Falls, ID (United States)

Sponsoring Organization: DOE USDOE, Washington, DC (United States)

Conference Title: 14. IEEE symposium on fusion engineering

Conference Location: San Diego, CA (United States) Conference Date: 30 Sep - 3 Oct 1991

Publication Date: 1991 (5 p)

Report Number(s): EGG-M-91280 CONF-910968--40

Order Number: DE92003289

Contract Number (DOE): AC07-76ID01570

Language: In English

Availability: OSTI; NTIS; INIS; GPO Dep.

Abstract: The ARIES-3 reactor study is an extensive examination of the viability of a D-³He-fueled commercial tokamak power reactor. Because neutrons are produced only through side reactions, the reactor has the significant advantages of reduced activation of the first wall and shield, low afterheat and Class A or C low level waste disposal. Since no tritium is required for operation, no lithium-containing breeding blanket is necessary. A ferritic steel shield behind the first wall protects the magnets from gamma and neutron heating and from radiation damage. The ARIES-3 reactor uses an organic coolant to cool the first wall, shield and divertor. The organic coolant has a low

efficiency. Radiation damage requires processing the coolant to remove and crack radiolytic products that would otherwise foul cooling surfaces. The cracking process produces waste, which must be disposed of through incineration or burial. We estimated the offsite doses due to incineration at five candidate locations. The plasma confinement requirements for a D-³He reactor are much more challenging than those for a D-T reactor. Thus, the demands on the divertor are more severe, particularly during a disruption. We explored the potential for isotopically tailoring the 4 mm tungsten layer on the divertor in order to reduce the offsite doses should a tungsten aerosol be released from the reactor after an accident. We also modeled a loss-of-cooling accident in which the organic coolant was burning in order to estimate the amount of radionuclides released from the first wall. We analyzed the disposition of the 20 g/day of tritium that is produced by D-D reactions and removed by the vacuum pumps. For our reference design, the tritium will be burned in the plasma. These results re-emphasize the need for low activation materials and advanced divertor designs, even in reactors using advanced fuels.

10/7/27 (Item 27 from file: 103)

03249963 GRA-91-91879; EDB-92-012720

Title: Waste-minimization assessment for a manufacturer of speed-reduction equipment. Environmental Research Brief

Author(s)/Editor(s): Kirsch, F.W.; Maginn, J.C.

Corporate Source: University City Science Center, Philadelphia, PA (United States)

Publication Date: Oct 1991 (5 p)

Report Number(s): PB-92-104363/XAB

Contract Number (Non-DOE): EPA-R814903

Note: Sponsored by Environmental Protection Agency, Cincinnati, OH. Risk Reduction Engineering Lab.

Language: In English

Availability: NTIS

Abstract: The U.S. Environmental Protection Agency (EPA) has funded a pilot project to assist small- and medium-size manufacturers who want to minimize their generation of hazardous waste but who lack the expertise to do so. Waste Minimization Assessment Centers (WMACs) were established at selected universities and procedures were adapted from the EPA Waste Minimization Opportunity Assessment Manual (EPA/625/7-88/003, July 1988). The WMAC team at Colorado State University performed an assessment at a plant manufacturing speed reduction equipment -- approximately 110,000 speed reduction units/yr. Plant operations include machining and assembling parts for worn gear shafts and other shafts, worn gear bodies, hubs and housings, bearings and seals. Keyed and threaded shafts are case-hardened, ground with a thread grinder, and deburred. Component parts are washed with an aqueous cleaner before assembly, and finished assemblies are spray painted with solvent-based paints and lacquer thinner. Spent cutting fluid and sludge, including turnings, and spent wash water are shipped offsite for disposal. Spent hydraulic oil and non-aqueous cutting fluid are shipped to a recycler. Waste paint and spent lacquer thinner are shipped offsite for incineration. The team's report, detailing findings and recommendations, indicated that most waste consists of spent aqueous cutting fluid, and that the greatest savings could be obtained by ultrafiltration and recycle of spent wash water.

THERMAL RECOVERY

9/9/2 (Item 2 from file: 103)

03283988 NOV-92-014231; EDB-92-046745

Title: Environmental aspects of heavy-oil recovery by thermal EOR processes

Author(s): Sarathi, P. (National Inst. for Petroleum and Energy Research (US))

Source: Journal of Petroleum Technology (United States) v 43:6. Coden:

JPTJA ISSN: 0022-3522

Publication Date: Jun 1991 p 662-667

Document Type: Journal Article

Language: In English

Journal Announcement: EDB9208

Subfile: ETD (Energy Technology Data Exchange); INS (US Atomindex input). NOV (DOE contractor)

US DOE Project/NonDOE Project: NP

Country of Origin: United States

Country of Publication: United States

Abstract: This paper summarizes the major U.S. and State of California environmental regulations relevant to thermal EOR processes and assesses their impact on the process. The environmental laws that have the greatest impact on thermal EOR processes pertain to air quality, water quality, hazardous wastes, and environmental quality. This paper also identifies the source and type of pollutant likely to be generated in a typical thermal EOR facility.

Major Descriptors: *ENVIRONMENTAL POLICY -- THERMAL RECOVERY; *THERMAL RECOVERY -- ENVIRONMENTAL POLICY; *THERMAL RECOVERY -- POLLUTION SOURCES

Descriptors: AIR QUALITY; CALIFORNIA; ENHANCED RECOVERY; HAZARDOUS MATERIALS; POLLUTANTS; REGULATIONS; USA; WASTES; WATER QUALITY

Broader Terms: DEVELOPED COUNTRIES; ENHANCED RECOVERY; ENVIRONMENTAL QUALITY; GOVERNMENT POLICIES; MATERIALS; NORTH AMERICA; RECOVERY; USA

Subject Categories: 021000* -- Petroleum -- Legislation & Regulations

020900 -- Petroleum -- Environmental Aspects

INIS Subject Categories: C5612* -- Environmental aspects of petroleum -- (1992-)

9/9/3 (Item 3 from file: 103)

03283967 NOV-92-014230; EDB-92-046724

Title: Control of waste gas from a thermal EOR operation

Author(s): Peavy, M.A.; Braun, J.E. (Oryx Energy Co. (US))

Source: Journal of Petroleum Technology (United States) v 43:6. Coden:

JPTJA ISSN: 0022-3522

Publication Date: Jun 1991 p 656-661

Document Type: Journal Article

Language: In English

Journal Announcement: EDB9208

Subfile: ETD (Energy Technology Data Exchange). NOV (DOE contractor)

US DOE Project/NonDOE Project: NP

Country of Origin: United States

Country of Publication: United States

Abstract: This paper summarizes a waste-gas treatment system designed to control emissions from thermal EOR wells. This case study discusses the need, design, installation, and operation of the system.

