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StandardGuide for Disposal of Laboratory Chemicals and Samples[1]

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1. Scope

1.1 This guide is intended to provide the chemical laboratory manager with guidelines for the disposal of small quantities 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 guide is intended to support compliance with environmental laws in the United States of America. Some of these laws provide for states to take over regulation of air quality or natural water quality with the approval of the Environmental Protection Agency (EPA). Other matters, such as laboratory waste tracking, disposal as household garbage and use of sewers, are handled at the state, local or provider level throughout the country. Examples of providers are air scrubber services, municipal sewer systems, municipal and private garbage services, and treatment, storage or disposal facilities (TSD). Go to the EPA home page, click Wastes > Regions/States/Tribes > States to get help locating state regulations. Unfortunately, it is not possible for any one source to provide all the information necessary for laboratories to comply with all regulations. To ensure compliance, the laboratory manager must communicate with regulators at all four levels.

1.3 Though it would be convenient to cite each reference by its Universal Resource Locator (URL), this guide eschews that (because such references are too labile) with the exception of http://www.epa.gov for the United States Environmental Protection Agency, http://www.dot.gov or http://www.hazmat.dot.gov for the United States Department of Transportation, and http://thomas.loc.gov to follow pending federal legislation in the United States. Intra-site links suggested here are also subject to obsolescence. However, one can enter in the web site search box the title of the document cited to locate it.

1.4 *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 *Department of Transportation Regulations:*[2]

49 CFR 172 Hazardous Materials Tables and Hazardous Materials Communications Regulations

49 CFR 172.203 DOT Hazardous Materials Table, Additional Description Requirements

49 CFR 173 Shippers—General Requirements for Shipments and Packagings

49 CFR 173.12(b) DOT Shippers' General Requirements for Shipments and Packagings. Exceptions for shipment of waste materials: Lab packs

49 CFR 178 Shipping Container Specifications

49 CFR 179 Specifications for Tank Cars

2.2 *EPA Regulations:*[3]

40 CFR 261 Protection of Environment. Identification and Listing of Hazardous Waste (includes 261.2, Definition of solid waste

40 CFR 261.3 Definition of Hazardous Waste

40 CFR 261.33 Discarded Commercial Chemical Products, Off-Specifications Species, Container Residues, and Residues Thereof

40 CFR 261.5 Special Requirements for Hazardous Waste Generated by Small Quantity Generators

40 CFR 262.34 RCRA Standards Applicable to Generators of Hazardous Waste. Accumulation Time

40 CFR 262.40 EPA Standards Applicable to Generators of Hazardous Waste. Recordkeeping and Reporting: Recordkeeping.

[1] This guide is under the jurisdiction of ASTM Committee D34 on Waste Management and is the direct responsibility of Subcommittee D34.01.01 on Planning for Sampling.

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[2] Available from PHMSA, U.S. Department of Transportation, 400 7th Street, SW, Washington, DC 20590; http://hazmat.dot.gov/regs/rules.htm

[3] Available from United States Environmental Protection Agency (EPA), Ariel Rios Bldg., 1200 Pennsylvania Ave., NW, Washington, DC 20460; http://www.epa.gov/epahome/lawregs.htm

40 CFR 262.42(b) EPA Standards Applicable to Generators of Hazardous Waste. Recordkeeping and Reporting: Exception reporting.
40 CFR 262.44 EPA Standards Applicable to Generators of Hazardous Waste. Recordkeeping and Reporting: Special requirements for generators of between 100 and 1000 kg/mo
40 CFR 262.100-108 EPA Standards Applicable to Generators of Hazardous Waste. University Laboratories XL Project—Laboratory Environmental Management Standard, Subpart J, and 52380 Federal Register/Vol 64, No. 187/Tuesday, September 28, 1999/Rules and Regulations; Project XL Site-specific Rulemaking for University Laboratories at the University of Massachusetts, Boston, MA, the Boston College, Chestnut Hill, MA, and the University of Vermont, Burlington, VT; Hazardous Waste Management System, EPA Final Rule
40 CFR 265.16 RCRA Hazardous Waste Training
40 CFR 403.5 EPA General Pretreatment Regulations for Existing and New Sources of Pollution. National pretreatment standards: Prohibited discharges.
40 CFR 761 Polychlorinated Biphenyls (PCB) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions

2.3 *Not-for-profit Institutions:*[4]

Managing Hazardous Wastes: HHMI Collaborative Project, Howard Hughes Medical Institute

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.

