Designation: E1266 – 12

Standard Practice for Processing Mixtures of Lime, Fly Ash, and Heavy Metal Wastes in Structural Fills and Other Construction Applications[1]

This standard is issued under the fixed designation E1266; 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 practice provides descriptions and references of existing test methods and commercial practices relating to the processing of lime, fly ash, and heavy metal wastes in construction applications.

1.2 *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:*[2]

C5 Specification for Quicklime for Structural Purposes
C25 Test Methods for Chemical Analysis of Limestone, Quicklime, and Hydrated Lime
C109/C109M Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)
C110 Test Methods for Physical Testing of Quicklime, Hydrated Lime, and Limestone
C206 Specification for Finishing Hydrated Lime
C207 Specification for Hydrated Lime for Masonry Purposes
C311 Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete
C400 Test Methods for Quicklime and Hydrated Lime for Neutralization of Waste Acid
C593 Specification for Fly Ash and Other Pozzolans for Use With Lime for Soil Stabilization
C618 Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
C821 Specification for Lime for Use with Pozzolans
C911 Specification for Quicklime, Hydrated Lime, and Limestone for Selected Chemical and Industrial Uses
C977 Specification for Quicklime and Hydrated Lime for Soil Stabilization
D559 Test Methods for Wetting and Drying Compacted Soil-Cement Mixtures (Withdrawn 2012)[3]
D560 Test Methods for Freezing and Thawing Compacted Soil-Cement Mixtures (Withdrawn 2012)[3]
D1557 Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3))
D1633 Test Methods for Compressive Strength of Molded Soil-Cement Cylinders
D2434 Test Method for Permeability of Granular Soils (Constant Head)
D2435 Test Methods for One-Dimensional Consolidation Properties of Soils Using Incremental Loading
D3877 Test Methods for One-Dimensional Expansion, Shrinkage, and Uplift Pressure of Soil-Lime Mixtures
D3987 Practice for Shake Extraction of Solid Waste with Water
D4318 Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
D5681 Terminology for Waste and Waste Management
E850 Guide for Characterization of Inorganic Process Wastes for Use as Structural Fill

2.2 *Environmental Protection Agency Documents:*

EPA/600/R-09-148 Technology Performance Review: Selecting and Using Solidification/Stabilization Treatment for Site Remediation,[4]

[1] This practice is under the jurisdiction of ASTM Committee D34 on Waste Management and is the direct responsibility of Subcommittee D34.03 on Treatment, Recovery and Reuse.

Current edition approved Dec. 15, 2012. Published January 2013. Originally approved in 1988. Last previous edition approved in 2005 as E1266-88(2005). DOI: 10.1520/E1266-12.

[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.

[3] The last approved version of this historical standard is referenced on www.astm.org.

[4] National Risk Management Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, OH, November 2009, http://www.epa.gov/nrmrl/pubs/600r09148/600r09148.pdf

EPA Resource Conservation and Recovery Act (RCRA)[5]
EPA SW-846 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods[6]
EPA SW-872 Properties of Stabilized/Solidified Waste[6]
RCRA Document EPA-IAG-D4-0569 Guide to the Disposal of Chemically Stabilized and Solidified Waste[6]
Hazardous and Solid Waste Amendments (HSWA)
Method 1311 Toxicity Characteristic Leaching Procedure[6]
Method 9095 Paint Filter Liquid Test (PFLT)[6]
EPA/530-R-93-007 Petitions to Delist Hazardous Waste: A Guidance Manual (Second Edition), NTIS: PB 93-169-365[6]
EPA/530-SW-86-016 OSWER Policy Directive No. 9487.00-2A, Prohibition on the Placement of Bulk Liquid Hazardous Waste in Landfills Statutory Interpretive Guidance http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=9100MTSR.txt[6]
EPA/540-2-86-001 Handbook for Stabilization/Solidification of Hazardous Waste, Superfund Document[6]