Major Descriptors: *GASEOUS WASTES -- WASTE PROCESSING; *THERMAL RECOVERY -- GASEOUS WASTES

Descriptors: AIR POLLUTION CONTROL; DESIGN; EMISSION; ENHANCED RECOVERY; INSTALLATION; OPERATION

Broader Terms: CONTROL; ENHANCED RECOVERY; MANAGEMENT; POLLUTION CONTROL; PROCESSING; RECOVERY; WASTE MANAGEMENT; WASTES

Subject Categories: 020800* -- Petroleum -- Waste Management

9/9/4 (Item 4 from file: 103)
02931389 GRA-90-72630; EDB-90-148633; ERA-15-049524
Title: Final response to BDAT related comments document. D009, K044, K045, K047, D011, P119, P120, and P and U wastes. Volume 1-I
Author(s)/Editor(s): Rosengrant, L.; Craig, R.
Corporate Source: Environmental Protection Agency, Washington, DC (USA).
Office of Solid Waste (Code: 9513743)
Publication Date: May 1990 (246 p)
Report Number(s): PB-90-234584/XAB EPA--530/SW-90/061K
Contract Number (Non-DOE): EPA-68-W9-0068
Note: See also Volume 1-H, PB--90-234576 and Volume 1-J, PB--90-234592.
Also available in set of 19 reports PC E99/MF E99, PB--90-234477
Document Type: Report
Language: In English
Journal Announcement: EDB9020
Availability: NTIS, PC A11/MF A02
Distribution: (Report):9 (MF):6 ND-00
Subfile: EPA (Energy Abstracts for Policy Analysis); ERA (Energy Research Abstracts); ETD (Energy Technology Data Exchange). GRA (NTIS NTS)
US DOE Project/NonDOE Project: NP
Country of Origin: United States
Country of Publication: United States

Abstract: The contents of this article include the following:
characteristic wastes for mercury p and u wastes containing mercury (data submission only, thermal recovery standard-demonstrability, establishment of bdat standard level below the characteristic level, stabilization as bdat or sulfide precipitated d009 as bdat, alternative treatment for debris and other wastes, reconsideration of the retort cutoff level, treatment standard mixed waste, and indigenous waste); wastes from the manufacturing and processing of explosives (treatment standard); characteristic wastes for silver (treatment standards, precipitation, and concentration-based standards vs. recovery or stabilization); vanadium containing wastes (treatment technology, waste classification, treatment standards, and data submission); and p and u wastes containing thallium (data submission).

Major Descriptors: *MERCURY -- STANDARDS

Descriptors: COMPLIANCE; DATA PROCESSING; EXPLOSIVES; GROUND DISPOSAL; HAZARDOUS MATERIALS; INDUSTRIAL WASTES; LEACHING; POLLUTION REGULATIONS ; REMEDIAL ACTION; SILVER; STABILIZATION; SULFIDES; TECHNOLOGY UTILIZATION; THALLIUM; VANADIUM; WASTE PROCESSING; WASTE WATER

Broader Terms: CHALCOGENIDES; DISSOLUTION; ELEMENTS; HYDROGEN COMPOUNDS; LIQUID WASTES; MANAGEMENT; MATERIALS; METALS; OXYGEN COMPOUNDS; PROCESSING; REGULATIONS; SEPARATION PROCESSES; SULFUR COMPOUNDS; TRANSITION ELEMENTS; WASTE DISPOSAL; WASTE MANAGEMENT; WASTES; WATER

Subject Categories: 540120* -- Environment, Atmospheric -- Chemicals

Monitoring & Transport -- (1990-)

540220 -- Environment, Terrestrial -- Chemicals Monitoring & Transport -- (1990-)

540320 -- Environment, Aquatic -- Chemicals Monitoring & Transport -- (1990-)

290300 -- Energy Planning & Policy -- Environment, Health, & Safety

VITRIFICATION

19/7/3 (Item 3 from file: 103)

03294907 EDB-92-057664

Title: The Hanford Waste Vitrification Plant Project Technology Exchange program

Author(s)/Editor(s): Woodcock, G.; Westphal, L.O.

Corporate Source: Westinghouse Hanford Co., Richland, WA (United States)

Sponsoring Organization: DOE USDOE, Washington, DC (United States)

Conference Title: American Nuclear Society annual meeting

Conference Location: Boston, MA (United States) Conference Date: 7-12 Jun 1992

Publication Date: Jan 1992 (6 p)

Report Number(s): WHC-SA-1427 CONF-920606--10

Order Number: DE92008081

Contract Number (DOE): AC06-87RL10930

Language: In English

Availability: OSTI; NTIS; INIS; GPO Dep.

Abstract: The status of the Hanford Waste Vitrification Plant (HWVP) Project is discussed, with its relationship to other waste vitrification efforts in the United States and abroad. The focus of this paper is on the benefits of the Technical Exchange program as a vehicle for making scientific, technical, and engineering data developed at a given site available to all organizations with interest in waste vitrification.

19/7/4 (Item 4 from file: 103)

03293700 EDB-92-056457

Title: Analyses of SRS waste glass buried in granite in Sweden and salt in the United States

Author(s)/Editor(s): Williams, J.P. (Tuskegee Inst., AL (United States));

Wicks, G.G. (Westinghouse Savannah River Co., Aiken, SC (United

States)); Clark, D.E. (Florida Univ., Gainesville, FL (United States))

; Lodding, A.R. (Chalmers Tekniska Hoegskola, Goeteborg (Sweden))

Corporate Source: Westinghouse Savannah River Co., Aiken, SC (United States)

Sponsoring Organization: DOE USDOE, Washington, DC (United States)

Conference Title: 5. international symposium on ceramics in nuclear and hazardous waste management

Conference Location: Cincinnati, OH (United States) Conference Date: 29 Apr - 3 May 1991

Publication Date: 1991 (13 p)

Report Number(s): WSRC-MS-90-370 CONF-9104261--6

Order Number: DE92009419

Contract Number (DOE): AC09-89SR18035

Language: In English

Availability: OSTI; NTIS; INIS; GPO Dep.