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

3.3 Procedures are not for recovery of the materials, or to render them non-hazardous and amenable to municipal landfill or in-house disposal, or to prepare them for disposal in an authorized chemical waste disposal site, but some sources for minimization activities are included.

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 "Stand-alone" laboratories rarely generate or handle large volumes of hazardous substances. However, the safe handling and disposal of these substances is still a matter of concern. Since the promulgation of the Resource Conservation and Recovery Act (RCRA) of 1976, more attention has been given to the proper handling and disposal of such materials. States may adopt more stringent requirements; information on this may be found along the path EPA Home > Wastes > Regions/States/Tribes > RCRA State Authorization > Data, Charts and Graphs (STATS) > State/Regional. To keep track of this, EPA classifies state regulatory language as *(1)* authorized, *(2)* procedural/enforcement, *(3)* broader in scope, and *(4)* unauthorized, and it publishes notices concerning the first three in the Federal Register.

4.2 Laboratory management should designate an individual who will be responsible for waste disposal and must review the RCRA guidelines, in particular:
40 CFR 261.3 - definition of a hazardous waste,
40 CFR 261.33 -specific substances listed as hazardous,
40 CFR 262 - generator requirements and exclusions, and proper shipping and manifesting procedures.

4.3 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 and is required by the EPA (40 CFR 265.16). For those who pack and ship, Hazardous Materials Shipper training is also required by DOT (49 CFR 172.203).[5]

4.4 If practical and economically feasible, it is, of course, recommended that all laboratory waste be either recovered, re-used, or disposed of in-house. 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. A university can set up its own chemical distributor to take orders from departments, order in economical quantities, sell at prorated bulk price plus expenses, and take back what is unused. For an example of a university central facility for minimizing over-ordering, storing chemical packages between uses, and disposing of hazardous wastes, see the web site of the University of Vermont, especially Procedure 12: Laboratory Waste Pickup and RCRA Hazardous Waste Determination.

4.5 The handling 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 account or process them, or both, and potentially combine them with larger quantities for recycling or disposal. Shipments of hazardous waste, including samples, are subject to RCRA regulations that do not apply to shipments of what is similar but not waste-like. A sample that was not a waste as received, and has not been contaminated or labeled as waste, need not be a waste when it is returned.

4.6 The small quantity generator exclusion (40 CFR 261.5) applies to some laboratories (those which generate less than 100 kg per month ~25 gal liquid). It is important to note that not every state allows the small quantity exclusion in this amount. Even so, the professional laboratory supervisor and his

[4] Howard Hughes Medical Institute, 4000 Jones Bridge Road, Chevy Chase, MD 20815–6789, (301) 215–8500.

[5] Where personnel changes have left a lab with potentially hazardous materials and no expertise in their safe handling and disposal, a Web search for the name of the material and "MSDS" will often provide a materials safety data sheet with basic information. Also helpful is Hazardous Technical Information Services of the Defense Logistics Agency, (800) 848-4847. For infectious agents, see Ref (5) in Recommended Reading at the end of this standard or call Centers for Disease Control at (404) 639-3311.

or her employers must balance the importance of *(1)* protecting human health and the environment from the adverse impact of potential mismanagement of small quantities of hazardous waste with *(2)* 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 of specific hazardous waste management facility criteria. Special rules have been made for some academic laboratories; see 40 CFR 262.100-108. Commercial services to facilitate Internet access to the regulations, and even to alert users to changes in chosen parts of these regulations, are available.[6]

5. Classification of Waste Types

5.1 *Classification:*

5.1.1 Hazardous waste is waste or a combination of wastes-including toxic, corrosive, irritating, sensitizing, radioactive, biologically infectious, explosive or flammable solid wastes that pose a present or potential threat to human health or the environment. There are three ways a waste can be required to be recognized as an RCRA hazardous waste. *(1)* The waste might contain certain listed chemicals, *(2)* the waste might have been generated from specific sources or manufacturing processes noted in the regulation, *(3)* the waste might display certain characteristics (D001-Ignitability, D002-Corrosivity, etc).

5.1.2 The individual responsible for classification and segregation must be familiar with the waste's chemical, physical, and hazardous properties in order to properly classify materials for disposal or transportation, or both. All generators of hazardous waste must register with EPA or State equivalent, but many laboratories may be classified as exempt or as small quantity generators.