2.3 *Code of Federal Regulations:*
40 CFR 264 Subpart B, section 264.13, Hazardous Waste Management System, Land Disposal Restrictions, Proposed Rule, Dec. 11, 1988
40 CFR 268 Hazardous Waste Management System; Land Disposal Restrictions; and California List Constituents

2.4 *Department of the Interior Document:*
U.S. Department of the Interior Earth Manual (Section Edition), 1974[7]

2.5 *Corps of Engineers Document:*
1110-2-1906 Permeability of Fine Materials, Falling Head Aug. 12, 1987.[8]

3. Terminology

3.1 *Definitions*—For definitions of terms used in this practice, refer to Terminology D5681.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *heavy metal wastes*—industrial wastes containing heavy metals such as arsenic, cadmium, chromium, barium, lead, silver, selenium, and mercury; these wastes are generally liquids, sludges, or filter cakes.

3.2.2 Heavy metal wastes may also contain small amounts of organic compounds. Special provisions are referenced to accommodate this class of material as stated in 8.4.

3.2.3 *lime*—a commercial product derived from the calcination of high calcium or dolomitic limestone. A number of ASTM standards relating to lime are given in 2.1.

3.2.4 *monolithic mass*—a mass that has good dimensional stability, to freezing and thawing resistance, low permeability, a high bearing capacity, and resistance to attack by biological agents.

3.2.5 *resource application*—use of stabilized products in specific areas such as earth liners, foundations, road base, backfills, embankments, earth dams, etc.

3.2.6 *resource structural products*—structural products produced by lime, fly ash, and heavy metal waste; examples are block, brick, aggregates, gabions, and miscellaneous structural shapes.

3.2.7 *solidification*—a binding physical and chemical treatment process that transforms materials containing free liquids into a solid, soil-like, or clayey material. This solid material can be a monolithic block with structural integrity.

3.2.8 *stabilization*—a treatment process that involves both a physical and chemical reaction for treating heavy metal waste. Heavy metal wastes are considered stabilized when they meet current applicable regulatory requirements.

3.2.9 *structural landfill*—man-made earth work meeting engineered practices and structural requirements. The fill must also be environmentally acceptable and meet EPA requirements. (See 40 CFR 268.)

4. Significance and Use

4.1 This practice provides users with current methods for preconditioning, handling, processing, and means of characterizing the materials that are produced.

4.2 Lime and fly ash, and mixtures of lime and fly ash can be useful for treating hazardous and nonhazardous waste as follows:

4.2.1 Treating hazardous waste for potential resource recovery application,

4.2.2 Solidifying liquids and sludges that are banned from land disposal because of excess free liquid content,

4.2.3 Treating hazardous waste that may require treatment because of hazardous constituents prior to land disposal, and,

4.2.4 Treating hazardous waste for potential delisting to a nonhazardous waste status. Each one of these applications, however, must comply with requirements of the Resource Recovery and Conservation Act and the Hazardous and Solid Waste Amendments.

5. Properties and Uses of Materials Applicable to the Practice

5.1 *Commercial Lime*— The following are properties and uses of commercial lime.

5.1.1 Neutralizes acids;

5.1.2 Provides hydroxide ions leading to reduced solubility of heavy metals and precipitation of metal species;

5.1.3 Provides high absorption rates of aqueous and non-aqueous liquids;

5.1.4 Solidifies and hardens a number of inorganic waste sludges;

5.1.5 Reacts chemically with soils, particularly clays, and thereby reduces plasticity; improves dimensional stability; and develops and controls structural applications;

[5] Documents 12/18/78, 9/13/79, 5/26/82, 7/26/82, and 4/4/83, available from *Federal Register* U.S. Government Printing Office Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401, http://www.access.gpo.gov.

[6] Available from Environmental Protection Agency, U.S. Government Printing Office, http://www.access.gpo.gov.

[7] Available from Bureau of Reclamation, Department of the Interior, Code D/7923A, P.O. Box 25007, Denver, CO 80225. http://www.usbr.gov.

[8] Available from Department of the Army, U.S. Army Corps of Engineers, Public Depot, 2803 52nd Ave., Hyattsville, MD 20781.