Abstract: Simulated Savannah River Site (SRS) waste glass forms have been buried in the granite geology of the Stirpa mine in Sweden for two years. Analyses of glass surfaces provided a measure of the performance of the waste glasses as a function of time. Similar SRS waste glass compositions have also been buried in salt at the WIPP facility in Carlsbad, New Mexico for a similar time period. Analyses of the SRS waste glasses buried in-situ in granite will be presented and compared to the performance of these same compositions buried in salt at WIPP.

19/7/5 (Item 5 from file: 103)

03293699 EDB-92-056456

Title: The DWPF product composition control system at Savannah River:

Statistical process control algorithm

Author(s)/Editor(s): Postles, R.L.; Brown, K.G.

Corporate Source: Westinghouse Savannah River Co., Aiken, SC (United States)

Sponsoring Organization: DOE USDOE, Washington, DC (United States)

Conference Title: Symposium on nuclear waste management

Conference Location: Cincinnati, OH (United States) Conference Date: 28 Apr - 2 May 1991

Publication Date: 1991 (11 p)

Report Number(s): WSRC-MS-91-104 CONF-9104256--15

Order Number: DE92009804

Contract Number (DOE): AC09-89SR18035

Language: In English

Availability: OSTI; NTIS; GPO Dep.

Abstract: The DWPF Process batch-blends aqueous radwaste (PHA) with solid radwaste (Sludge) in a waste receipt vessel (the SRAT). The resulting SRAT-Batch is transferred to the next process vessel (the SME) and there blended with ground glass (Frit) to produce a batch of feed slurry. The SME-Batch is passed to a subsequent hold tank (the MFT) which feeds a Melter continuously. The Melter produces a molten glass wasteform which is poured into stainless steel canisters for cooling and, ultimately, shipment to and storage in a geologic Repository. The Repository will require that the glass wasteform be resistant to leaching by any underground water that might contact it. In addition, there are processing constraints on Viscosity and Liquidus Temperature of the melt. The Product Composition Control System (PCCS) is the system intended to ensure that the melt will be Processible and that the glass wasteform will be Acceptable. Within the PCCS, the SPC Algorithm is the device which guides control of the DWPF process. The SPC Algorithm is needed to control the multivariate DWPF process in the face of uncertainties (variances and covariances) which arise from this process and its supply, sampling, modeling, and measurement systems.

19/7/6 (Item 6 from file: 103)

03293697 EDB-92-056454

Title: Numerical simulation of high-level radioactive nuclear waste glass production

Author(s)/Editor(s): Choi, I.G. (Westinghouse Savannah River Co., Aiken, SC (United States)); Ungan, A. (Purdue Univ., Indianapolis, IN (United States). Dept. of Mechanical Engineering)

Corporate Source: Westinghouse Savannah River Co., Aiken, SC (United States)

Sponsoring Organization: DOE USDOE, Washington, DC (United States)

Conference Title: International waste management conference

Conference Location: Seoul (Korea, Republic of) **Conference Date:** 21-26 Oct 1991

Publication Date: 1991 (10 p)

Report Number(s): WSRC-MS-91-099 CONF-911040--13

Order Number: DE92009901

Contract Number (DOE): AC09-89SR18035

Language: In English

Availability: OSTI; NTIS; INIS; GPO Dep.

Abstract: Vitrification of radioactive waste has become an international approach for converting highly radioactive wastes into a durable solid prior to placing them in a permanent disposal repository. The technology for the process is not new. The conversion melter is a direct descendant of all electric melters used for manufacturing of some commercial glass types. Therefore, the vitrification process of radioactive wastes inherits typical problems of all electric furnaces and creates some other specific problems such as noble metal sedimentation. The noble metals and nickel sulfides in the melter are heavier than molten glass and have a low solubility. In a reducing condition, these metals amalgamate and tend to settle on the melter floor. The metal deposit resulting from this settling has a potential to short circuit the melter. The objective of this paper is to identify the typical problems that have been encountered in the waste melter operations and to address how these problems can be tackled using state-of-the-art numerical simulation techniques. It is believed that the large amount of pilot-scale melter experience throughout the world, combined with the knowledge gained from state-of-the-art computer modeling techniques would give assurance that the existing and future radioactive wastes can be effectively converted into a durable glass material and safely placed in a permanent repository.

SOLIDIFICATION

15/7/3 (Item 3 from file: 103)

03293671 EDB-92-056428

Title: Choosing solidification or vitrification for low-level radioactive and mixed waste treatment

Author(s)/Editor(s): Gimpel, R.F.

Corporate Source: Westinghouse Environmental Management Co. of Ohio, Cincinnati, OH (United States).

Fernald Environmental Management Project

Sponsoring Organization: DOE USDOE, Washington, DC (United States)

Conference Title: Annual meeting of the Air and Waste Management Association (AWMA)

Conference Location: Kansas City, MO (United States) Conference Date: 21-26 Jun 1992

Publication Date: 14 Feb 1992 (16 p)

Report Number(s): FEMP-2256 CONF-9206114--2

Order Number: DE92009077

Contract Number (DOE): AC05-86OR21600

Language: In English

Availability: OSTI; NTIS; INIS; GPO Dep.

Abstract: Solidification (making concrete) and vitrification (making glass) are frequently the treatment methods recommended for treating inorganic or radioactive wastes. Solidification is generally perceived as the most economical treatment method. Whereas, vitrification is considered (by many) as the most effective of all treatment methods. Unfortunately, vitrification has acquired the stigma that it is too expensive to receive further consideration as an alternative to solidification in high volume treatment applications. Ironically, economic studies, as presented in this paper, show that vitrification may be more competitive in some high volume applications. Ex-situ solidification and vitrification are the competing methods for treating in excess of 450,000m³ of low-level radioactive and mixed waste at the Fernald Environmental Management Project (FEMP or simply, Fernald) located near Cincinnati, Ohio. This paper summarizes how Fernald is choosing between solidification and vitrification as the primary waste treatment method.

