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ITEM 3

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Standard Guide for
DISPOSAL OF LABORATORY CHEMICALS AND SAMPLES[1]

This standard is issued under the fixed designation D 4447; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide is intended to provide the chemical laboratory manager with guidelines for the disposal of small quantitites of laboratory wastes safely and in an environmentally sound manner. This guide is applicable to laboratories that generate small quantities of chemical or toxic wastes. Generally, such tasks include, but are not limited to, analytical chemistry, process control, and research or life science laboratories. It would be impossible to address the disposal of all waste from all types of laboratories. This guide is intended to address the more common laboratory waste streams.

1.2 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of whoever uses this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Applicable Documents

2.1 *Department of Transportation Regulations:*

40 CFR 173 Shippers—General Requirements for Shipments and Packagings[2]
40 CFR 178 Shipping Container Specifications[2]
40 CFR 179 Specifications for Tank Cars[2]
40 CFR 261.3 Definition of Hazardous Waste[2]
40 CFR 261.33 Discarded Commercial Chemical Products, Off-Specifications Species, Container Residues, and Residues Thereof[2]
40 CFR 261.5 Special Requirements for Hazardous Waste Generated by Small Quantity Generators[2]
40 CFR 761 Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions[2]
49 CFR 172 Hazardous Materials Tables and Hazardous Materials Communications Regulations[2]

3. Summary of Guide

3.1 The necessary classification of the waste for shipping and manifesting is addressed both by their common or generic chemical name and by Department of Transportation (DOT) guidelines.

3.2 Various types of wastes are listed and defined in a manner necessary to segregate them for recovery, pretreatment, or disposal, or both.

3.3 Procedures are not for recovery of the materials, or to render them nonhazardous and amenable to municipal landfill or in-house disposal, or to prepare them for disposal in an authorized chemical waste disposal site.

3.4 Various methods of disposal are discussed.

3.5 Each type of waste is designated a specific recovery or pretreatment and disposal method. In most cases, disposal alternatives are offered.

4. Significance and Use

4.1 Laboratories rarely generate or handle large volumes of hazardous substances. However, the safe handling and disposal of these substances are impaired by diversity, toxicity, high hazard risks, and contemptuous familiarity. With the promulgation of the Resource Conservation and

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[1] This guide is under the jurisdiction of ASTM Committee D-34 on Waste Disposal and is the direct responsibility of Subcommittee D34.01 on Sampling and Monitoring.
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Recovery Act (RCRA) of 1976, more attention is being given to the proper handling and disposal of such materials. Laboratory management should designate an individual who will be responsible for waste disposal and must review the RCRA guidelines, in particular, the definition of a hazardous waste, the specific substances listed as hazardous, generator requirements and exclusions, and proper shipping and manifesting procedures. Because many laboratory employees could be involved in the proper (and improper) treatment and disposal of laboratory chemicals and samples, it is suggested that a safety and training program be designed and presented to all regarding procedures to follow in the treatment and disposal of designated laboratory wastes.

4.2 If practical and economically feasible, it is, of course, recommended that all laboratory waste be either recovered, re-used, or disposed of in-house. The disposal of laboratory samples, especially those received in large numbers or quantities from a specific source, can often be accommodated by returning the material to the originator, so he can combine them with larger quantities for recycling or disposal. However, should this not be the case, other alternatives are presented. This guide is intended only as a suggested organized method for classification, segregation, and disposal of chemical laboratory waste.

4.3 Even though the small quantity generator exclusion (40 CRF 261.5) may apply to laboratories, the professional laboratory supervisor and his or her employers must balance the importance of protecting human health and the environment from the adverse impact of potential mismanagement of small quantities of hazardous waste, with the need to hold the administrative and economic burden of management of these wastes under RCRA within reasonable and practical limits. Additionally, all lab supervisors should be aware of all current local, state, and federal regulations, and specific hazardous waste management facility criteria.

5. Classification of Waste Types

5.1 The individual responsible for classification and segregation must be familiar with the waste's chemical, physical, and hazardous properties. If the waste is ultimately to be disposed of off-site, it must be segregated, packaged, and classified according to defined DOT hazard classification, as specified in the DOT hazardous materials regulations 49 CFR 172.