5.1.6 Develops cements when mixed with natural pozzolans, such as diatomaceous earth, cherts, shales, volcanic ash, and also fly ash formed in the combustion of pulverized coal; and

5.1.7 Capable of increasing pH of heavy metal waste.

5.2 *Pulverized Coal Fly Ash*—The following are properties and uses of pulverized coal fly ash.

5.2.1 Serves as a filler in the treatment of liquid waste;

5.2.2 Provides siliceous glass that reacts with lime to form cementitious compounds (tobermorites);

5.2.3 Provides aluminous glass which reacts with lime and sulfates to form cementitious compounds (ettringites); and

5.2.4 Contributes to stabilizing heavy metals that are insolubilized with lime.

5.2.5 Fly ash is available in different classes depending on the type of coal. These classes are described in Specification C618 and in Test Method C311. Class C contains some free calcium oxide that can generate considerable heat when mixed with water. In some applications, this type of fly ash may need to be preconditioned as described in 8.1.1. Standards pertaining to lime and lime/fly ash are Test Methods C25, C110, C311, and C400, Specifications C5, C206, C207, C593, C618, C821, C911, and C977.

NOTE 1—Additional information may be found in Test Methods C109/C109M, D1557, D1633, D2434, D2435, D3877, D3987, and D4318.

6. Applications Pertaining to Hazardous Wastes

6.1 *Resource Recovery Application*—Lime fly ash mixtures can be used to solidify and stabilize the heavy metal waste and render these treated wastes suitable for use as a resource structural product. In this application, the lime and fly ash mixtures solidify the waste and stabilize the heavy metals contained in the waste.

6.2 *Solidifying Waste Liquids and Sludges*—Lime/fly ash mixtures may be useful for stabilizing/solidifying liquids and sludges that are banned from land disposal because they contain free liquids. Mixtures of lime/fly ash can be used to react with the aqueous portion of the waste, thereby solidifying it so that the treated waste will pass the EPA tests for free or released liquids (e.g., SW-846 Method 9095 or Method 9096) and other RCRA regulatory requirements and thus be acceptable for disposal into hazardous waste landfills. In some cases, the liquid waste treated by the lime/fly ash mixtures may be required to also pass an unconfined compressive strength test. Requirements and guidance for the free or release liquids testing and compression testing can be found in EPA/530-SW-86-016.

6.3 *Treating of Hazardous Waste Prior to Land Disposal*—Lime and fly ash may be acceptable materials for treating selected heavy metal waste by stabilization/solidification when such waste requires treatment prior to land disposal because of specific hazardous constituents. More information on selection and use of solidification/stabilization technology for treatment of wastes is available in EPA/600/R-09/148 while specific requirements are listed in EPA/530-SW-86-016.

6.4 *Delisting of Hazardous Waste*—In some cases, lime/fly ash mixtures may be useful in treating hazardous waste to render them nonhazardous and, therefore, potentially applicable for delisting. Appropriate mixtures of lime and fly ash for treating a waste for delisting will need to be determined on a case by case basis. Procedures and requirements for petitioning for delisting of a hazardous waste could require a research development and demonstration project permit (see EPA/530-R-93-007).

6.5 The appropriate mixtures of the lime/fly ash that will treat the waste to meet the requirements will need to be determined on a case by case basis. Presence of organics may interfere in the treatment process, and appreciable amounts can obviate the use of the lime/fly ash systems.

7. Laboratory Procedures to Determine Design of Mixtures

7.1 Quicklime/fly ash and hydrated lime/fly ash mixtures and proportions are prepared and tested using the following ASTM standards:

Unconfined compressive strength	Test Method C109/C109M
Lime for use with pozzolans	Specification C821
Lime for chemical uses	Specification C911
Moisture density	Test Method D1557
Confined compressive strength	Test Method D1633

7.1.1 The results of these tests may serve as a basis for establishing mixtures appropriate for the structural applications under consideration. Compressive strength requirements may range from a high strength value for applications as listed in 3.2.6 to low strengths for products as listed in 3.2.5. Sufficient lime is added to obtain the desired strength at optimum moisture content.