15/7/4 (Item 4 from file: 103)

03293659 EDB-92-056416

Title: Polyethylene encapsulation of mixed wastes: Scale-up feasibility

Author(s)/Editor(s): Kalb, P.D.; Heiser, J.H.; Colombo, P.

Corporate Source: Brookhaven National Lab., Upton, NY (United States)

Sponsoring Organization: DOE USDOE, Washington, DC (United States)

Conference Title: Waste management '92

Conference Location: Tucson, AZ (United States) Conference Date: 1-5 Mar 1992

Publication Date: 1991 (9 p)

Report Number(s): BNL-47122 CONF-920307--46

Order Number: DE92010046

Contract Number (DOE): AC02-76CH00016

Language: In English

Availability: OSTI; NTIS; INIS; GPO Dep.

Abstract: A polyethylene process for the improved encapsulation of radioactive, hazardous, and mixed wastes have been developed at Brookhaven National Laboratory (BNL). Improvements in waste loading and waste form performance have been demonstrated through bench-scale development and testing. Maximum waste loadings of up to 70 dry wt % mixed waste nitrate salt were achieved, compared with 13--20 dry wt % using conventional cement processes. Stability under anticipated storage and disposal conditions and compliance with applicable hazardous waste regulations were demonstrated through a series of lab-scale waste form performance tests. Full-scale demonstration of this process using actual or surrogate waste is currently planned. A scale-up feasibility test was successfully conducted, demonstrating the ability to process nitrate salts at production rates (up to 450 kg/hr) and the close agreement between bench- and full-scale process parameters. Cored samples from the resulting pilot-scale (114 liter) waste form were used to verify homogeneity and to provide additional specimens for confirmatory performance testing.

15/7/5 (Item 5 from file: 103)

03293635 EDB-92-056392

Title: Initial demonstration of DWPF process and product control strategy using actual radioactive waste

Author(s)/Editor(s): Andrews, M.K.; Bibler, N.E.; Jantzen, C.M.; Beam, D.C.
Corporate Source: Westinghouse Savannah River Co., Aiken, SC (United States)
Sponsoring Organization: DOE USDOE, Washington, DC (United States)
Conference Title: 93. annual meeting and exposition of the American Ceramic Society (ACerS)
Conference Location: Cincinnati, OH (United States) Conference Date: 28 Apr - 2 May 1991
Publication Date: 1991 (14 p)
Report Number(s): WSRC-MS-91-012 CONF-910430--23
Order Number: DE92009635
Contract Number (DOE): AC09-89SR18035
Language: In English
Availability: OSTI; NTIS; INIS; GPO Dep.

Abstract: The Defense Waste Processing Facility at the Savannah River Site (SRS) will vitrify high-level nuclear waste into borosilicate glass. The waste will be mixed with properly formulated glass-making frit and fed to a melter at 1150{degrees}C. Process control and product quality are ensured by proper control of the melter feed composition. Algorithms have been developed to predict the processability of the melt and the durability of the final glass based on this feed composition. To test these algorithms, an actual radioactive waste contained in a shielded facility at SRS was analyzed and a frit composition formulated using a simple computer spreadsheet which contained the algorithms. This frit was then mixed with the waste and the resulting slurry fed to a research scale, joule-heated melter operated remotely. Approximately 24 kg of glass were successfully prepared. This paper will describe the frit formulation, the vitrification process, and the glass durability.

15/7/6 (Item 6 from file: 103)
03287805 AIX-23-024974; EDB-92-050562
Title: Polymers in the nuclear power industry
Author(s): Phillips, D.C.; Burnay, S.G. (AEA Industrial Technology, Harwell (United Kingdom))
Title: Irradiation effects on polymers
Author(s)/Editor(s): Clegg, D.W.; Collyer, A.A. (Sheffield Polytechnic (United Kingdom)) (eds.)
Publisher: London (United Kingdom) Elsevier Applied Science
Publication Date: 1991 p 345-381 (460 p)
ISBN: 1-85166-563-3
Language: In English

Abstract: This chapter is concerned with practical uses of organic polymers in the nuclear industry in applications where they are subjected to high energy radiation. Materials based on organic polymers are used as widely in the nuclear industry because of their versatility, low cost, ease of manufacture, corrosion resistance, and many other advantages which make them attractive for a wide range of applications. They are used for coatings, seals, cables containers, gloveboxes for example. However, these materials are susceptible to damage by ionising radiation with resulting changes in properties. The following have been looked at in detail: coatings and liners, plastic surfaces, seals and cables. Polymeric materials have also been considered for the immobilisation of intermediate level radioactive waste. (author).

STABILIZATION

11/7/12 (Item 12 from file: 103)

03275974 EDP-92-038731

Title: Fiscal year 1992 program plan for evaluation and remediation of the generation and release of flammable gases in Hanford Site waste tanks

Author(s)/Editor(s): Johnson, G.D.

Corporate Source: Westinghouse Hanford Co., Richland, WA (United States)

Sponsoring Organization: DOE USDOE, Washington, DC (United States)

Publication Date: Jan 1992 (85 p)

Report Number(s): WHC-EP-0537

Order Number: DE92008383

Contract Number (DOE): AC06-87RL10930

Language: In English

Availability: OSTI; NTIS; INIS; GPO Dep.

Abstract: The Waste Tank Flammable Gas Stabilization Program was established in 1990 to provide for resolution of a major safety issue identified for 23 of the high-level waste tanks at the Hanford Site. This safety issue involves flammable gas mixtures, consisting mainly of hydrogen, nitrous oxide, and nitrogen, that are generated and periodically released in concentrations that exceed the lower flammability limit. Initial activities of the program have been directed at Tank 241-SY-101 because it exhibits the largest risk. The purpose of this document is to provide a brief description of the FY 1992 priorities, logic, work breakdown structure (WBS) and task descriptions for the Waste Tank Flammable Gas Stabilization Program. A major change for FY 1992 involves the core sampling and sample analyses. All activities associated with these tasks will be conducted under the Tank Waste Characterization Program (1N4). Resource requirements for the Waste Tank Flammable Gas Stabilization Program for fiscal years beyond 1) are given in the Waste Tank Safety Program Overview Plant (Gasper 1991).

