PROPOSED
BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT)
BACKGROUND DOCUMENT FOR D008
AND P AND U LEAD WASTES

Submitted to:

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1. INTRODUCTION

Pursuant to section 3004(m) of the Resource Conservation and Recovery Act (RCRA), enacted as a part of the Hazardous and Solid Waste Amendments (HSWA) on November 8, 1984, the Environmental Protection Agency (EPA) is proposing treatment standards based on best demonstrated available technology (BDAT) for any lead-containing waste identified in 40 CFR 261.24 as D008, and for the commercial chemical product wastes identified in 40 CFR 261.33 as U144, U145, U146, and P110. Compliance with the final BDAT treatment standards is a prerequisite for the placement of these wastes in units designated as land disposal units according to 40 CFR Part 268. The effective date of final promulgated treatment standards for these wastes will be May 8, 1990.

This background document provides the Agency's technical support and rationale for the development of proposed treatment standards for the constituents to be regulated for the lead-containing wastes. Sections 2 through 6 present waste-specific information for the D008 wastes. Section 2 describes the industries affected by regulation of these wastes, explains the processes generating these wastes, and presents available waste characterization data. Section 3 specifies the applicable and demonstrated treatment technologies for these wastes. Section 4 contains performance data for the demonstrated technologies, Section 5 analyzes these performance data to determine BDAT for each waste, and Section 6 presents the promulgated BDAT treatment standards for the regulated constituents. Section 7 discusses associated lead-containing P- and U-code wastes and details the development of the proposed treatment standards for these wastes.

The BDAT program and promulgated methodology are more thoroughly described in two additional documents: Methodology for Developing BDAT Treatment Standards (USEPA 1989a) and Generic Quality Assurance Project Plan for Land Disposal Restrictions Program ("BDAT") (USEPA 1988a). The petition process to be followed in requesting a variance from the BDAT treatment standards is discussed in the methodology document.

For the purpose of determining the applicability of the proposed treatment standards, wastewaters are defined as wastes containing less than 1 percent (weight basis) total suspended solids* and less than 1 percent (weight basis) total organic carbon (TOC). Waste not meeting this definition must comply with the proposed treatment standards for nonwastewaters.

Because of the diversity of D008 wastes, there are several demonstrated treatment technologies. For specific wastes, the best demonstrated available technology (BDAT) must be determined on a case-by-case basis. For the nonwastewater forms of the non-indigenous recyclable D008 wastes (high concentrations of lead) recovery/recycle has been determined to be BDAT. For D008 solid residuals from wastewater treatment, stabilization has been determined to be BDAT. For D008 reactive solids, aqueous chemical deactivation followed by chemical precipitation and stabilization has been determined to be BDAT. For D008 nonwastewaters from lead acid battery recycling, recovery/recycle followed by stabilization has been determined to be BDAT. These standards only apply for lead acid batteries that are identified as RCRA hazardous wastes and that are not elsewhere excluded from regulation under the land disposal restrictions of 40 CFR 268 or exempted under other EPA regulations (see 40 CFR 266.80). For inorganic wastewaters, BDAT is chemical precipitation. For D008 wastes containing organic

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* The term "total suspended solids" (TSS) clarifies EPA's previously used terminology of "total solids" and "filterable solids." Specifically, the quantity of total suspended solids is measured by Method 209c (Total Suspended Solids Dried at 103°C to 105°C) in Standard Methods for the Examination of Water and Wastewater, 15th Edition (APHA, AWWA, and WPCF 1985).

compounds or organo-lead constituents (such as tetraethyl lead), incineration has been determined to be BDAT, followed by treatment of incineration residuals by the technologies specified as BDAT for inorganic nonwastewaters and wastewaters.

The proposed treatment standards for lead wastes are listed in Tables 1-1 through 1-4.

Table 1-1 Proposed Treatment Standards for D008, P110, U144, U145, U146 (Wastewaters)

Regulated constitutent	Maximum for any Single Grab Sample Total Composition (mg/l)
Lead	0.040

Table 1-2 Proposed Treatment Standards for P110, U144, U145, U146 (Nonwastewaters)

Regulated constitutent	Maximum for any Single Grab Sample Total Composition (mg/l)
Lead	0.51

Table 1-3 Proposed Treatment Standards for D008 Low Lead Subcategory - Less than 2.5 Percent Lead (Nonwastewaters)

Regulated constitutent	Maximum for any Single Grab Sample TCLP (mg/l)
Lead	0.51

Table 1-4 Proposed Treatment Standards for D008 High Lead Subcategory - Greater Than or Equal to 2.5 Percent Lead (Nonwastewaters)

THERMAL RECOVERY AS A METHOD OF TREATMENT

2. INDUSTRIES AFFECTED AND WASTE CHARACTERIZATION

As defined in 40 CFR 261.24, D008 wastes are wastes that exhibit the characteristic of EP Toxicity for lead. In other words, D008 wastes have a lead concentration of greater than 5 mg/l, as measured by the EP Toxicity Leaching Procedure. Section 2.1 describes the industries affected by the land disposal restrictions for D008 wastes and describes the processes identified by EPA that may generate these wastes. Section 2.2 summarizes the available waste characterization data for these wastes. Section 2.3 uses the Agency's analysis of the sources of D008 wastes and waste composition to divide D008 wastes into several waste treatability groups.

2.1 Industries Affected and Process Description

The industries affected by the land disposal restrictions for D008 wastes are (1) the inorganic chemicals industry, which produces various inorganic lead compounds; (2) manufacturers of organo-lead compounds; (3) manufacturers and recyclers of lead-acid batteries; and (4) several industries that use lead compounds to manufacture various products. Processes in these industries that may generate lead-containing wastes are discussed below.

2.1.1 Production of Lead Chemicals

Lead is used in industry as the metal and as various inorganic and organic lead compounds. The production of inorganic and organic lead specialty chemicals is discussed in this section. A list of current manufacturers of the most common lead compounds is provided in Table 2-1.

Lead monoxide is produced by the reaction of molten lead with air or oxygen in a furnace.

Table 2-1 Current Manufacturers of Lead Compounds

Compound	Plant	Location
Lead Monoxide	ASARCO Incorporated	Denver, CO
	Cookson America, Inc., Anzon Incorporated, subsidiary	Philadelphia, PA
	Quenell Enterprises, Inc.	City of Commerce, CA
Lead Acetate	Hummell Chemical Company, Inc.	South Plainfield, NJ
	The Procter & Gamble Company J.T. Baker Inc., subsidiary	Phillipsburg, NJ
Lead Carbonate	Hammond Lead Products, Inc. Halstab Division	Hammond, IN
	National Industrial Chemical Co.	Chicago, IL
Lead Tetroxide	Hammond Lead Products, Inc.	Hammond, IN
	Oxide & Chemical Corporation	Brazil, ID
Lead Sulfate (basic)	Eagle-Picher Industries, Inc.	Joplin, MO
	Hammond Lead Products, Inc.	Hammond, IN
Lead Sulfate (tribasic)	Cookson America, Inc., Anzon Incorporated, subsidiary	Philadelphia, PA
	Hammond Lead Products, Inc.	Hammond, IN
Tetraethyl Lead	E.I. duPont de Nemours & Company, Inc., Specialty Chemicals Div.	Deepwater, NJ
	Ethyl Corporation	Baton Rouge, LA

Source: SRI 1989.