7.2 Lime/sludge mixtures are tested to determine quantity of lime necessary to neutralize acid and precipitate the heavy metals. The EPA provides the solubility of metal hydroxides as a function of pH (40 CFR 268). Methods C400 is also helpful in addressing waste neutralization.

7.3 The lime/fly ash blend is added to the lime-treated heavy metal waste in sufficient quantities to comply with the necessary requirements for the contemplated use.

7.3.1 Compressive strength tests of the final mixture may be compared with the previous results in 7.1. If major changes such as loss in strength occur, determine if additional curing time or an increase in the lime dosage is needed.

NOTE 2—Quicklime and hydrated lime are commonly in design mixtures and can be used interchangeably. However, quicklime may reduce the amount of water in a heavy metal sludge because of the heat of hydration when quicklime is used in place of the hydrated lime (as hydrated lime has a lower heat of hydration). Since quicklime consumes considerable water in hydration, the quicklime/fly ash blend may be added dry to the wet, heavy-metal waste sludge as an alternate procedure that may reduce the lime/fly ash requirement.

7.4 To complete the laboratory tests, the following test methods may be useful, depending on the particular application:

Wet/dry weathering	Test Methods D559
Freezing and thawing	Test Methods D560
Falling head permeability	Corps of Engineers 1110-2-1906
Toxicity Characteristic Leaching Procedure	EPA Method 1311

NOTE 3—If Method 1311 results show excessive concentration of soluble ingredients, additional curing may be beneficial.

8. Construction Practice

8.1 Lime and fly ash are usually stored in closed bins such as employed at plants that are designed to provide lime/fly ash/aggregate mixtures for use in construction of roads. These plants frequently employ conventional equipment for blending lime/fly ash and soil, and are adaptable for weighing and mixing lime and fly ash with wet sludges. This equipment is frequently portable and can be located at the construction sites.

8.1.1 Class F fly ash can be stockpiled wet for a maximum of two weeks. Longer periods of stockpiling may affect the reactivity of the ash. Class C fly ash should not be stored wet.

8.1.2 When a dry Class C fly ash is used, adding water to the lime/Class C fly ash mixture will usually generate considerable heat. After cooling the freshly formed mixture, the sludge should be added within a few hours. If the sludge cannot be used within 24 h, it is generally necessary to precondition the lime/Class C fly ash and water mixture by rerunning the blend through a pug mill to avoid formulations of solid slabs. After remixing, the lime/fly ash mixture can be kept in a stockpiled condition until the heavy metal waste is available for preparing the final mixture for the field project. This also can be accomplished in a pug mill.

8.2 Where structural shapes are formed, it is generally acceptable to supply the lime and fly ash mixture in a moist condition and use separate containers for the waste. These materials can be fed through the plant equipment using a variety of mixers where the blending and addition of water is accomplished. Examples are found in block or brick plants. The equipment and practice is found in commercial plants which produce items such as briquettes, concrete block, or brick. Aggregate can be formed by crushing and screening the shapes to desired size.

8.3 Storage of the processed waste is a major factor when the material is intended to be used as a resource structural product. This is useful in providing curing time for the shapes. It is also necessary to build stockpiles in order to meet scheduling required by the contractors. Storage of the material is carried out in several ways, such as open warehouse, open piles using tarps, and open or closed bins.

8.4 Construction of monolithic fill should conform to standard practices employed with conventional materials. The U. S. Department of the Interior Earth Manual provides suitable construction practices. Inspection of the fill should be carried out during construction to ensure compliance with specifications. Practice E850 contains special provisions that are related to this section. The EPA has developed requirements to restrict the disposal of untreated industrial waste containing heavy metal wastes and organic materials in the landfills such as EPA/SW-872, EPA/530-SW-85-0031, EPA/530-SW-86-016; and EPA/540-2-86-001.