11/7/9 (Item 9 from file: 103)

03284437 EDB-92-047194

Title: Technology needs for treatment of DOE's low-level mixed wastes

Author(s)/Editor(s): Harmon, L.H.; Rhoderick, J.E. (USDOE Office of Environmental Restoration and Waste Management, Washington, DC (United States). Office of Waste Operations); Borduin, L.C. (Los Alamos National Lab., NM (United States)); Musgrave, B.C. (Lawrence Livermore National Lab., CA (United States)); Ross, W.A. (Pacific Northwest Lab., Richland, WA (United States))

Corporate Source: Los Alamos National Lab., NM (United States)

Sponsoring Organization: DOE USDOE, Washington, DC (United States)

Conference Title: Waste management '92

Conference Location: Tucson, AZ (United States) Conference Date: 1-5 Mar 1992

Publication Date: 1992 (17 p)

Report Number(s): LA-UR-92-644 CONF-920307--30

Order Number: DE92008481

Contract Number (DOE): W-7405-ENG-36

Language: In English

Availability: OSTI; NTIS; INIS; GPO Dep.

Abstract: The US Department of Energy (DOE) stores and generates significant amounts of low-level mixed wastes (LLMW) consisting of radioactive materials mixed with hazardous chemical substances. Many of these wastes are regulated under the US Environmental Protection Agency (EPA) Land Disposal Restrictions and must be treated and disposed in compliance with applicable state and federal requirements. In general, treatment requirements include elimination of organic hazardous constituents and stabilization of inorganic hazardous constituents. Final waste forms must meet both EPA leach testing and DOE disposal acceptance criteria. The DOE currently does not have an adequate capability to meet these treatment objectives. The Mixed Waste Treatment Project has been established by the DOE to define needed LLMW

treatment capabilities as a basis for either a prototype plant design or an existing facility modifications. Existing DOE mixed waste data bases were analyzed to identify the range of waste quantities and types and to define broad treatment categories needed to bring these wastes into compliance. Using these treatment categories as a starting point, we constructed a baseline flow sheet defining process steps from receipt through final form. From this baseline flow sheet, we developed functional and operational requirements (F ORs) for each process train. An initial set of near-term technologies was identified for each process step, and alternative near- and long-term options were listed. Based on these analyses, we identified technology gaps and improvement needs in the areas of characterization, waste handling, segregation and sorting, size reduction, decontamination, materials recycle, primary and secondary treatment for RCRA compliance, offgas treatment, and final waste forms.

11/7/6 (Item 6 from file: 103)

03293611 EDB-92-056368

Title: ISV of a simulated seepage trench: A Radioactive Field Test at ORNL

Author(s)/Editor(s): Tixier, J.S.; Powell, T.D. (Pacific Northwest Lab., Richland, WA (United States)); Jacobs, G.K.; Spalding, B.P. (Oak Ridge National Lab., TN (United States))

Corporate Source: Oak Ridge National Lab., TN (United States)

Sponsoring Organization: DOE USDOE, Washington, DC (United States)

Conference Title: American Nuclear Society annual meeting

Conference Location: Boston, MA (United States) Conference Date: 7-12 Jun 1992

Publication Date: 1992 (6 p)

Report Number(s): CONF-920606-8

Order Number: DE92007832

Contract Number (DOE): AC05-84OR21400; AC06-76RL01830

Language: In English

Availability: OSTI; NTIS; INIS; GPO Dep.

Abstract: The pits and trenches used at Oak Ridge National Laboratory (ORNL) from 1951

through 1966 to dispose of over a million curies of radioactive liquid wastes are currently undergoing remedial investigations/feasibility studies to identify potential technologies for cleanup and/or stabilization. In situ vitrification (ISV) is a leading technology candidate because of the high risks associated with options requiring retrieval, and because of the high-quality waste form produced by ISV. The Radioactive Field Test, conducted on a simulated ORNL seepage trench, in May 1991, is the second step in evaluating ISV as a remedial action at these sites. This document discusses this field test.

ACID LEACHING

6/7/6 (Item 6 from file: 103)

02897784 GRA-90-01940; EDB-90-115025; ERA-15-040389; INS-90-029266

Title: Uranium ore treatment. June 1981-March 1990 (A Bibliography from the COMPENDEX data base). Report for June 1981-March 1990

Corporate Source: National Technical Information Service, Springfield, VA (USA)

Publication Date: May 1990 (110 p)

Report Number(s): PB-90-869785/XAB

Note: Supersedes PB--81-864290. See also PB--90-869777

Language: In English

Availability: NTISPC N01/MF N01

Abstract: The treatment of uranium ores is reviewed with emphasis placed on acid leaching as the primary step in the process. Tailing disposal and proper handling of radioactive materials is emphasized. Primary treatment procedures include ion-exchange, sulfuric acid leaching, solvent extraction, and sedimentation. Environmental aspects of uranium milling and mining are examined in a related published bibliography. (This updated bibliography contains 265 citations, all of which are new entries to the previous edition.)

6/7/7 (Item 7 from file: 103)

02897783 GRA-90-01939; EDB-90-115024; ERA-15-040388; INS-90-029265

Title: Uranium ore treatment. January 1970-May 1981 (A Bibliography from the COMPENDEX data base). Report for January 1970-May 1981

Corporate Source: National Technical Information Service, Springfield, VA (USA)

Publication Date: May 1990 (267 p)

Report Number(s): PB-90-869777/XAB

Note: See also PB--90-869785

Language: In English

Availability: NTISPC N01/MF N01

Abstract: The treatment of uranium ores is reviewed with emphasis placed on acid leaching as the primary step in the process. Tailing disposal and proper handling of radioactive materials is emphasized. Primary treatment procedures include ion-exchange, sulfuric acid leaching, solvent extraction, and sedimentation. Environmental aspects of uranium milling and mining are examined in a related published bibliography. (This updated bibliography contains 300 citations, none of which are new entries to the previous edition.)

