



Standard Guide for Packaging and Shipping Environmental Samples for Laboratory Analysis¹

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1. Scope*

1.1 This standard provides guidance on the selection of procedures for proper packaging and shipment of environmental samples to the laboratory for analysis to ensure compliance with appropriate regulatory programs and protection of sample integrity during shipment.

1.2 This standard does not address transport of hazardous wastes for disposal purposes.

1.3 This standard does not address the selection of parameter-specific sample bottles or containers.

1.4 This guide offers an organized collection of information or a series of options and does not recommend a specific course of action. This guide cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this guide may be applicable in all circumstances. This guide is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this guide be applied without consideration of the many unique aspects of a project. The word “standard” in the title of this guide means only that the guide has been approved through the ASTM consensus process.

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 requirements prior to use.*

2. Referenced Documents

2.1 ASTM Standards:²

[D653 Terminology Relating to Soil, Rock, and Contained Fluids](#)

¹ This guide is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.21 on Groundwater and Vadose Zone Investigations.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard’s Document Summary page on the ASTM website.

[D4220 Practices for Preserving and Transporting Soil Samples](#)

[D4840 Guide for Sample Chain-of-Custody Procedures](#)

[D5079 Practices for Preserving and Transporting Rock Core Samples](#)

[D5903 Guide for Planning and Preparing for a Groundwater Sampling Event](#)

[D6089 Guide for Documenting a Groundwater Sampling Event](#)

[D6517 Guide for Field Preservation of Groundwater Samples](#)

2.2 Shipping Regulations:

[International Air Transport Association \(IATA\) Dangerous Goods Regulations, 56th Edition, January 2015, or current edition](#)

[International Atomic Energy Agency \(IAEA\) Regulations for the Safe Transport of Radioactive Material, Section 10, Publication IAEA TS-R-1 \(2005\), or current edition](#)

[International Civil Aviation Organization \(ICAO\) Technical Instructions for the Safe Transport of Dangerous Goods by Air, Document #9284-AN/905 \(2013-2014 edition\), or current edition](#)

[United States Government Printing Office, Title 40 Code of Federal Regulations Resource Conservation and Recovery Act \(RCRA\), Part 261](#)

[United States Government Printing Office, Title 49 Code of Federal Regulations Transportation \(DOT\), Parts 170-174](#)

[United States Postal Service, Hazardous, Restricted and Perishable Mail USPS Publication 52 \(Updated May 15, 2014\), or current edition](#)

3. Terminology

3.1 For definitions of common terminology terms used within this guide, refer to Terminology [D653](#).

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *carrier*—a commercial company that is responsible for the actual shipment of environmental samples from the point of sample receipt from the shipper to the sample’s final destination.

3.2.2 *dangerous goods*—those goods that meet the criteria of one or more of nine United Nations (UN) hazard classes

*A Summary of Changes section appears at the end of this standard

and, where applicable, one of three UN packaging groups according to the provisions of shipping regulations.

3.2.3 *environmental sample*—containerized liquids, solids or gases that are collected for the purpose of laboratory analysis.

3.2.4 *inner packaging*—packaging for which an outer package is required for transport (for example, a sample bottle or container).

3.2.5 *outer packaging*—the outer protection of a composite or combination packaging together with any absorbent materials, cushioning and any other components necessary to contain and protect sample bottles or inner packaging.

3.2.6 *shipper*—the person who actually packages and presents environmental samples to a commercial carrier for shipment or who personally transports samples. The shipper is commonly the person who collected the environmental samples.

3.2.7 *shipping*—the commercial or private transport of environmental samples via highway, rail, vessel or aircraft.

4. Significance and Use

4.1 This standard provides guidance in determining the most appropriate procedures for packaging and shipping environmental samples. Use of this guide by personnel involved in packaging and shipping environmental samples will facilitate safe, effective and compliant procedures.

4.2 Due to the changing nature of regulations and other information, users are advised to thoroughly research requirements related to packaging and shipping prior to initiating a sampling event that will require shipment of the samples.

5. Regulatory Requirements

5.1 The shipment of many environmental samples falls under the jurisdiction of national and standardized international regulations whenever samples exhibit one or more properties that classify the samples as being dangerous or hazardous. Not all environmental samples, however, satisfy the criteria for being classified as dangerous or hazardous substances. These samples can be packaged and shipped as non-regulated or non-hazardous environmental samples.