Lead acetate, often used for the preparation of other lead salts, is made by dissolving lead monoxide or lead carbonate in strong acetic acid.

Lead carbonate is made by passing carbon dioxide into a cold dilute solution of lead acetate, or by mixing a suspension of a lead salt less soluble than the carbonate with ammonium carbonate at low temperature.

Lead tetroxide, or red lead, is manufactured by heating lead monoxide in a reverbatory furnace in the presence of air at 450°C to 500°C until the desired composition is obtained.

Lead sulfate is prepared by treating lead oxide, hydroxide, or carbonate with warm sulfuric acid, or by treating a soluble lead salt with sulfuric acid. The resultant precipitate is filtered and dried. Basic lead sulfate and tribasic lead sulfate are prepared by high-temperature fusing of lead oxide and lead sulfate or by boiling aqueous suspensions of these two compounds.

Tetraethyl lead (TEL) is produced by the batch ethylation of sodium-lead alloy (NaPb) in an autoclave using ethyl chloride and a catalyst (usually acetone) or by a continuous process in which the lead alloy is fed continuously and agitated in a cascade reactor with excess ethyl chloride and a catalyst.

2.1.2 Uses of Lead Chemicals

Industries using lead chemicals and other products from which D008 may be derived include primary and secondary lead smelters, producers of lead-containing alloys, metal fabricators producing parts containing such alloys (e.g., castings, sleeve bearings, bushings), the mining and construction industries, producers of lead sheathing for cable insulation, lead-acid battery manufacturers, and producers of lead pigments.

Table 2-2 lists the major uses of lead and its compounds. The largest use is in the manufacture of automobile batteries. Over 50 percent of the lead consumed in the United States is utilized in the manufacture of plates and terminals for automotive lead-acid batteries. Other uses include the manufacture of pigments for use in paints and inks, the manufacture of additives for use in textile dyeing and printing, and use in the ceramic industry for electrical insulators and capacitors. All of these processes generate a variety of lead-containing nonwastewaters and wastewaters. Treatment of the wastewaters generates lead-bearing nonwastewater residues.

Tetraethyl lead is used as an additive in leaded gasolines. Thus, organo-lead wastes may be generated in the petroleum industry. (Leaded tank bottoms from the petroleum industry are the listed waste K052.)

2.2 Waste Characterization

Although the Agency has data from EPA's National Survey of Hazardous Waste Generators on the facilities generating D008 wastes, these waste characterization data show a wide range of component concentrations. Consequently, no general statement can be made with respect to the characterization of D, P, and U wastes discussed here, except that they are extremely diverse.

2.3 Determination of Waste Treatability Group

Characteristic wastes (i.e., D-code wastes) may have the same waste code but could be generated in different processes in a specific industry or in different industries. Consequently, the wastes may have different waste characteristics, such that they may not be treatable to similar concentrations using the same technology. In these instances, the Agency may subdivide waste codes into several treatability groups. This is done when the chemical forms of the wastes are different and clearly require

Table 2-2 U.S. Industrial Lead Consumption by Product (%)

Storage batteries	59.85
Annealing, weights, galvanizing ballast	17.29
Pigments	7.66
Ammunition	4.89
Solders	3.74
Brass and bronze	1.44
Cable covering	1.44
Bearing metal	1.13
Casting metals	0.87
Sheet lead	0.61
Terne metal (lead-coated steel)	0.44
Caulking lead	0.37
Pipes, traps, bends	0.27

Reference: Kirk-Othmer 1978.

different treatments or combinations of treatments. For example, inorganic and organometallic compounds containing the same metal(s) frequently require different types of treatment. Because of the muliplicity of lead uses and applications, D008 wastes can exist as inorganic liquids, inorganic solids or sludges, organic liquids, organic sludges, ash, slag from smelting operations, or lead-acid batteries. Each of these wastes will require different treatments or combinations of treatments.

From a partial analysis of responses to EPA's 1986 National Survey of Hazardous Waste Generators, the Agency has identified 82 facilities that generate D008 wastes. Based on a careful review of information on the generation of D008 wastes and available waste characterization data, the Agency has determined that D008 nonwastewaters and wastewaters comprise seven treatability groups: (1) inorganic solids or sludges with high (i.e., recoverable) concentrations of lead; (2) inorganic wastewaters, including wastewaters generated from recycle/recovery of lead nonwastewaters and incineration of organic lead wastes; (3) inorganic wastewater treatment sludges and other inorganic nonwastewaters containing nonrecoverable concentrations of lead; (4) organic lead wastes (both nonwastewaters and wastewaters); (5) explosive wastes containing lead (wastewater treatment sludges from the manufacture of lead initiating compounds are the listed waste K046); (6) nonwastewaters generated from the recycling of lead-acid batteries; and (7) radioactive lead solids waste. The Agency feels that these seven groups arc unique in terms of treatability requirements (i.e., all seven groups will require different methods of treatment) and that all types of D008 wastes that it expects could be generated could be classified into one of these seven groups in terms of waste treatability. The concentration of lead, as well as the concentration of organic constituents and other physicochemical parameters that can affect treatment of the various wastes, is dependent on the particular production process employed and the method of generation of the waste.

3. APPLICABLE AND DEMONSTRATED TREATMENT TECHNOLOGIES

Section 2 established six treatability groups for nonwastewater and wastewater forms of D008 wastes. This section identifies the treatment technologies that are applicable to treatment of these wastes and determines which, if any, of the applicable technologies can be considered demonstrated for the purpose of establishing BDAT.

To be applicable, a technology must be theoretically usable to treat the waste in question or to treat a waste that is similar in terms of the parameters that affect treatment selection. (For detailed descriptions of the technologies applicable for these wastes, or for wastes judged to be similar, see EPA's Treatment Technology Background Document (USEPA 1989b.) To be demonstrated, the technology must be employed in full-scale operation for the treatment of the waste in question or a similar waste. Technologies available only at pilot- and bench-scale operations are not considered in identifying demonstrated technologies.

3.1 Applicable Treatment Technologies

Because of the diversity of D008 wastes, there are several applicable treatment technologies.

The technologies applicable for treatment of lead-containing wastes are those that reduce the concentration of BDAT list metals in the treated residual and/or reduce the leachability of these metals in the treated residual. Because some forms of D008 waste may contain organic lead compounds, treatment technologies that are applicable to these wastes must also be able to free the lead from its organic bond. Treatment of the organic constituents may also be required.