6/7/8 (Item 1 from file: 6)

1475987 NTIS Accession Number: PB90-234618/XAB

Final Response to BDAT Related Comments Document. K071 and K106: Mercury Cell Process Wastes K086: Residues from Ink Production Wastes Containing Cyanide. Volume 1-L

Rosengrant, L. ; Craig, R.

Environmental Protection Agency, Washington, DC. Office of Solid Waste Corp.

Source Codes: 031287518

Report No.: EPA/530/SW-90/061N May 90 251p

Languages: English

Journal Announcement: GRAI9020

See also Volume 1-K, PB90-234600 and Volume 1-M, PB90-234626.

Also available in set of 19 reports PC E99/MF E99, PB90-234477.

NTIS Prices: PC A12/MF A02

Country of Publication: United States

Contents: Mercury cell process wastes (data submission only, thermal recovery standard-demonstrability, treatment standard for K071 and K106 wastewater, multimedia impacts, stabilization as BDAT option, retain existing BDAT standard for K071 nonwastewater, reconsideration of retort cutoff level, and indigenous waste); Chlorinated hydrocarbon wastes (no comments were received for this waste code); Residues from ink production (treatment standards, subcategories, total chromium vs hexavalent chromium, mixture and derived-from rule, and soft hammer); Waste leaching solution from acid leaching of emission control dust/sludge from secondary lead smelting (no comments were received for this issue); Wastes containing cyanide (analytical methodology, BDAT, treatment standards, and soil/debris).

6/7/9 (Item 2 from file: 6)

1475939 NTIS Accession Number: PB90-234121/XAB

Final Treatment Standards for Nonwastewater and Wastewater Forms of K100. Volume 12 (Memorandum rept)

Paintal, A. S.

Versar, Inc., Springfield, VA.

Corp. Source Codes: 060372000

Sponsor: Environmental Protection Agency, Washington, DC. Office of Solid Waste.

Report No.: EPA/530/SW-90/059L 8 May 90 38p

Languages: English

Journal Announcement: GRAI9020

See also Volume 11, PB90-234113 and Volume 13, PB90-234139. Sponsored by

Environmental Protection Agency, Washington, DC. Office of Solid Waste.

Also available in set of 25 reports PC E99/MF E99, PB90-234006.

NTIS Prices: PC A03/MF A01

Country of Publication: United States

Contract No.: EPA-68-W9-0068

Contents: The memorandum presents the technical support and rationale for the development of treatment standards for nonwastewater and wastewater forms of K100. According to 40 CFR Part 261.32 (hazardous wastes from specific sources), waste code K100 is listed as waste leaching solution from acid leaching of emission control dust/sludge from secondary lead smelting. Treatment standards for K100 wastes were originally scheduled to be promulgated as part of the Third Third rulemaking. However, a treatment standard of 'No Land Disposal Based on No Generation' for K100 nonwastewaters was promulgated on August 8, 1988, and was subsequently revised on May 1, 1989, (54 FR 18836) to be applicable only to nonwastewater forms of these wastes generated by the process described in the listing description and disposed after August 17, 1988, and not generated in the course of treating wastewater forms of these wastes (Based on No Generation).

6/7/10 (Item 1 from file: 41)

179043 92-00992

Treated waste/soil interactions and long-term metal mobility under acid rainwater leaching conditions

Donahoe, R.J.; Gong, Chang-Rui; Chasse, J.L.

Dep. Geol., Univ. Alabama, Box 870338, Tuscaloosa, AL 35487, USA

3. Annu. Symp. of the GCHSRC on Bioremediation, Fundamental and Effective

Application Beaumont, TX (USA) 21-22 Feb 1991

J. HAZARDOUS MATER VOL. 28, NO. 1-2, pp. 236-237, Publ.Yr: 1991

SUMMARY LANGUAGE - ENGLISH

Languages: ENGLISH

Journal Announcement: V23N1

Contents: Column flow-through experiments have been conducted in which a treated municipal waste effluent has been reacted with two silty loam and two sandy loam soil samples having different TOC values, clay contents, and densities to study the attenuation of waste solution metals on soil columns.

CHEMICAL TREATMENT

5/7/1 (Item 1 from file: 103)

03258380 NOV-91-026152; EDB-92-021137

Title: Chemical basis for pyrochemical reprocessing of nuclear fuel

Author(s): Ackerman, J.P. (Chemical Technology Div., Argonne National Lab., Argonne, IL (US))

Source: Industrial and Engineering Chemistry Research (United States) v 30:1. Coden: IECRE ISSN: 0888-5885

Publication Date: Jan 1991 p 141-145

Language: In English

Abstract: The integral fast reactor (IFR) is an advanced breeder reactor concept that includes on-site reprocessing of spent fuel and wastes. Spent metallic fuel from the IFR is separated from fission products and cladding, and wastes are put into acceptable forms by use of a compact pyrochemical process based on partition of fuel and wastes between molten salt and liquid metal. To minimize reagent usage and, consequently, waste volume, electrotransport between metal phases is used extensively for feed dissolution and product recovery, but chemical oxidation and reduction are required for some operations. This paper describes the processes that are used and presents the chemical theory that was developed for quantitatively predicting the results of both chemical and electrotransport operations.

5/7/2 (Item 2 from file: 103)

03242544 INS-91-033168; EDB-92-005301

Title: Mediated electrochemical hazardous waste destruction

Author(s)/Editor(s): Hickman, R.G.; Farmer, J.C.; Wang, F.T.

Corporate Source: Lawrence Livermore National Lab., CA (United States)

Sponsoring Organization: DOE USDOE, Washington, DC (United States)

Conference Title: IEC special symposium of the American Chemical Society

Conference Location: Atlanta, GA (United States) Conference Date: 1-3 Oct 1991

Publication Date: Aug 1991 (14 p)

Report Number(s): UCRL-JC-106676 CONF-9110158--2

Order Number: DE92001819

Contract Number (DOE): W-7405-ENG-48

Language: In English

Availability: OSTI; NTIS; INIS; GPO Dep.