5.1.3 *Priority Chemicals*—EPA OSW has identified 31 chemical categories (EPA Home > Wastes > Waste Minimization > Priority Chemicals & Fact Sheets) as priority hazards for bioaccumulation, given the quantities in which they have been used. That web page quantifies the hazards to the individual but does not guide disposal, since its focus is minimization. Disposal should be as shown in Section 7, but with increased priority to avoid environmental release. These are cadmium, lead, mercury, 1,2,4-trichlorobenzene, 1,2,4,5-tetrachlorobenzene, 2,4,5-trichlorophenol, 4-bromphenyl phenyl ether, acenaphthene, acenaphthalene, anthracene, benzo(g,h,i)perylene, dibenzofuran, dioxins/furans, endosulfan (alpha or beta), fluorine, heptachlor, heptachlor epoxide, hexachlorobenzene, hexachlorobutadiene, gamma-hexachlorocyclohexane, hexachloroethane, methoxychlor, naphthalene, the PAH group of polycyclic aromatic compounds, pendimethalin, pentachlorobenzene, pentachloronitrobenzene, pentachlorophenol, phenanthrene, pyrene, and trifluralin, in addition to polychlorinated biphenyls as mentioned in 8.1.4. Note that some of these have been acceptable household products, but their hazards to the environment if released in bioavailable form have since been recognized.

5.1.4 *Segregation*—In order to assist in the classification, transportation and disposal of chemicals, the chemical waste may be segregated into the following waste types:

5.1.4.1 Trash, inert chemicals, non-toxic, non-reactive, non-ignitable, non-corrosive solids in accordance with RCRA or DOT guidelines,

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

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

5.1.4.4 Concentrated aqueous acid solutions and related compounds,

5.1.4.5 Concentrated aqueous alkaline solutions and related compounds,

5.1.4.6 Ignitable (flash point, closed cup, °F < 140°) (°C < 60°), non-halogenated organic solvents and related compounds,

5.1.4.7 High total organic compounds (TOC) (≥10 %) ignitable, which RCRA prohibits from dilution into wastewater,

5.1.4.8 Ignitable halogenated organic solvents and related compounds,

5.1.4.9 Non-ignitable non-halogenated organic solvents and related compounds,

5.1.4.10 Non-ignitable halogenated organic solvents and related compounds,

5.1.4.11 Organic acids,

5.1.4.12 Organic bases,

5.1.4.13 Inorganic oxidizers, peroxides,

5.1.4.14 Organic oxidizers, peroxides,

5.1.4.15 Toxic heavy metals,

5.1.4.16 Toxic poisons, herbicides, pesticides, and carcinogens,

5.1.4.17 Aqueous solutions of reducing agents and related compounds,

5.1.4.18 Pyrophoric substances,

5.1.4.19 Water reactive substances,

5.1.4.20 Cyanide, sulfide, and ammonia bearing waste,

5.1.4.21 Explosive materials,

5.1.4.22 Radioactive materials,

5.1.4.23 Infectious waste,

5.1.4.24 Medical waste generated by medical research and by the medical treatment of human beings and animals,

5.1.4.25 Water soluble waste of unknown origin or properties,

5.1.4.26 Water insoluble waste of unknown origin or properties,

5.1.4.27 Empty containers,

5.1.4.28 Asbestos or asbestos containing waste,

5.1.4.29 Contaminated labware and trash, and

5.1.4.30 Polychlorinated biphenyls (PCBs).

5.2 *Transportation:*

5.2.1 If the waste is ultimately to be disposed of off-site, it must be segregated, packaged, and classified according to

[6] Examples of government regulations access services are CyberRegs, Citation Publishing, Inc., 2 Argonaut Suite 255 AlisoViejo, CA, 92656 (949) 770-2000, RegAlert, NETSCAN iPublishing Inc., 803 West Broad Street, Fourth Floor, Falls Church, VA 22046 and RegScan, Inc., 800 West Fourth Street, Williamsport, PA 17701 USA (800) 734-7226 (ext. 1415).