3.1.1 Applicable Treatment Technologies for Solids or Sludges with High Concentrations of Lead

EPA has identified technologies applicable to nonwastewater forms of D008 wastes that contain high (i.e. recoverable) concentrations of lead. These are discussed separately in the following subsections.

(1) High-temperature metals recovery. The basic principle of operation for this technology is that metal oxides and salts are separated from a waste through a high-temperature thermal reduction process that uses carbon, limestone, and silica (sand) as raw materials. The carbon acts as a reducing agent and reacts with metal oxides to generate carbon dioxide and free metal. The silica and limestone serve as fluxing agents. This process yields a metal product for reuse and reduces the concentration of metals in the residuals and, hence, the amount of waste that needs to be land disposed. For lead, this reaction is:

$$2\ PbO + C \rightarrow 2\ Pb + CO_2$$

High-temperature metals recovery technologies are discussed in the Treatment Technology Background Document (USEPA 1989b).

(2) Stabilization technologies. Stabilization is identified as an applicable technology for treatment of nonwastewaters containing BDAT-list metals, such as the residues (slag) generated from high-temperature metals recovery. Stabilization technologies involve mixing the waste with lime/fly ash mixtures, cement, concrete mixtures, or other formulations, both proprietary and nonproprietary. Water is then added, and the mixture sets into a solid mass in which the leachability of the metals is reduced compared to that in the untreated waste. Stabilization technologies are discussed in detail in the Treatment Technology Background Document (USEPA 1989b).

3.1.2 Applicable Treatment Technologies for Wastewaters Containing Inorganic Lead Compounds

The Agency has identified one technology applicable to aqueous wastewaters containing lead. These wastes may be generated from electroplating processes, battery manufacture, or the use of soluble lead compounds. The applicable technology for treatment of these wastes is chemical precipitation, followed by settling and filtration.

Chemical precipitation is used when dissolved metals are to be removed from solution. This technology can be applied to a wide range of wastewaters containing dissolved lead and other metals. It has been practiced widely by industrial facilities since the 1940s.

The underlying principle of chemical precipitation is that metals in wastewater are removed by the addition of a treatment chemical that converts the dissolved metal to a metal precipitate. The precipitate settles out of solution, leaving a lower concentration of the dissolved metal present in the solution. The principal chemicals used to convert soluble metal compounds to the less soluble forms include: hydrated lime ($Ca(OH)_2$), caustic soda (NaOH), sodium sulfide (Na_2S), and, to a lesser extent, soda ash (Na_2CO_3), ferrous sulfide (FeS), and several other chemicals, depending on the metal(s) to be removed.

In the treatment of aqueous inorganic lead-containing wastes, the wastewaters are typically treated by alkaline hydroxide precipitation (with caustic soda or hydrated lime), whereby lead hydroxide is precipitated between pH values of 8 and 10.

Chemical precipitation is discussed in detail in the Treatment Technology Background Document (USEPA 1989b).

3.1.3 Applicable Treatment Technologies for Inorganic Wastewater Treatment Sludges

The residuals from treatment of inorganic D008 wastewaters will generally contain lead that may have a higher concentration in the EP leachate than the characteristic level. The Agency has identified stabilization as an applicable treatment technology for these residuals. Stabilization is discussed in Section 3.1.1.

3.1.4 Applicable Treatment Technologies for Organo-Lead Wastes

Organic wastes containing lead may be generated in the petroleum, paint and ink industries. These wastes could contain inorganic lead compounds mixed with solvent wastes, such as F001-F005, or organo-lead compounds such as tetraethyl lead.

The Agency has identified several technologies applicable to organo-lead waste forms of D008--incineration technologies, chemical oxidation/wet air oxidation, and carbon adsorption. These technologies are described below.

(1) Incineration technologies. A wide variety of incineration technologies may be applicable for destruction of the organic components of organo-lead-containing wastes. These technologies include liquid injection incineration, rotary kiln incineration, fluidized bed incineration, and fixed hearth incineration. A more detailed discussion regarding the applicability of these technologies can be found in the Treatment Technology Background Document (USEPA 1989b).

(2) Chemical oxidation/wet air oxidation. Chemical oxidation and wet air oxidation are also applicable to treatment of lead wastes containing organic constituents. Typical aqueous chemical oxidizing agents used are sodium hypochlorite, hydrogen peroxide, potassium

permanganate, and ozone. Wet air oxidation is oxidation by dissolved oxygen at high temperature and pressure. Oxidation treatment methods destroy the organic constituents of the waste. A more detailed discussion regarding the applicability of these technologies can be found in the Treatment Technology Background Document (USEPA 1989b).

(3) Carbon adsorption. Carbon adsorption is typically used to treat wastewaters containing dissolved organics at concentrations less than 1,000 mg/l and, to a much lesser extent, dissolved metal and other inorganic contaminants. The two most common carbon adsorption processes are granular activated carbon (GAC) and powdered activated carbon (PAC).

The basic principle of operation for carbon adsorption is the transfer and adsorption of a molecule from a liquid stream to the surface of an activated carbon particle. Effluent and residuals from carbon adsorption may require additional treatment. Carbon adsorption is discussed in detail in the Treatment Technology Background Document (USEPA 1989b).

Treatment of organic lead wastes by the applicable technologies discussed above will, in most cases, generate wastewater and/or residuals (e.g., incinerator ash, scrubber water) with a concentration of lead that would need further treatment by the technologies specified in Sections 3.1.1 through 3.1.3 for inorganic lead wastes.

3.1.5 Applicable Treatment Technologies for Lead-Containing Explosive Wastes

Wastes generated in the explosives industry during the manufacture of explosive initiating compounds such as lead azide may contain treatable concentrations of lead and may also be reactive. These wastes are typically generated as aqueous solutions. EPA has identified deactivation technologies as applicable for treatment of these wastes. Deactivation of explosive lead wastes (such as wastes containing lead azide) is accomplished by treatment of aqueous wastes using sodium nitrite and sodium carbonate. This treatment method results in the formation of a nonreactive wastewater treatment sludge containing lead carbonate. This sludge may require stabilization treatment, as discussed in Section 3.1.1.

3.1.6 Applicable Treatment Technologies for Lead-Acid Battery Wastes

Lead-acid battery wastes are generated from recycle of lead-acid batteries at battery-breaking facilities during breaking of the battery case to separate the lead-bearing components. Lead is present in the wastewater and the lead components of the batteries.

The Agency has identified high-temperature metals recovery, chemical precipitation, and stabilization as applicable to treatment of lead-acid battery wastes. These technologies are described below.

(1) High-temperature metals recovery. In the recovery of metallic lead, the lead components of the batteries are mixed with other lead-bearing raw materials and are smelted into metallic lead. High-temperature metals recovery technologies are discussed in the Treatment Technology Background Document (USEPA 1989b).