Abstract: There are few permitted processes for mixed waste (radioactive plus chemically hazardous) treatment. We are developing electrochemical processes that convert the toxic organic components of mixed waste to water, carbon dioxide, and innocuous anions such as chloride. Aggressive oxidizer ions such as $\text{Ag}^{\text{sup } 2+}$ or $\text{Ce}^{\text{sup } +4}$ are produced at an anode. These can attack the organic molecules directly. They can also attack water which yields hydroxyl free radicals that in turn attack the organic molecules. The condensed (i.e., solid and/or liquid) effluent streams contain the inorganic radionuclide forms. These may be treated with existing technology and prepared for final disposal. Kinetics and the extent of destruction of some toxic organics have been measured. Depending on how the process is operated, coulombic efficiency can be nearly 100%. In addition, hazardous organic materials are becoming very expensive to dispose of and when they are combined with transuranic radioactive elements no processes are presently permitted. Mediated electrochemical oxidation is an ambient-temperature aqueous-phase process that can be used to oxidize organic components of mixed wastes. Problems associated with incineration, such as high-temperature volatilization of radionuclides, are avoided. Historically, $\text{Ag}(2)$ has been used as a mediator in this process. $\text{Fe}(6)$ and $\text{Co}(3)$ are attractive alternatives to $\text{Ag}(2)$ since they form soluble chlorides during the destruction of chlorinated solvents. Furthermore, silver itself is a toxic heavy metal. Quantitative data has been obtained for the complete oxidation of ethylene glycol by $\text{Fe}(6)$ and $\text{Co}(3)$. Although ethylene glycol is a nonhalogenated organic, this data has enabled us to make direct comparisons of activities of $\text{Fe}(6)$ and $\text{Co}(3)$ with $\text{Ag}(2)$. Very good quantitative data for the oxidation of ethylene glycol by $\text{Ag}(2)$ had already been collected. 4 refs., 6 figs.

5/7/3 (Item 3 from file: 103)

03183354 GRA-91-32591; EDB-91-110790

Title: Review of treatment for hazardous-waste streams (Chapter 21). Book chapter

Author(s)/Editor(s): Grosse, D.W.

Corporate Source: Environmental Protection Agency, Cincinnati, OH (United States). Hazardous Waste Engineering Research Lab.

Publication Date: 1991 (74 p)

Report Number(s): PB-91-191163/XAB EPA-600/D-91/088

Note: Pub. in Library of Environmental Science, v3 Aug 90 and Advances in Environmental Technology and Management, Mar 90.

Language: In English

Availability: NTIS

Abstract: The publication will examine some of the practices being used or considered for use at on-site or commercial hazardous waste treatment, storage and disposal facilities (TSDF). Options for managing hazardous wastes containing heavy metals and/or cyanide compounds involve conventional treatment processes, recycle/reuse applications and waste minimization. Some of the technologies to be reviewed in this section include: precipitation applications such as hydroxide (e.g. lime, magnesium and iron oxyhydroxide), sulfide and carbonate systems; reduction techniques employing chromium, mercury and selenium reducing agents; adsorption/selection techniques using activated carbon ion exchange and hydrous solids; stabilization/fixation with discussion on applications, interferences and landfill design; cyanide destruction, including chemical oxidation (e.g. alkaline chlorination, ozonation/photolysis), electrolytic decomposition and incineration; and pollution prevention measures such as source reduction, recycling and reuse. Each of these options will be described in terms of effectiveness of treatment in removing the hazardous constituents of interest and characterization of the generated treatment residuals or in the case of waste minimization practices, the degree to which the constituents of concern are eliminated at the point of waste generation.

5/7/4 (Item 1 from file: 6)

1538508 NTIS Accession Number: PB91-191163/XAB

Review of Treatment for Hazardous Waste Streams (Chapter 21) (Book chapter)

Grosse, D. W.

Environmental Protection Agency, Cincinnati, OH. Hazardous Waste Engineering Research Lab.

Corp. Source Codes: 034122080

Report No.: EPA/600/D-91/088 1991 74p

Languages: English Document Type: Journal article

Journal Announcement: GRAI9116

Pub. in Library of Environmental Science, v3 Aug 90 and Advances in Environmental Technology and Management, Mar 90.

NTIS Prices: PC A04/MF A01

Country of Publication: United States

Contents: The publication will examine some of the practices being used or considered for use at on-site or commercial hazardous waste treatment, storage and disposal facilities (TSDF). Options for managing hazardous wastes containing heavy metals and/or cyanide compounds involve conventional treatment processes, recycle/reuse applications and waste minimization. Some of the technologies to be reviewed in this section include: precipitation applications such as hydroxide (e.g. lime, magnesium and iron oxyhydroxide), sulfide and carbonate systems; reduction techniques employing chromium, mercury and selenium reducing agents; adsorption/selection techniques using activated carbon ion exchange and hydrolysis.

NEUTRALIZATION

10/7/1 (Item 1 from file: 103)

03289054 DE-92-003559; EDB-92-051811

Title: Application of UASB-reactors to industrial waste-water treatment; performance data and results in granulation control

Author(s): Morvai, L.; Mihaltz, P.; Czako, L.; Hollo, J. (Technical Univ., Budapest (Hungary). Inst. of Agricultural Chemical Technology)

Source: Acta Biotechnologia (Germany) v 11:5. Coden: ACBTD ISSN: 0138-4988

Publication Date: 1991 p 409-418

Language: In English

Abstract: Several types of high organic matter pollutants containing (COD-range: 3-50 kg.m⁻³) industrial waste waters were treated in laboratory scale (1.2-23 dm³) sludge blanket (UASB) and UASB-fixed bed hybrid (UBF) reactors. In most cases higher than 80% of COD-removal efficiency has been attained. The CO₂ content of the biogas developed was mainly influenced by the neutralization (base to acid) ratio related to feed pH. Cell immobilization by granule formation was considered as a change in microbial population: Enrichment and aggregate formation of Methanotrix-like filamentous microorganisms. Based on physiological and physical indexes of microbial selection and with regard to the different sensitivities of microorganisms to substrate inhibition, a new start-up method was developed for rapid (40-45 days) granulation of raw digested sludge. (orig.).