5.2 The chemical waste may be segregated into the following waste types,

5.2.1 Trash, inert chemicals, non-toxic, non-reactive, non-ignitable, non-corrosive solids as per RCRA or DOT guidelines,

5.2.2 Weak aqueous acid solutions (<10 % weight) and related compounds,

5.2.3 Weak aqueous alkaline solutions (<10 % weight) and related compounds,

5.2.4 Concentrated aqueous acid solutions and related compounds,

5.2.5 Concentrated aqueous alkaline solutions and related compounds,

5.2.6 Flammable (flash point, closed cup, °F < 140°), non-halogenated organic solvents and related compounds,

5.2.7 Flammable halogenated organic solvents and related compounds,

5.2.8 Non-flammable non-halogenated organic solvents and related compounds,

5.2.9 Non-flammable halogenated organic solvents and related compounds,

5.2.10 Organic acids,

5.2.11 Organic bases,

5.2.12 Inorganic oxidizers, peroxides,

5.2.13 Organic oxidizers, peroxides,

5.2.14 Toxic heavy metals,

5.2.15 Toxic poisons, herbicides, pesticides, and carcinogens,

5.2.16 Aqueous solutions of reducing agents and related compounds,

5.2.17 Pyrophoric substances,

5.2.18 Water reactive substances,

5.2.19 Cyanide, sulfide, and ammonia bearing waste,

5.2.20 Explosive materials,

5.2.21 Radioactive materials,

5.2.22 Infectious waste in life science laboratories,

5.2.23 Infectious waste in hospitals,

5.2.24 Water soluble waste of unknown origin or properties,

5.2.25 Water insoluble wate of unknown origin or properties

5.2.26 Empty containers,

5.2.27 Asbestos or asbestos containing waste,

5.2.28 Contaminated labware and trash,

5.2.29 Polychlorinated biphenyls (PCBs).

6. Pretreatment and Recovery Methods

6.1 The following methods may be employed for the recovery or pretreatment of waste in the laboratory. All persons using chemicals in the laboratory must be aware of the toxic or hazardous properties of the substance(s) used, including consideration of the toxic properties of possible reaction products. In incorporating the following procedures, examine the possible hazards associated with each.

6.1.1 *Recovery, re-use*—Consideration should be given to distillation for the recovery of larger volumes of solvents. Many laboratories have systems for the recovery and re-use of mercury. Other recovery methods such as precipitation or crystallization may be practical.

6.1.2 *Dilution*—Many laboratory chemical wastes can be diluted to an extent to allow disposal to the sewer system. However, this procedure is not recommended for toxic substances exhibiting characteristics of eroaccumulation, persistence, or degradation to more toxic substances. Strong acid and bases should be diluted to pH 3-11 for this purpose. Some solutions of water soluble flammable solvents can be diluted enough to render them non-flammable. Small amounts of various heavy metal compounds may be diluted to an extent that does not pose a hazard to a sewer system. Consult the local wastewater treatment facility for acceptable guidelines.

6.1.3 *Neutralization*—Strong acids and bases can carefully be neutralized to pH 3-11 to render them less hazardous for disposal.

6.1.4 *Oxidation*—Compounds such as sulfides, cyanides, aldehydes, mercaptans, and phenolics can be oxidized to less toxic and less odoriferous compounds.

6.1.5 *Reduction*—In addition to oxidizers and peroxides, various organic chemicals and heavy metal solutions can be reduced to less toxic substances. Aqueous waste containing hexavalent chromium may be reduced to tri-valent using reducing agents such as bisulfite and ferrous sulfate. Mercury, lead, and silver may be removed from aqueous streams by the process of reduction/precipitation. Organo-lead compounds can be removed by the same type processes. The resulting concentrated heavy metal waste can be containerized and disposed of at an authorized hazardous waste management facility, or subjected to recovery at a treatment facility.