(2) Chemical precipitation. During the battery-breaking process, wash waters containing lead are generated. The Agency has identified chemical precipitation followed by filtration as a method of treatment of these wash waters. Chemical precipitation is discussed in Section 3.1.2.

(3) Stabilization. High-temperature metals recovery and chemical precipitation each generate a solid residual containing lead. These residuals may require further treatment by stabilization. Stabilization is discussed in Section 3.1.1.

3.1.7 Applicable Treatment Technologies for Radioactive Lead Solids

The radioactive lead solids include, but are not limited to, all forms of lead shuldings, lead "pigs," and other elemental forms of lead. These lead solids do not include treatment residuals such as hydroxide sludges, other wastewater treatment residuals, or incinerator ashes that can undergo conventional pozzolanic stabilization, nor do they include organolead materials that can be incinerated and then stabilized as ash.

The Agency believes that metal recovery is not an available technology for these type of wastes. Any lead recovered would be radioactive, and thus unusable.

Stabilization, on the other hand, should not be affected by the presence of radioactive versus nonradioactive lead.

3.2 Demonstrated Treatment Technologies

3.2.1 Demonstrated Technologies for Nonwastewaters

Lead recovery technologies (high-temperature metals recovery) have been in widespread use in the mining and lead-acid battery industries for over a decade. They have been installed primarily to maximize lead recovery and minimize lead losses.

Incineration technologies are well-developed and well-understood processes that are demonstrated for treatment of many hazardous wastes containing organic constituents mixed with metals. Chemical oxidation and wet air oxidation are demonstrated for treatment of various hazardous wastes (both nonwastewaters and wastewaters) containing organic constituents together with metals.

Stabilization technologies have been used on a commercial basis to treat the listed wastes K061 and F006 and other wastes. Some F006 wastes contain high levels of lead. The commercial use of stabilization to treat F006 wastes is described in the F006 background document (USEPA 1988c).

3.2.2 Demonstrated Technologies for Wastewaters

Chemical precipitation has been in use in the lead pigments industry for over a decade as a method for the removal of lead from inorganic process wastewaters. Data on the demonstrated effectiveness of this technology are provided in the effluent guidelines document developed for the inorganic chemicals industry (USEPA 1982). Carbon adsorption, in addition to chemical oxidation and wet air oxidation, is demonstrated for treatment of wastes containing organic constituents and metals.

4. PERFORMANCE DATA BASE

This section presents the data available to EPA on the performance of demonstrated technologies in treating the listed wastes. These data are used elsewhere in this document for determining which technologies represent BDAT (Section 5) and for developing treatment standards (Section 6). Eligible data, in addition to full-scale demonstration data, may include data developed at research facilities or obtained through other applications at less than full-scale operation, as long as the technology is demonstrated in full-scale operation for a similar waste or wastes, as defined in Section 3.

Performance data, to the extent that they are available to EPA, include the untreated and treated waste concentrations for a given constituent, values of operating parameters that were measured at the time the waste was being treated, values of relevant design parameters for the treatment technology, and data on waste characteristics that affect the performance of the treatment technology.

Where data are not available on the treatment of the specific wastes of concern, the Agency may elect to transfer data on the treatment of a similar waste or wastes using a demonstrated technology. To transfer data from another waste category, EPA must find that the wastes for which treatment standards are being developed are no more difficult to treat (based on the waste characteristics that affect performance of the demonstrated treatment technology) than the treated wastes from which performance data are being transferred.

4.1 Performance Data for Nonwastewaters

Presented in this section are data collected by EPA and submitted to EPA on treatment of various F-code and K-code wastes containing lead.

These data include performance data for high-temperature metals recovery of K061 wastes, stabilization of K061 and F006 wastes, and incineration of K048 and K051. The Agency believes that K061 is similar in waste characteristics to many D008 wastes that may be generated (such as off-specification lead chemicals and incinerator ash residues containing lead). Additionally, EPA believes that F006 wastes are similar to D008 wastewater treatment sludges in terms of waste characteristics and lead concentrations because both are generated from alkaline precipitation of lead-containing wastewaters.

4.1.1 Performance Data for High-Temperature Metals Recovery

The Agency has 11 data sets for treatment of K061 waste by high-temperature metals recovery. Tables 4-1 to 4-4 at the end of this section summarize the treatment performance data collected for high-temperature metals recovery for each of the 11 data sets. Seven of the data sets represent data that the Agency collected on a rotary kiln unit (presented in Table 4-1); all other data were submitted by industry and include two data sets from plasma arc furnace treatment (see Table 4-2), one from a rotary hearth electric furnace (see Table 4-3), and one from a molten slag reactor (see Table 4-4).

Table 4-1 presents total composition data for the untreated waste and total composition and TCLP leachate data for the treated nonwastewater residual, as well as design and operating data for each sample set. Table 4-2 presents total composition data for the untreated waste, treated nonwastewater, and treated scrubber wastewater and TCLP leachate data for the treated nonwastewater. Table 4-3 presents TCLP leachate data for both the untreated waste and the treated nonwastewater, and Table 4-4 presents EP Toxicity Procedure leachate data for the untreated waste and the treated nonwastewater.

For high-temperature metals recovery, treatment performance is measured by the reduction in the concentration of metal constituents from the untreated waste and also by the reduction of the leachability of the metals in the residual as compared to that in the untreated wastes.

4.1.2 Performance Data for Stabilization

The Agency has performance data for treatment of lead-containing nonwastewaters using stabilization, shown in Tables 4-5, 4-6, and 4-7. The data presented in Table 4-5 are performance data developed from stabilization of K061 waste. The data in Table 4-6 represent treatment of F006 wastes. The data in Table 4-7 represent treatment of K046 wastes. These data sets present untreated waste total composition and TCLP data and treated waste TCLP data. Tables 4-5 and 4-7 also present design and operating parameters for these tests. The treatment data indicate that these listed wastes can be treated to below the characteristic level by well-designed and well-operated stabilization processes.

4.1.3 Performance Data for Incineration

The Agency has six data sets for treatment of K048 and K051 waste by fluidized bed incineration. Table 4-8 at the end of this section summarizes the treatment performance data collected by EPA for each of the six data sets. Table 4-8 presents total composition data for the untreated waste and total composition and TCLP leachate data for the treated nonwastewater residual, as well as design and operating data for each sample set. The data show that the concentration in the TCLP leachate of the fluidized bed incinerator ash for all the sets is below the characteristic level.

