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Standard Guide 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, chemical laboratory safety officer, and other relevant staff 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 primarily intended to support compliance with environmental laws in the United States of America; however, the information contained herein can be useful to laboratories in other geopolitical jurisdictions. 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). 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 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

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.

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

[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

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
29 CFR 1910.1450 Occupational Exposure to Hazardous Chemicals in Laboratories

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 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 than required under RCRA. 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 treatment and disposal of laboratory chemicals and samples, it is recommended 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. This recommendation is required in the United States 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 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 University of Vermont website (http://www.uvm.edu/safety/lab/waste).

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 for processing and potentially combining with larger quantities of the same material 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 manager/supervisor and their employers must balance the importance of (*1*) protecting human health and the environment from the adverse impact of potential mismanagement of small quantities

[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 "SDS" will often provide a 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.

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 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 life, 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; and (*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 the State equivalent agency, 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 (https://archive.epa.gov/epawaste/hazard/wastemin/web/html/priority.html) as priority hazards for bioaccumulation, given the quantities in which they have been used. That website 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 chemical categories 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 substances have been considered acceptable household products, but their hazards to the environment if released in bioavailable form are now 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 offsite, it must be segregated, packaged, and classified according to defined DOT hazard classification, as specified in the United

[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).

States Department of Transportation (DOT) Hazardous Materials Regulations 49 CFR 172, by a person formally trained to do this. The DOT Hazardous Materials Table assigns numbered Proper Shipping Names (PSNs) 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. PSNs, 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 offsite 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 into a sewer system, careful consideration of applicable laws (including sewer use ordinances) must precede the disposal activity. However, this procedure is not recommended for toxic substances exhibiting characteristics of bioaccumulation, persistence, or degradation to more toxic substances. Concentrated strong 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 of 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; 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 publicly owned treatment works (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 be carefully 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 quantities of organics are absent, intermittently acidic effluent can be passed through a bed of limestone that will dissolve and neutralize the acid as needed. An alarm for exhaustion of the neutralizer is needed in this case.

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 or oxidation states. Aqueous waste containing hexavalent chromium may be reduced to tri-valent chromium 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.

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

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, chelation, filtration, ion exchange, carbon adsorption, combustion, solvent extraction, hydrolysis, ozonolysis, and electrolysis. As the quantity of contaminants in wastewater increases to make its discharge to a POTW less acceptable, the feasibility increases of applying the principles of wastewater treatment and water purification in-house. These principles include comminution, aerobic and anaerobic biodegradation, coagulation, flocculation, flotation (including that aided by bringing out of solution dissolved air or nitrogen), centrifugation, and filtration. Note that the priority chemicals listed in 5.1.3 resist natural degradation. As the proportion of hydrophobic material approaches that of water in an emulsion, adding well-chosen surfactants can become useful in breaking up the emulsion.

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 in this manner by laboratories may be regulated by local authorities.

7.2 *Disposal to the Sewer System, for example, Publicly Owned Treatment Works (POTW)*—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 coworkers with these regulations. In addition to the statements made earlier regarding dilution (6.1.2) and neutralization (6.1.3), 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. Massive discharge of clean water to a POTW is harmful because it needlessly increases the volume to be treated. For cooling water, consider a separate drain to a pond or storm sewer, ensuring that only clean water can go into this drain.

7.3 *Permitted Thermal Treatment, Solvent Recovery*—Waste solvents free of solids and corrosive or reactive substances should be collected, segregated, and containerized. Noxious vapors from such containers can be controlled with an aspirator. 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., if allowed by state regulation. 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. Due to the fact that some thermal treatment or solvent recovery sites will not handle chlorinated solvents, it is often necessary to segregate into two or three types of waste solvents. The laboratory manager/supervisor should be aware of the chemicals collected, and ensure that incompatible materials are not commingled.

7.4 *Lab Pack*—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. For a generator shipping of 101 to 1000 kg of hazardous waste per month to a licensed disposal facility, recordkeeping requirements are minimal (40 CFR 262.44). Unless the EPA has requested otherwise or has an enforcement action underway, the Hazardous Waste Manifest and any test results must be kept for three years (40 CFR 262.40). If the disposal facility has not acknowledged in writing receipt of a shipment sent 60 days earlier, the generator must send the Hazardous Waste Manifest with a note to the EPA Regional Administrator (40 CFR 262.42(b)). For large quantity generators (>1000 kg/month), a signed copy of the manifest indicating receipt at the disposal facility must be received within 45 days of initial shipment.

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, ignitables, corrosives-acids, and corrosives-alkalies. See 49 CFR 173.12(b) for materials that may be lab packed.

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, 40 CFR 178, and 40 CFR 179, if those regulations specify a particular inside container, and placed in DOT-approved open-top metal drums.