6.1.6 *Controlled Reactions/Processes*—Other methods for reducing the hazardous properties of waste will involve processes specific to particular waste generated by the laboratory. To be practical, the waste would have to be of sufficient volume and, for safety purposes, the process would need to be carefully studied and the resulting products identified. Examples may include evaporation, filtration, ion exchange, carbon adsorption, solvent extraction, hydrolysis, ozonolysis, and electrolysis.

7. Disposal Methods

7.1 *Containerization* (*Dumpster*)—This method should be used only in the disposal of inert laboratory solid waste. Each institution should have a procedure for handling solid waste to include classification, segregation, and collection. Materials disposed of in this manner must be suitable for sanitary landfill disposal and must be of no threat to the personnel handling the waste. Many materials disposed of in this manner by laboratories may be regulated by local authorities.

7.2 *Disposal to the Sewer System*—Many laboratory chemicals, with or without pretreatment by one or more of the above prescribed methods, are amenable to sewer disposal. RCRA regulations (40 CFR 261.3) grant special exemptions for laboratory effluents from hazardous waste regulations if the annualized average flow of laboratory wastewater is less than 1% of the total wastewater going to the headworks of the water treatment facility and the concentration of hazardous material is less than 1 ppm in the headwaters. Also, local regulations govern the concentrations and types of chemicals that may be let to a sewer. Laboratory supervisors must familiarize themselves and their co-workers with these regulations. In addition to the statements made earlier regarding dilution (5.1.2) and neutralization (5.1.3), it is important to emphasize that highly toxic, malodorous, or lachrymatory chemicals should not be disposed of down the drain. Laboratory drains are usually interconnected, and a substance that goes down one sink may arise as a vapor from another. Additionally, the comingling of waste from different sources in the sewer system may present definite hazards for example, the sulfide poured down one drain may contact an acid poured into another. Some simple reactions, such as ammonia plus iodine or silver nitrate plus ethanol, may produce explosions. Laboratory supervisors must be aware of the types of chemicals disposed in this manner so that the risk of potential laboratory accidents is reduced.

7.3 *Incineration, Solvent Recovery*—Waste solvents free of solids and corrosive or reactive substances should be collected, segregated, and containerized. Due to the fact that some incineration or solvent recovery sites will not handle chlorinated solvents, it is often necessary to segregate into two or three types of waste solvents. In addition to solvent recovery techniques that may be employed in the laboratory, some of these materials may be disposed of in-house by mixing with fuel oils for combustion in process boilers, power generators, etc. Additionally, outside disposal firms may be contacted for disposal, but they generally are less interested in handling small volume waste streams, particularly if inconsistent in composition. The laboratory supervisor should be aware of the chemicals collected, and ensure that incompatible materials are not comingled.

7.4 *Lab Pack*—Recent Environmental Protection Agency (EPA) regulations allow the disposal of small containers of hazardous waste (liquids and solids) in overpacked drums in secure or specially permitted landfills.

7.4.1 Each chemical is to be identified by its generic or common name, the quantity, and the DOT hazard classification. All chemicals are to be segregated and packaged according to the following classification: poisons, oxidizers, flammables, corrosives-acids, and corrosives-alkalies.

7.4.2 Many chemicals that are similarly classified will react for example, concentrated solutions of nitric acid mixed with acetic acid can cause spontaneous ignition. Therefore, an employee of the waste generator, familiar with the chemicals and their respective hazards, is to be responsible for not only segregation, but also for the documentation and packaging operations. Compatible materials, of the same classification, are to be packaged in tightly and securely sealed inside containers of the size and type specified in the DOT hazardous materials regulations 40 CFR 173, 178, and 179, if those regulations specify a particular inside container, and placed in DOT-approved open-top metal drums.

7.4.3 Vermiculite or an other inert and compatible material is to be placed around the original waste containers to avoid breakage and to act as an absorbent should any breakage or leakage occur. The chemicals are to be equally distributed within the drum with not less than an equal volume of vermiculite. The drums must be completely filled and properly sealed.