4.2 Performance Data for Wastewaters

The Agency has 11 data sets for treatment of mixed metals wastewaters containing K062 wastes and other listed wastes by chemical precipitation and filtration. Table 4-9 at the end of this section summarizes the treatment performance data collected by EPA for the K062 waste for each of the 11 data sets. Table 4-9 presents total concentration data for the untreated waste and the treated wastewater. The data show that wastewaters containing lead can be treated to the characteristic level by chemical precipitation and filtration. The Agency also has additional extensive data on the use of chemical precipitation for removal of toxic metals, including lead, from wastewaters. These data were developed as part of the effort to establish effluent limitations guidelines for various industries. The effluent guidelines development document for the inorganic chemicals point source category (USEPA 1982) contains a large amount of data on the effectiveness of various precipitation processes for removal of lead from solution, as well as the results of engineering site visit studies at lead pigment plants. These data clearly show that with the use of chemical precipitation, the residual lead levels in the effluent are reduced below the characteristic level of 5 mg/l.

Table 4-1 Treatment Performance Data for High-Temperature Metals Recovery of K061 Waste: Waelz Kiln (EPA-Collected Data)

Constituent	Concentration (units) Untreated concentration (ppm)	Treated concentration (ppm)	Treated TCLP (mg/l)
Sample Set #1			
Lead	19,400	1,720	<0.025
Sample Set #2			
Lead	14,900	2,080	<0.25
Sample Set #3			
Lead	15,500	1,940	<0.025
Sample Set #4			
Lead	20,800	365	<0.025
Sample Set #5			
Lead	21,900	738	<0.025
Sample Set #6			
Lead	15,400	4,270	0.046
Sample Set #7			
Lead	16,400	2,370	<0.025

[a]Some of the design and operating data associated with these data have been claimed to be confidential. The remaining design and operating data associated with these data are shown at the end of this table.

Source: USEPA 1987a.

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Table 4-1 (continued)

Waste Characteristics Affecting Performance[a]

Boiling Point (in increasing order)

Mercury	356°C
Cadmium	765°C
Zinc	909°C
Lead	1760°C
Chromium	2672°C

Boiling Point of Metal - No low boiling point metals are present in concentrations that could impact product (recovered metal) purity and use.

Thermal Conductivity[b] - The thermal conductivity of K061 waste has been estimated to be approximately 28 Btu/hr-ft°F.

Design and Operating Data for Rotary Kiln High-Temperature Metals Recovery

Parameter	Nominal value[c]	Operating value						
		6/2/87			6/3/87			
		SS #1	SS #2	SS #3	SS #4	SS #5	SS #6	SS #7
Kiln temperature (°C)	700-800	760-840[d]	730-820[d]	740-840[d]	720-840[e]	600-1065[e]	575-740[e]	575-740[e]
Feed rate (ton/hr)		-	-	-	-	-	-	-
Rate of rotation (min/rev)		1.5	1.5	1.3	1.5	1.1	1.1	1.1
Zinc content (%)		-	-	-	-	-	-	-
Moisture content (%)		13.3	10.8	11.2	14.7	11.4	14.4	9.2
Carbon content (%)		-	-	-	-	-	-	-
Calcium/silica ratio		3.48	3.33	9.84	5.6	5.89	8.54	8.8

[a]The waste characteristics affecting performance for high-temperature metals recovery are relative volatility and the heat transfer characteristics of the waste. As the best approximate measure of the parameters, EPA is using boiling point and thermal conductivity.

[b]Thermal conductivity was calculated based on major constituents present in the waste and their respective thermal conductivities. This calculation can be found in the Administrative Record for K061.

[c]This system was built in the 1920s and was not originally designed for treatment of K061 waste. Nominal values were developed by the plant in lieu of design values.

[d]Values reflect those for kiln #2.

[e]Values reflect those for kiln #3.

- = This information is considered Confidential Business Information.

Source: USEPA 1987a.

Table 4-2 Treatment Performance Data for High-Temperature Metals Recovery of K061 Waste: Plasma Arc Reactor

	BDAT constituents detected			
	Untreated waste[a] (ppm)	Treated slag (ppm)	Treated slag TCLP (mg/l)	Treated wastewater (mg/l)
Sample Set #1 (Stainless Steel)				
Lead	6,000-14,000	<5	-	<0.01
Sample Set #2 (Carbon Steel)				
Lead	24,000-50,000	50-1,500	<0.05	<0.01-0.01

- = No data.

[a] For the untreated waste, EPA has values for ranges only. Data were not available on the specific untreated values that corresponded to the treated values.

Comments:

1. Data were not provided showing the specific operating conditions at the time the wastes were treated.

2. No data were provided on treatment characteristics that affect performance.

Source: SKF Plasmadust 1987.

Table 4-3 Treatment Performance Data for High-Temperature Metals Recovery of K061 Waste: Rotary Hearth/Electric Furnace

	BDAT constituents detected	
Constituent	Untreated waste TCLP (mg/l)	Treated waste TCLP (mg/l)
Lead	365	0.38
Zinc	4,973	0.94
Cadmium	56	0.05
Chromium	<0.1	<0.1

Comments:

1. Data were not provided on untreated total concentrations.

2. Data were not provided on the design and operating values.

3. Data were not provided on waste characteristics that affect performance.

Source: INMETCO 1987 (Sample Set #3).

Table 4-4 Treatment Performance Data for High-Temperature Metals Recovery of K061 Waste: Molten Slag System

Constituent	BDAT constituents detected	
	Untreated waste EP Tox (mg/l)	Treated slag EP Tox (mg/l)
Lead	348-556	0.05-0.80

Comments:

1. Data were not provided on total waste concentrations.

2. Data were not provided on the design and operating values.

3. Data were not provided on waste characteristics that affect performance.

Source: Sumitomo 1987 (Sample Set #2).

Table 4-5 Treatment Performance Data for Stabilization of K061 Waste (EPA-Collected Data)

Test #1 - Binder: Cement

BDAT constituents	Untreated waste Total (ppm)	Untreated waste TCLP (mg/l)	Treated waste - TCLP (mg/l) Run #1	Treated waste - TCLP (mg/l) Run #2	Treated waste - TCLP (mg/l) Run #3
Lead	20,300	45.1	1.03	1.20	1.24

Test #2 - Binder: Kiln Dust

BDAT constituents	Untreated waste Total (ppm)	Untreated waste TCLP (mg/l)	Treated waste - TCLP (mg/l) Run #4	Treated waste - TCLP (mg/l) Run #5	Treated waste - TCLP (mg/l) Run #6
Lead	20,300	45.1	1.30	0.711	0.350

Test #3 - Binder: Lime/Fly Ash

BDAT constituents	Untreated waste Total (ppm)	Untreated waste TCLP (mg/l)	Treated waste - TCLP (mg/l) Run #7	Treated waste - TCLP (mg/l) Run #8	Treated waste - TCLP (mg/l) Run #9
Lead	20,300	45.1	0.150	0.069	0.066

Note: Design and operating data associated with these data can be found at the end of this table.

Source: USEPA 1988d.