5.2 It is the shipper's responsibility to determine which regulations apply to the environmental samples requiring shipment. This determination must be made prior to sample collection to ensure compliance with shipping regulations at the conclusion of sample collection. The primary sources of shipping regulations that can apply to environmental samples in the United States include the U.S. Department of Transportation (DOT), the International Air Transport Association (IATA), and the U.S. Postal Service (USPS). DOT regulations govern transport of samples by water, rail, roadway and air; IATA regulations govern air transport of samples; USPS regulates both ground and air delivery of samples through the U.S. Postal System. Other agencies such as the U.S. Department of Agriculture (USDA) (restrictions on interstate shipment of soil samples to prevent the spread of biological contaminants), The International Atomic Energy Agency (IAEA) (transport of radioactive materials by air), the Interna-

tional Civil Aviation Organization (ICAO) (shipment of the dangerous goods by air). The International Maritime Dangerous Goods Code (shipment by vessel) may also need to be considered. Sample shippers must also be aware of the potential for restrictions on shipping samples at both the state and local levels. Shippers should contact state and local agencies to determine any shipping restrictions. Other countries may have additional or equivalent agencies and regulations.

5.3 Should dangerous or hazardous samples be shipped using methods not in full compliance with applicable regulatory requirements, the following penalties can be assessed to the shipper:

5.3.1 Refusal to deliver the environmental samples to their intended destination, which can result in sample integrity being compromised, chain-of-custody being broken, or sample holding times being exceeded;

5.3.2 Assessment of financial penalties which can be severe; and/or

5.3.3 Imprisonment for blatant illegal shipment of dangerous or hazardous substances.

6. Procedures for Packaging and Shipping Environmental Samples

6.1 *Planning*—As indicated in Guide **D5903**, the Sampling and Analysis Plan (SAP) for a project will specify the number of samples to be collected for each medium being sampled (for example, soil, groundwater, surface water, soil gas, sediment and corresponding quality control samples). This SAP will also include a discussion on the need to plan for the appropriate number, size(s), and type(s) of outer packaging based on the number and sizes of sample containers to be filled and to plan for adequate space in outer packaging to accommodate inner packing materials and temperature controls. The SAP will specify the analyses to be performed on each sample and should also indicate the type of sample bottle or container and volume required for each analyte. The SAP should also provide guidance on selection of the methods for sample packaging and shipment of samples to the laboratory for analysis when dangerous or hazardous samples are anticipated.

6.2 *Regulatory Responsibilities of the Shipper*—The sample shipper is responsible for ensuring that all environmental samples are packaged, labeled, and marked in a manner that is consistent with applicable shipping regulations. Failure to do so puts the shipper at risk of the penalties discussed in **5.3**.

6.3 *Determination of Dangerous or Hazardous Properties of Environmental Samples*:

6.3.1 Prior to collection of environmental samples, it is necessary to determine the hazard class of a sample. If this is unknown, the shipper must use best professional judgment to determine the potential for samples to exhibit one or more hazardous characteristics (for example, through background research review, interviews and review of purchasing and disposal records) and to determine the appropriate degree of danger associated with those hazardous properties as defined by applicable shipping regulations (see **Note 1**). **Table 1** summarizes the nine United Nations (UN) hazard classes that are defined within shipping regulations and provides three

TABLE 1 Summary of United Nations Hazard Classes

Class 1	Explosives
Class 2	Gases
Class 3	Flammable Liquids
Class 4	Flammable Solids; Substances Liable to Spontaneous Combustion; Substances Which, in Contact with Water, Emit Flammable Gases (for example, soil sample contaminated with high concentrations of gasoline released from an underground storage tank)
Class 5	Oxidizing Substances and Organic Peroxide
Class 6	Toxic and Infectious Substances (for example, samples of refuse collected from a solid waste landfill)
Class 7	Radioactive Material
Class 8	Corrosives (for example, nitric acid used for preservation of some groundwater samples) (see Note 2)
Class 9	Miscellaneous Dangerous Goods

examples of environmental samples that might meet the criteria of a given hazard class. [Table 2](#) summarizes the degree of hazard associated with dangerous goods being shipped as defined by applicable shipping regulations.