7.4.4 A list detailing the contents of each drum, including the chemicals' common or generic names, the DOT hazard classes, quantities of each, and any pertinent comments, must be available for completion of manifesting purposes and for the disposal firm.

7.5 *Solidification*—In addition to the lab pack, an alternate drum disposal method involves the solidification of compatible liquid chemical waste with vermiculite or a suitable solidification agent such as diatomaceous earth or clay.

7.5.1 A suggested procedure is as follows: A DOT-approved open-top metal drum (17 H) containing a free-standing liner is filled to approximately one-third with the adsorbent. The liquid waste is then carefully poured into the adsorbent, mixed, and allowed to stand. The liquid waste may need pretreatment (for example, neutralization, reduction, etc.) to render it compatible with the solidification agent. The remainder of the drum is then filled in the same manner. An extra layer of dry adsorbent (about 2 in.) is added to top-off the drum to contain any free liquid that may surface in transporting or handling. The drum must be completely full, contain only solids, properly sealed, and labeled.

7.5.2 A list detailing the contents of each drum, including the chemicals' common or generic names, the DOT hazard classes, quantities of each, and any pertinent information, must be available for manifesting purposes and for the disposal firm.

7.6 *Waste Exchange*—Evaluate the possibility of using a waste exchange for specific waste generated by a laboratory, especially if large quantities are produced. The laboratory's unused chemicals or waste may be another's reagent, with possibly only minor pretreatment methods.

8. Special Waste

8.1 Various types of waste cannot be readily disposed of within the laboratory, or through normal outside waste disposal contractors. Disposal alternatives for special waste are discussed.

8.1.1 *Local Fire and Police Department*—Local emergency response offices are often called upon by institutions for disposal of especially dangerous wastes, in most cases explosives. Examples of substances that may be handled in this manner are metallic sodium, picric acid, metal azides, organic azides, and organic peroxides. Often, this type of service is offered only in the larger metropolitan areas. If laboratory personnel are unable to perform controlled degradation processes, contact the local fire or police department for guidance.

8.1.2 *Radioactive Waste Disposal*—The method of disposal will depend upon the activity level, the type of waste, and the radiochemical properties of the isotopes. The two major methods for waste management are dilution for environmental disposal and containment. Dilution is the process of mixing the waste with sufficient inert material to reduce the concentration of activity below the permissible levels. An example would be the flushing of microcurie amounts of an isotope into the sewer system. Large concentrations may require precipitation or flocculation followed by filtration to remove the concentrated activity and the carrier. Nonetheless, any laboratory involved in radioactive waste disposal should be familiar with local regulations and the federal regulations set forth in the Code of Federal Regulations (CFR), Title 10, Chapter 1.

8.1.3 *Infectious Waste*—The USEPA has published a guide to infectious waste management.[2] The manual discusses environmentally acceptable techniques for infectious waste management. Topics covered include a definition of infectious waste, and packaging, transportation, treatment, storage, and disposal practices. Recommendations are presented for methods of treating different types of infectious waste.

8.1.4 *Polychlorinated biphenyls (PCB's) (4.2)*—The disposal of PCB's is well defined in Toxic Substance and Control Act (TSCA) regulations. PCB's in concentrations less than 50 ppm are currently non-regulated, and disposal in a municipal landfill is possible with local regulatory agency approval. Also, quantities of less than 50 ppm could be comingled with compatible organic wastes destined for incineration. PCB's in concentrations of 50 to 500 ppm are designated by TSCA as "PCB contaminated wastes," and those above 500 ppm "PCB wastes." Disposal of these wastes will require detoxification, or management at a facility approved by the USEPA for the disposal (incineration or landfilling) of PCB's. It is suggested that laboratory managers concerned with PCB disposal consult the TSCA regulations (40 CFR 761) and their regional EPA office.