Table 4-5 (continued)

	Design and Operating Data: Stabilization process/binder								
	Cement			Kiln dust			Lime and fly ash[a]		
Parameter	Run #1	Run #2	Run #3	Run #4	Run #5	Run #6	Run #7	Run #8	Run #9
Binder-to-waste ratio	0.05	0.05	0.05	0.05	0.05	0.05	0.10	0.10	0.10
Water-to-waste ratio	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Mixture pH	10.9	11.5	10.5	11.5	11.6	11.1	12.1	12.0	12.0
Cure time (days)	28	28	28	28	28	28	28	28	28
Unconfined compressive strength (psi)	29.7	88.8	95.7	133.0	167.2	141.2	54.8	58.0	50.7

Waste Characteristics Affecting Performance

Fine particulates - 90% of the waste composed of particles <63 µm or less than 230 mesh sieve size

Oil and grease - 282 ppm

Sulfates - 8,440 ppm

Chlorides - 19,300 ppm

Total organic carbon - 4,430 ppm

[a] This binder consisted of equal parts of lime and fly ash.

Source: USEPA 1988d.

Table 4-6 Treatment Performance Data for Stabilization of F006 Waste

	Concentration					
	Untreated waste		Treated waste - TCLP (mg/l)			
	Total	TCLP	Binder-to-waste ratio[a]			
Constituent	(mg/kg)	(mg/l)	0.2	0.5	1.0	1.5
Sample Set #1 (Source-unknown)						
Cadmium	1.3	0.01	0.01	NR	NR	NR
Oil and grease	1,520	-	-	-	-	-
TOC	14,600	-	-	-	-	-
Sample Set #2 (Source-auto parts manufacturing)						
Cadmium	31.3	2.21	0.50	0.01	NR	NR
Oil and grease	60	-	-	-	-	-
TOC	1,500	-	-	-	-	-
Sample Set #3 (Source-aircraft over-hauling facility)						
Cadmium	67.3	1.13	0.06	0.02	NR	NR
Oil and grease	37,000	-	-	-	-	-
TOC	137,000	-	-	-	-	-
Sample Set #4 (Source-aerospace manufacturing-mixture of F006 & F007)						
Cadmium	1.69	0.66	NR	NR	<0.01	0.01
Oil and grease	3,870	-	-	-	-	-
TOC	8,280	-	-	-	-	-
Sample Set #5 (Source-zinc plating)						
Cadmium	1.30	0.22	0.01	0.01	NR	NR
Oil and grease	1,150	-	-	-	-	-
TOC	21,200	-	-	-	-	-
Sample Set #6 (Source-unknown)						
Cadmium	720	23.6	3.23	0.01	NR	NR
Oil and grease	20,300	-	-	-	-	-
TOC	28,600	-	-	-	-	-

Table 4-6 (continued)

Constituent	Concentration					
	Untreated waste		Treated waste - TCLP (mg/l)			
	Total (mg/kg)	TCLP (mg/l)	Binder-to-waste ratio[a] 0.2	0.5	1.0	1.5
Sample Set #7 (Source-small engine manufacturing)						
Cadmium	7.28	0.3	0.02	0.01	NR	NR
Oil and grease	2,770	-	-	-	-	-
TOC	6,550	-	-	-	-	-
Sample Set #8 (Source-circuit board manufacturing[b])						
Cadmium	5.39	0.06	0.01	0.01	NR	NR
Oil and grease	130	-	-	-	-	-
TOC	550	-	-	-	-	-
Sample Set #9 (Source-unknown)						
Cadmium	5.81	0.18	0.01	0.01	NR	NR
Oil and grease	30	-	-	-	-	-
TOC	10,700	-	-	-	-	-
Sample Set #10 (Source-unknown)						
Cadmium	5.04	0.01	<0.01	<0.01	NR	NR
Oil and grease	1,430	-	-	-	-	-
TOC	5,960	-	-	-	-	-

\- = Not applicable.

NR = Results of tests at this binder-to-waste ratio were not reported.

[a]Binder-to-waste ratio = $\frac{\text{weight of binder material}}{\text{weight of waste}}$

[b]Oil and grease and total organic carbon (TOC) have been identified by EPA as waste characteristics that affect the performance of stabilization.

[c]Circuit board manufacturing waste is not in its entirety defined as F006; however, an integral part of the manufacturing operation is electroplating. Treatment residuals generated from treatment of these electroplating wastes are F006.

Source: CWM 1987.

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Table 4-7 Treatment Performance Data for Stabilization of K046 Waste

Test #1 - Binder: Cement

BDAT constituents	Untreated waste Total (ppm)	Untreated waste TCLP (mg/l)	Treated waste - TCLP (mg/l) Run #1	Run #2	Run #3
Lead	967	103	0.072	0.1	0.062

Test #2 - Binder: Kiln Dust

BDAT constituents	Untreated waste Total (ppm)	Untreated waste TCLP (mg/l)	Treated waste - TCLP (mg/l) Run #1	Run #2	Run #3
Lead	967	103	0.9	1.1	1.0

Test #3 - Binder: Lime/Fly Ash

BDAT constituents	Untreated waste Total (ppm)	Untreated waste TCLP (mg/l)	Treated waste - TCLP (mg/l) Run #1	Run #2	Run #3
Lead	967	103	0.4	1.4	0.4

Note: Design and operating data associated with these data can be found at the end of this table.

Table 4-7 (continued)

Parameter	Design and Operating Data: Stabilization process/binder								
	Cement			Kiln dust			Lime and fly ash[a]		
	Run #1	Run #2	Run #3	Run #1	Run #2	Run #3	Run #1	Run #2	Run #3
Binder-to-waste ratio	1.2	1.2	1.2	1.4	1.4	1.4	0.7	0.7	0.7
Dry waste + water weight (g)	600	600	600	600	600	600	600	600	600
Binder weight (g)	720	720	720	840	840	840	420	420	420
Mixture pH	12.35	12.35	12.35	12.25	12.15	12.35	12.25	12.15	12.35

Waste Characteristics Affecting Performance:

Oil and grease - 3.8 mg/l

Sulfates - 190 mg/l

Total organic carbon - 461 mg/l

pH - 11.91

[a]This binder consisted of equal parts of lime and fly ash.

Source: USEPA 1988e.

Table 4-8 Treatment Performance Data for Fluidized Bed Incineration of K048 and K051 Wastes (EPA-Collected Data)

Constituent	Concentration			
	Untreated waste		Treated nonwastewater	
	K048[a] concentration (mg/kg)	K051 concentration (mg/kg)	Total (mg/kg)	TCLP (mg/l)
Sample Set #1				
Lead	400	940	940	<0.05
Sample Set #2				
Lead	390	670	1,100	<0.05
Sample Set #3				
Lead	410	790	1,100	<0.05
Sample Set #4				
Lead	340	690	1,200	<0.05
Sample Set #5				
Lead	330	700	1,300	<0.05
Sample Set #6				
Lead	350	640	1,100	<0.05

[a] K048 is a dewatered mixture of DAF float (K048) and waste biosludge.