10/7/2 (Item 2 from file: 103)

03285898 EDB-92-048655

Title: Waste knowledge: The key to waste minimization

Author(s): Noskin, H.A. (Idaho National Engineering Lab., Idaho Falls (United States))

Title: DOE model conference on waste management and environmental restoration. Proceedings

Corporate Source: USDOE, Washington, DC (United States)

Conference Title: 6. annual Department of Energy model conference on waste management and environmental restoration

Conference Location: Oak Ridge, TN (United States) Conference Date: 29 Oct - 2 Nov 1990

Publication Date: 1990 p 1, Paper 12 (343 p)

Report Number(s): CONF-9010166--

Order Number: DE91010951

Language: In English

Availability: OSTI; NTIS; INIS

Abstract: Waste minimization is an important aspect of waste management. One very simple way to reduce or minimize waste is through good housekeeping. In this case segregation, and knowing what kind of waste you truly have. A key problem to waste management is the ultra-conservative approach GOCO's have taken. In a time when the contractors are playing catch-up, many decisions have been made without a common sense justification. These kinds of decisions are making a bad problem worse and at the same time confusing employees. Approximately 240,000 kg of hazardous waste is generated in the US annually. There are only about 250 operating hazardous waste landfills, and those are closing at a very fast rate. In addition, soon most hazardous waste will fall under the Land Disposal Restriction requirements. Segregation, neutralization, and sampling are important ingredients to solving waste problems. Make sure that the waste is characterized properly. Anti-c clothing should be visually inspected for hazardous waste contamination; if it hasn't been contaminated, it shouldn't be disposed of as hazardous waste. Non-listed acids and basics can be neutralized and removed. These good housekeeping measures, among other common sense ideas, can reduce waste generated at the source and give employees a clear understanding of good waste management.

10/7/3 (Item 3 from file: 103)

03284549 EDB-92-047306

Title: Effluent testing for the Oak Ridge Toxic Substances Control Act mixed waste incinerator emissions tests of January 16 and 18, 1991

Author(s)/Editor(s): Shor, J.T. (Oak Ridge National Lab., TN (United States)); Bostick, W.D.; Coroneos, A.C.; Bunch, D.H.; Gibson, L.V.; Hoffmann, D.P.; Shoemaker, J.L. (Oak Ridge K-25 Site, TN (United States))

Corporate Source: Oak Ridge K-25 Site, TN (United States)

Sponsoring Organization: DOE USDOE, Washington, DC (United States)

Publication Date: Feb 1992 (52 p)

Report Number(s): K/QT-407

Order Number: DE92008519

Contract Number (DOE): AC05-84OT21400

Language: In English

Availability: OSTI; NTIS; INIS; GPO Dep.

Abstract: On January 16 and 18, 1991, special emissions tests were conducted at the Oak Ridge, K-25 Site Toxic Substances Control Act (TSCA) Incinerator. Both tests were approximately 6 h long and were performed at TSCA temperatures (1200{degrees}C, secondary combustion chamber (SSC)). Liquid feed and effluent samples were collected every 30 min. A filter was used to collect particles from stack gases to study morphology and composition during the first test. Isokinetic air samples were also taken during the second test. Metals emissions from the second test were evaluated using the Environmental Protection Agency (EPA) Method 5 sampling train. The aqueous waste was collected and fed in batches to the Central Neutralization Facility (CNF), where it was treated by iron coprecipitation and polymer flocculation and data were collected. In the first test (1-16-91), the aqueous and organic wastes were fed directly to the kiln or primary combustion chamber (PCC). In the second test (1-18-91), the remaining organic waste from the first test was fed into the SSC, and other organic waste was fed into the PCC. One objective of the two tests was to determine if feeding the same organic waste into the two combustion chambers made a difference in a partitioning of uranium and other metals. No evaluation of radionuclides other than uranium was made. The partition coefficient of uranium to the quench water was 0.3 on January 16 and 0.35 on January 18; so directing Tank 306A to the feed to the primary vs the secondary combustion chamber appears to have made little difference. The partition coefficient of uranium to the stack on January 18 was 0.0039. 5 refs., 15 figs., 26 tabs.

10/7/4 (Item 4 from file: 103)

03275905 FRD-92-000131; EDB-92-038662

Title: Solidification of TRU wastes in a ceramic matrix

Original Title: Verfestigung TRU-haltiger abfaelle in keramischer matrix

Author(s)/Editor(s): Loida, A.; Schubert, G. (Kernforschungszentrum Karlsruhe GmbH (DE). Inst. fuer nukleare Entsorgungstechnik)

Corporate Source: Commission of the European Communities, Luxembourg (Luxembourg)

Publication Date: 1991 (86 p)

Report Number(s): EUR-13509

Order Number: TI92772855

Contract Number (Non-DOE): F11W-0021-D (B)

Language: In German

Availability: OSTI; NTIS (US Sales Only)

Abstract: Aluminumsilicate based ceramic materials have been evaluated as an alternative waste form for the incorporation of TRU wastes. These waste forms are free of water and - cannot generate hydrogen radiolytically, - they show good compatibility between the compounds of the waste and the matrix, - they are resistant against aqueous solutions, heat and radiation. R and D-work has been performed to demonstrate the suitability of this waste form for the immobilization of TRU-wastes. Four kinds of original TRU-waste streams and a mixture of all of them have been immobilized by ceramization, using glove box and remote operation technique as well. Clay minerals, (kaolinite, bentonite) and reactive corundum were selected as ceramic raw materials (KAB 78) in an appropriate ratio yielding 78 wt% $\text{Al}_{\text{sub } 2}\text{O}_{\text{sub } 3}$ and 22 wt% $\text{SiO}_{\text{sub } 2}$. The main process steps are (i) pretreatment of the liquid waste (concentration, denitration, neutralization, solid- liquid separation), (ii) mixing with ceramic raw materials and forming, (iii) heat treatment with T max. of 1300{sup 0}C for 15 minutes. The waste load of the ceramic matrix has been increased gradually from 20 to 50, in some cases to 60 wt.%.

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4 / 12 / 93