9. Recommended Pretreatment and Disposal Methods for Laboratory Chemical Wastes

9.1 A summary of pretreatment and disposal methods for lab chemicals is given in Table 1 by waste type, however, applicable recovery methods are not given. Recovery methods are not indicated in this section, but rather, methods by which to prepare waste chemicals for disposal and the disposal methods themselves. As mentioned above, if practical and economical, recovery and re-use is the preferred method for the management of chemical waste. Additionally, controlled reactions/processes are not referred to since they are waste specific. Small quantities of pyrophoric and hydrophoric substances, under controlled conditions in the laboratory, could possibly be reduced to less hazardous compounds, forming products more easily managed. The disposal methods cited are those generally applicable to the types of wastes mentioned, and are recommended contingent upon a proper and thorough pretreatment, if necessary, and where prescribed.

9.2 Pretreatment and disposal methods are addressed separately for the following wastes:

9.2.1 *Water-Soluble Waste of Unknown Origin or Properties (4.2)*—In order to determine a proper disposal method for these wastes, the following minimal data should be determined: radioactivity, water solubility, pH, cyanide content, ignitability, sulfide content, and reactivity. Based on this information, the waste type and corresponding pretreatment and disposal method can be determined.

9.2.2 *Water-Insoluble Wastes of Unknown Origin or Properties (4.2)*—In order to determine a proper disposal method for these wastes, the following minimal data should be determined: ignitability (flash point), organic halide content, PCB content, total solids, and ash.

NOTE—If disposal of these materials is desired by methods other than through a hazardous waste management facility, a more complete analysis, sufficient for safe handling and disposal will be necessary.

9.2.3 *Empty Containers (4.2)*—Containers with less than three percent of the weight of the original contents of a hazardous substance would be classified as trash and proper disposal would be by means of containerization (6.1), unless they

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[2] *Draft Manual for Infectious Waste Management*, SW-957, USEPA, Washington, DC, September 1982.

contained substances as identified in 40 CFR 261.33(d). If so identified, the containers must be managed as specified in 40 CFR 261.33(c).

9.2.4 *Asbestos or Asbestos Containing Waste* (*4.2*)—Asbestos or asbestos containing waste must be wetted, and sealed into a leak-tight container while wet. The containers must bear a warning label stating: "Caution, contains asbestos—avoid opening or breaking container—breathing asbestos is hazardous to your health." Disposal is permitted only in authorized landfills.

9.2.5 *Contaminated lab ware, trash* (*4.2*)—Disposal for this type of waste is difficult to determine. Obviously, if the material cannot be recovered, cleaned, or used for another purpose, it must be disposed. The RCRA regulations should be reviewed to determine proper disposal (see 40 CFR 261.3). In essence, if the waste exhibits any of the characteristics lised in 40 CFR 261 Subpart C (ignitability, reactivity, corrosivity, or toxicity), or is a listed waste or a mixture of a solid waste and one or more wastes listed in 40 CRF 261 Subpart D, it is defined as a hazardous waste.

TABLE 1 Pretreatment and Disposal Methods

Waste Types (4.2)	Pretreatment Methods Section 5	Disposal Methods Section 6
Trash		containerization
Weak acids	dilution, neutralization	sewer solidification
Weak bases	dilution, neutralization	sewer solidification
Concentrated acids	dilution, neutralization	sewer lab pack solidification
Concentrated bases	dilution, neutralization	sewer lab pak solidification
Flammable non-halogenated solvents	...	incineration lab pack solidification
Flammable halogenated solvents	...	incineration lab pack solidification
Non-flammable, non-halogenated solvents	...	incineration lab pack solidification
Non-flammable, halogenated solvents	...	incineration lab pack solidification
Organic acids	neutralization	sewer incineration lab pack
Organic bases	neutralization	sewer incineration lab pack
Inorganic oxidizers	dilution, reduction	sewer lab pack
Organic oxidizers	dilution, reduction	sewer lab pack
Toxic metals	dilution, reduction	sewer lab pack solidification
Toxic organics	dilution, reduction	sewer lab pack solidification
Aqueous solutions of reducing agents	dilution, oxidation	sewer lab pack solidification
Pyrophorics	...	fire or police department
Hydrophorics	...	fire or police department
Cyanide, sulfide, or ammonia containing waste	dilution, oxidation	sewer lab pack
Explosives	...	fire or police department
Radioactive	...	special waste
Infectious wastes	sterilization, disinfection (see 7.1.3)	incineration lab pack
PCB's	...	see 7.1.4

RECOMMENDED READINGS

"Hazardous Waste Management System" (RCRA), U.S. Environmental Protection Agency, Part 261, *Federal Register*, May 19, 1980, pp 33083–33133.