Table 4-8 (continued)

Design and operating parameters	Nominal operating range	Operating range during Sample Set #1	Operating range during Sample Set #2	Operating range during Sample Set #3	Operating range during Sample Set #4	Operating range during Sample Set #5	Operating range during Sample Set #6
Bed temperature (°F)	1200-1300 (1400 max.)	1213-1240	1227-1323	1227-1287	1200-1260	1220-1253	1220-1240
Freeboard temperature (°F)	1250-1350 (1450 max.)	1240-1253	1253-1293	1253-1287	1253-1273	1253-1267	1253-1267
API separator sludge feed rate (gpm)	0-24	22.3	22.3	22.3-22.4	22.3-22.4	22.3	22.3
Undewatered DAF float mixture feed rate (gpm)	30-90	43	53	50	61	53	61
Constriction plate pressure differential (In. H_2O)+	15-20	10.7-18.7	8.7-18.0	9.3-18.7	8.7-18.3	8.7-18.7	10.0-18.0
Fluidized bed pressure differential (In. H_2O)+	60-100	90.4-102.4	91.2-104.0	91.2-104.0	91.2-105.6	92.8-105.6	92.8-105.6
O_2 (% volume)	NA	8.2-16.2	9.2-16.0	9.5-16.8	10.5-17.0	10.8-17.3	10.8-16.0
CO (ppm-volume)	35-800	50-135	80-355	45-140	40-340	30-910	50-770
CO_2 (% volume)	NA	2.2-9.0	2.3-8.1	2.2-8.6	2.8-7.9	2.8-7.5	5.7-7.7

NA = Not applicable.

Source: USEPA 1987b.

Table 4-9 Treatment Performance Data for Treatment of K062 Waste by Chemical Reduction Followed by Chemical Precipitation and Vacuum Filtration (EPA-Collected Data)

Constituent	Concentration: Untreated waste composite concentration[a] (ppm)	Concentration: Treated wastewater concentration (ppm)
Sample Set #1		
Lead	64	<0.01
Sample Set #2		
Lead	54	<0.01
Sample Set #3		
Lead	<10	<0.01
Sample Set #4		
Lead	<10	<0.01
Sample Set #5		
Lead	18	0.01
Sample Set #6		
Lead	<10	<0.01
Sample Set #7		
Lead	108	<0.01
Sample Set #8		
Lead	212	<0.01
Sample Set #9		
Lead	<10	<0.01
Sample Set #10		
Lead	<10	<0.01
Sample Set #11		
Lead	136	<0.01

[a] Untreated waste is a composite of K062, F006, F019, and/or D002 waste streams.

Source: USEPA 1986.

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5. IDENTIFICATION OF BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT)

This section presents the Agency's rationale for determining best demonstrated available technology (BDAT) for nonwastewater and wastewater forms of D008.

To determine BDAT, the Agency examines all available performance data on technologies that are identified as demonstrated to determine (using statistical techniques) whether one or more of the technologies performs significantly better than the others. The technology that performs best on a particular waste or waste treatability group is then evaluated to determine whether it is "available." To be available, the technology must (1) be commercially available to any generator and (2) provide "substantial" treatment of the waste, as determined through evaluation of treatment performance data. In determining whether treatment is substantial, EPA may consider data on the performance of a waste similar to the waste in question, provided that the similar waste is at least as difficult to treat. If the best technology is found to be not available, then the next best technology is evaluated, and so on.

The most desirable waste management technology is one that results in no residual streams or a residual stream with no hazardous properties. In this instance, lead recovery eliminates the D008 waste streams in many cases. This is especially true for lead-acid battery wastes, where most if not all of the lead can be recovered from these waste streams as lead metal. For nonwastewater forms of D008 (wastes processed by secondary lead smelters, such as lead-aeid battery wastes), as well as for K061 wastes containing up to 50,000 mg/kg lead, recovery technologies have been shown to reduce the leachate concentration of lead to below the characteristic level of 5 mg/l in the nonwastewater residual. The Agency realizes, however, that not all nonwastewater and wastewater forms of

D008 may be readily amenable to recovery processes. Lead may be present in refractory solid matrices from which it cannot easily be extracted, or it may be present in wastes containing inorganic lead compounds mixed with solvent wastes or other organics. For inorganic nonwastewater forms of D008 with high concentrations of lead for which recovery of the lead is practical (such as for lead-acid battery wastes), the Agency has determined that recovery/recycle provides treatment of nonwastewater residuals to the EP leachate characteristic level. The Agency, however, does not at this time have data that support setting a level of lead above which recovery or reuse is required.

For inorganic wastewater forms of D008 wastes, EPA has data on treatment of a similar waste (K062) containing lead and a variety of other metals. These data show that the lead concentration is reduced to below 5 mg/l in the treated wastewater by a treatment system consisting of chemical reduction followed by chemical precipitation and filtration. (The chemical reduction step is included for treatment of hexavalent chromium in the waste and should not affect the treatment of lead.) These data are presented in Table 4-9. The Agency has determined, based on these data, that chemical precipitation followed by filtration is the best technology for treatment of these wastes and is demonstrated to provide treatment to less than the characteristic level of 5 mg/l. For the inorganic nonwastewater residuals generated from wastewater treatment, the Agency has determined that stabilization is the best technology for these wastes and provides treatment to the EP leachate characteristic level.

EPA has treatment data, presented in Section 4 (Table 4-8), for fluidized bed incineration of listed petroleum refinery wastes (K048-K052) that contain high concentrations of organic compounds and lead. For organo-lead nonwastewater forms of D008, the Agency has determined, based on the fluidized bed incineration data for K048-K052, that incineration is the best method of treatment for the organic components of the waste. The Agency believes that the transfer of these data to treatment of D008 organic wastes is technically feasible because of the high (330 to 960 mg/kg) concentration of lead present in the K048 and K051 wastes that were incinerated. Also, these wastes had significant concentrations of organic constituents, and the lead concentration of these wastes was primarily in the form of tetraethyl lead. These treatment data show that the ash residuals from incineration of wastes that are expected to be similar to organo-lead wastes have TCLP concentrations less than the characteristic level of 5 mg/l. If these residuals do require treatment for lead, stabilization has been shown to provide treatment to less than the characteristic level on wastes with higher concentrations of lead in the TCLP leachate (K061, for instance). Incineration is demonstrated for many wastes containing organic compounds and lead (such as K048 to 52 from the petroleum industry). Moreover, incineration technologies are commercially available for use. Stabilization also has been shown to reduce the lead concentration in leachate from wastes containing high leachate levels of lead (up to 300 mg/l) and is commercially available. Therefore, the Agency has determined that incineration followed by stabilization is the best technology for treatment of lead wastes containing organics or organo-lead compounds.