defined DOT hazard classification, as specified in the United States Department of Transportation (DOT) hazardous materials regulations 49 CFR 172, by a person formally trained to do so. The DOT Hazardous Materials Table assigns numbered Proper Shipping Names (PSN) to many compounds and mixtures, and those not otherwise specified (n.o.s.) that are hazardous are shipped under numbers and names assigned by hazard and state of matter followed by "n.o.s." and the name in parentheses of the most hazardous constituent. The International Air Transport Association (IATA) Dangerous Goods Regulations are the internationally acceptable equivalent of the DOT Hazardous Materials Regulations and are recognized by DOT and preferred by some parcel forwarding services, whose special restrictions they include. PSN, placards and hazard labels are almost the same, and the Shipper's Declaration for Dangerous Goods substitutes for the DOT shipping documents. It does not, however, substitute for the documents required by other agencies, such as EPA or state agencies EPA has authorized to administer RCRA requirements. The choice of DOT or IATA shipping documents does not affect whether a Hazardous Waste Manifest is required. Copies of the IATA Dangerous Goods Regulations are available for purchase.[7]

5.2.2 As stated by the EPA, "The Hazardous Waste Manifest System is a set of forms, reports, and procedures designed to seamlessly track hazardous waste from the time it leaves the generator facility where it was produced, until it reaches the off-site waste management facility that will store, treat or dispose of the hazardous waste."

5.2.3 The Hazardous Waste Manifest for each shipment meets EPA, DOT and state requirements.

6. Pretreatment and Recovery Methods

6.1 It should be noted that the EPA allows treatment without a permit in the accumulation containers or tanks or as part of the process prior to declaring the material a waste if the generator is in conformance with the requirements of 40 CFR 262.34 (accumulation time, limited to 90, 180 or 270 days if total exceeds 55 gal, or one quart if acutely hazardous, for the whole facility) and subparts J (Tanks) or I (Use and Management of Containers). 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. Cooling water can be cooled and re-used; cost of the equipment and energy might be offset by cost of water not used.

6.1.2 *Dilution*—Although many laboratory chemical wastes may be diluted to an extent to allow disposal to the sewer system, careful consideration of applicable laws (including the sewer use ordinance) must precede the disposal activity. However, this procedure is not recommended for toxic substances exhibiting characteristics of eroaccumulation, persistence, or degradation to more toxic substances. Concentrated trong acids and bases must never by poured down the drain, even if the drain is made to withstand them. Some solutions of water soluble ignitable solvents can be diluted enough to render them non-ignitable (closed cup flash point above 140°F or 60°C). Small amounts of various heavy metal compounds may be diluted to an extent that does not pose a hazard to a sewer system. However, RCRA listed wastes must not be diluted for disposal, even where the resulting concentrations of harmful compounds could be lawfully disposed had they not been parts of listed wastes. Often federal rules require an end of process monitoring site, which would preclude attaining compliance through mixing with other discharges that might help minimize the pH problem (such as detergents). CHECK WITH LOCAL SEWER AUTHORITIES FOR DISPOSAL REQUIREMENTS AND LIMITS. REMEMBER THAT LOCAL REGULATORY ACTIVITIES ARE PERMITTED TO BE MORE RESTRICTIVE THAN FEDERAL RULES INDICATE. There is good technical reason for local discretion: some water supplies have less alkalinity than others do; some sewer systems use concrete pipes that are very sensitive to acid, while others use plastic; some systems do not mix laboratory effluent with household effluent which tends to include detergents with buffering capacity, and use of these detergents is declining; some treatment works have more difficulty with low pH than others do. Users who corrode sewer pipes can be billed for their replacement. Once they are made aware of the problems, individual users are responsible for their discharges which cause (by what is called pass through or interference) that which comes out of a POTW to exceed its federal limits (40 CFR 403.5). Some POTW effluents are closer to state and federal limits for heavy metals than others are. Only discussion between the laboratory manager and the sewer system manager can make clear what is both lawful and harmless.

6.1.3 *Neutralization*—Strong acids and bases can carefully be neutralized into pH ranges specified by the local authority to render them less hazardous for disposal. Packaged automatic waste stream neutralization systems are available. Alternatively, if large organics are absent, intermittently acidic effluent can be passed through a bed of limestone that will dissolve as needed. An alarm for exhaustion of the neutralizer is needed.

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 similar processes. The resulting concentrated heavy metal waste can be containerized and disposed of

[7] Unz & Co., 8 Easy Street, Bound Brook, NJ 08805 (800) 631-3098