Prudent Practices for Handling Hazardous Chemicals in Laboratories, National Research Council, National Academy Press, Washington, DC, 1981.

Prudent Practices for Disposing of Chemicals from Laboratories, National Academy Press, Washington, DC, 1983.

Sax, N. Irving, *Dangerous Properties of Industrial Materials*, Fifth Edition, Van Nostrand Reinhold Company, New York, NY, 1979.

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ITEM 4

Standard Guide for Sampling Waste and Soils for Volatile Organic Compounds

1. Scope

1.1 This guide describes recommended procedures for the collection, handling, and preparation of solid waste, soil, and sediment samples for subsequent determination of volatile organic compounds (VOCs). This class of compounds (i.e., VOCs) includes low molecular weight aromatics, hydrocabons, halogenated hydrocarbons, ketones, acetates, nitriles, acrylates, ethers, and sulfides with boiling points below 200°C that are insoluble or slightly soluble in water.

1.2 Methods of sample collection, handling, and preparation for analysis are described.

1.3 This guide does not cover the details of sampling design, laboratory preparation of containers, and the analysis of the samples.

1.4 It is recommended that this guide be used in conjunction with Guide D 4687.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

D 4687 Guide for General Planning of Waste Sampling
D 5792 Generation of Environmental Data Related to Waste Management Activities: Development of Data Quality Objectives
D 6051 Standard Guide for: Composite Sampling and Field Subsampling for Environmental Waste Management Activities
D 4700 Soil Sampling from the Vadose Zone
E 856 Definitions of Terms and Abbreviations Relating to Physical and Chemical Characteristics of Refuse–Derived Fuel

3. Terminology

3.1 *material, n*—for the purpose of this practice, material covers any soil, sediment, or waste that is solid.

3.1.1 The term "solid waste" is a reference to a waste that exists as a physical solid and is not a reference to the Recourse Conservation and Recovery Act (RCRA) specified definition (40 CFR 261.2) for solid waste.

3.2 *sample, n*—a portion of material taken from a larger quantity for the purpose of estimating properties or composition of the larger quantity. E 856

3.2.1 At the time of sample collection, a sample should ideally contain solids, liquids, and gases in the same proportions as the parent material, i.e., an intact sample. Although these equilibrium–driven proportions in the different phases change during sample preparation and analysis, the intention of the methods in this guide is to minimize overall VOC losses.

4. Summary of Guide

4.1 This guide addresses the use of tools for sample collection and transfer, conditions for sample storage, sample preservation, and two common means of sample preparation for analysis. Special attention is given to each step from sample collection to analysis to limit the loss of VOCs by volatilization or biodegradation. The sample collection, handling, and preservation methods are intended for use with two commonly used preparation methods for VOC analysis, methanol extraction and vapor partitioning (i.e., purge–and–trap and headspace).

The method of sample preparation for VOC analysis is dependent on the data quality objectives (see D 5792). Therefore, the advantages and disadvantages of these two sample preparation procedures, methanol extraction and vapor partitioning, are discussed first in this guide (Section 6), followed by discussions on sample collection and handling methods (Sections 7 and 8).

5. Significance and Use

5.1 This guide presents sample collection and handling procedures designed to minimize losses of VOCs, thereby providing more representative samples than achieved with most other methods. The principal mechanisms for the loss of VOCs from materials during collection and handling are volatilization and biodegradation. Susceptibility of various VOCs to these two loss mechanisms is both compound and matrix specific. In general, compounds with higher vapor pressures are more susceptible to volatilization than compounds with lower vapor pressures. Also, aerobically degradable compounds are generally more susceptible to biodegradation than anaerobically degradable compounds. In some cases, the formation of other compounds not originally present in the waste material can occur. Loss or gain of VOCs