NOTE 1—Dangerous or hazardous properties of environmental samples are as defined specifically by shipping regulations. Definitions developed for use under other regulatory programs may be substantially different and are not applicable. For example, a corrosive liquid under IATA definition is “a substance which, in the event of leakage, can cause severe damage by chemical action when in contact with living tissue or can materially damage other freight or the means of transportation.” This is determined through a series of intact skin tissue exposure tests and/or corrosive tests on steel or aluminum for defined exposure periods. Under the Resource Conservation and Recovery Act (RCRA), a corrosive liquid is defined as a liquid with a pH less than or equal to 2 or greater than or equal to 12.5, as determined by a pH meter using EPA Method 9090.

NOTE 2—In a letter dated April 11, 1979, the Associate Director for Hazardous Materials Regulation of the Research and Special Programs Administration granted exception to the DOT hazardous materials regulations for water samples containing the corrosives: hydrochloric acid, mercuric chloride, nitric acid, sulfuric acid, sodium hydroxide and phosphoric acid. The listed corrosives include the preservatives commonly used in water samples. This exception was revalidated in a letter first issued on April 11, 1979, reconfirmed on December 13, 1993 and again in a letter dated February 14, 1997, and February 2003 and in Interpretation #08–0222 dated October 2, 2008. This exception may not apply in other shipping regulations. When in doubt, consult the regulations, interpretations, and exemptions in place for the materials and quantities in question.

6.3.1.1 When the actual hazard class of a sample is unknown, the most conservative packaging group possible for the chosen shipping name must be used. Refer to [6.4.1](#) for guidance on choosing the appropriate shipping name.

6.3.2 It is possible that environmental samples may not exhibit a dangerous or hazardous property and, as such, may be packaged and shipped as a non-regulated sample using methods described in [6.5](#) and [6.6](#). Other packaging and shipping guidance is provided in Practices [D4220](#), [D5079](#), and [D6517](#).

6.3.3 The shipper must make the determination of sample hazard prior to collection to ensure that an appropriate carrier has been selected to transport samples to the laboratory and to

TABLE 2 Summary of Packing Groups By Hazard Level

Packing Group I—High (Great) Danger
Packing Group II—Medium Danger
Packing Group III—Low (Minor) Danger

ensure that appropriate packaging materials are available in the field at the time of sample preparation for shipping.

6.4 Determination of Proper Shipping Name and UN Number for Dangerous or Hazardous Samples:

6.4.1 Once the shipper has determined that an environmental sample does or will likely exhibit one or more hazardous characteristics, the shipper must select the “proper shipping name” for the sample as defined by the regulations under which the sample is to be shipped (see [Table 3](#)). These shipping names are standard names used in the shipping industry to identify the dangerous article or substance on the outside of the package and on the “Shipper’s Declaration for Dangerous Goods” and are not names created at random by the shipper. To determine the proper shipping name for each environmental sample, the shipper must refer to the shipping regulations that will be followed directly. It is possible for there to be more than one shipping name. The selected shipping name must accurately reflect the chemical, physical or biological characteristics of the sample being shipped and must not include a Trade name.

6.4.2 When selecting the proper shipping name, the shipper must consider:

- 6.4.2.1 The dangerous or hazardous property of the sample,
- 6.4.2.2 If the sample is classified as a solid (for example, soil or sediment), liquid (for example, groundwater or surface water) or gas (for example, soil gas or atmospheric air),
- 6.4.2.3 The anticipated or known contaminant(s) contained in the sample,
- 6.4.2.4 Whether the contaminant is present in a pure form or a mixture, and
- 6.4.2.5 The preferred method of sample shipment (for example, ground transportation versus overnight air transportation).

6.4.3 Once selected, the proper shipping name is used by the shipper to obtain the following information from the appropriate shipping regulations:

- 6.4.3.1 The corresponding UN number,
- 6.4.3.2 Correct sample packaging (inner and outer packaging),
- 6.4.3.3 Required package labels and markings,
- 6.4.3.4 Restrictions on sample volumes per package,
- 6.4.3.5 Applicable exceptions for small quantity shipments (see [Note 3](#)), and
- 6.4.3.6 Available shipping options (for example, passenger versus cargo aircraft).

TABLE 3 Examples of Proper Shipping Names and Associated UN Numbers

Proper Shipping Name/Description	UN Number	Example of Environmental Sample
Flammable solid, organic, n.o.s.	1325	Soil sample saturated with gasoline
Nitric acid	2031	Sample preservative that is other than red fuming, with 70 % or less, but more than 20 % nitric acid
Refrigerant gas, n.o.s. (Tetrafluoromethane, Trifluoromethane)	1078	Surface water sample containing mixture of Freon 14™ and Freon 23™