For explosive wastes containing lead, the Agency has determined that the one demonstrated technology for treatment of these wastes, aqueous deactivation followed by chemical precipitation, filtration, and stabilization, provides treatment to the EP leachate characteristic level. Stabilization data for wastewater treatment sludges (K046 wastes) generated from treatment of reactive lead wastes, presented in Table 4-7, show reduction in lead concentration from greater than 300 mg/l to less than 5 mg/l.

For radioactive lead solids, the Agency is proposing surface deactivation or removal of radioactive lead portions followed by encapsulation or direct encapsulation as BDAT.

For lead-acid battery D008 nonwastewaters, the Agency has determined that metals recovery followed by stabilization of the generated slag is the best technology and provides treatment to less than the EP leachate characteristic level of 5 mg/l, as discussed above for wastes with high concentrations of lead. For wastewater forms of D008 wastes generated during breaking of lead-acid batteries for secondary lead smelting, the Agency has determined that chemical precipitation followed by dewatering of the precipitate represents best treatment for these wastes and will result in treatment residuals with total and TCLP leachate concentrations below 5 mg/l for wastewaters and nonwastewaters, respectively.

EPA has determined that the best demonstrated technologies specified above for the D008 treatability groups--recovery and stabilization for high-concentration lead wastes, chemical precipitation and filtration for inorganic wastewaters, stabilization for inorganic wastewater treatment sludges, incineration for wastes (both nonwastewaters and wastewaters) containing organic constituents and organo-lead compounds, chemical deactivation for reactive lead wastes, and recovery and stabilization for lead-acid battery nonwastewaters--are available and thus represent BDAT.

6. DEVELOPMENT OF BDAT TREATMENT STANDARDS

In Section 5, the Agency chose the best demonstrated available technology (BDAT) for both nonwastewaters and wastewaters based on the treatment data available to the Agency. In this section, proposed BDAT treatment standards will be developed based on the performance of these technologies. Lead is selected as the only regulated constituent because it is the only constituent for which this waste is listed. If D008 wastes are mixed with other listed or characteristic hazardous wastes and thus contained other constituents, other treatment standards would also apply.

The Agency bases treatment standards for regulated constituents on the performance of well-designed and well-operated BDAT treatment systems. These standards must account for analytical limitations in available performance data and must be adjusted for variabilities related to treatment, sampling, and analytical techniques and procedures.

BDAT standards are determined for each constituent by multiplying the arithmetic mean of accuracy-adjusted constituent concentrations detected in treated waste by a "variability factor" specific to each constituent for each treatment technology defined as BDAT. Accuracy adjustment of performance data has been discussed in Section 5 in relation to defining BDAT. Variability factors account for normal variations in the performance of a particular technology over time. They are designed to reflect the 99th percentile level of performance that the technology achieves in commercial operation. (For more information on the principles of calculating variability factors, see EPA's publication Methodology for Developing BDAT Treatment Standards (USEPA 1989a).) Details on the calculation of variability factors for lead-containing nonwastewaters and wastewaters are presented in this section.

For the forms of the non-indigenous recyclable D008 wastes containing high concentrations of lead, EPA is proposing thermal recovery followed by stabilization as a treatment standard. Residues from recycling indigenous D008 materials would be subject to the D008 standard if such residues exhibit EP-toxicity for lead. For D008 wastewaters, the Agency is proposing a treatment standard of based on chemical precipitation. For D008 wastewater treatment sludges, the Agency is proposing treatment standards based on stabilization. For D008 reactive wastes, the Agency is proposing chemical deactivation followed by chemical precipitation as a method of treatment. For D008 organic and organo-lead nonwastewaters and wastewaters, the Agency is proposing treatment standards based on incineration followed by stabilization for nonwastewater residuals and chemical precipitation for wastewater residuals.

For D008 lead-acid battery nonwastewaters, the Agency is proposing recovery as a treatment standard. These standards only apply for lead acid batteries that are identified as RCRA hazardous wastes and that are not elsewhere excluded from regultion under the land disposal restrictions of 40 CFR 268 or exempted under other EPA reguations (see 40 CFR 266.80). Table 6-1 shows the proposed treatment standards for D008 wastes.

Table 6-1 Proposed Treatment Standards for D008 Wastes

Waste type	Regulated constituent	Proposed treatment standard Maximum for any single grab sample mg/l
Nonwastewaters		
D008 nonwastewaters with less than 2.5% lead	Lead	TCLP 0.51
D008 nonwastewaters with greater than or equal to 2.5% lead	Lead	Thermal recovery.
Wastewaters		
D008 reactive wastewaters	Lead	Total composition 0.040

7. P AND U WASTE CODES

This section addresses regulation of P and U wastes that are generated by the manufacturers and users of lead compounds. These wastes, listed in Table 7-1, are identified in 40 CFR 261.33 as "discarded commercial chemical products, off-specification species, container residues, and spill residues thereof."

7.1 Industries Affected

Industries that may generate lead-containing P and U wastes are producers of tetraethyl lead (TEL) for use as antiknock additives for gasoline; producers of inorganic and organic lead pigments and specialty chemicals for applications such as the preparation of reagents for sugar analyses and organic syntheses, the preparation of rubber antioxidants, and processing agents for the cosmetic, perfume, and toiletry industries.

7.2 Applicable and Demonstrated Treatment Technologies

Wastewaters containing soluble lead compounds such as lead acetate (U144), lead phosphate (U145), and lead subacetate (U146) are expected to be similar in nature to K062 and other wastes generated from metal finishing operations in terms of the concentration of lead and other waste characteristics affecting treatment performance. The Agency believes that chemical precipitation, followed by dewatering of the precipitate and stabilization of the dewatered solids, is applicable and demonstrated to treat these wastes.

The Agency believes that organo-lead wastes, such as tetraethyl lead (P110), are similar in nature to K048-K052 wastes generated in the petroleum refining industry. The Agency believes that incineration, chemical oxidation, wet air oxidation, carbon adsorption, and solidification are applicable and demonstrated to treat these wastes.

Table 7-1 P and U Waste Codes Proposed for Regulation

Waste code	Chemical compound	Regulated constituent
P110	Tetraethyl lead	Lead
U144	Lead acetate	Lead
U145	Lead phosphate	Lead
U146	Lead subacetate	Lead

7.3 Identification of Best Demonstrated Available Technology

EPA believes that the U-code wastes listed in Table 7-1, as commonly generated, are similar to K062 wastes. These U-code wastes are soluble lead compounds or leak or spill residues containing these compounds. The Agency, therefore, expects these wastes to be generated as wastewaters or to be easily dissolvable in water prior to treatment. The Agency believes that the best way to treat nonwastewater forms of these U-code wastes is to dissolve them in water (if they are not already dissolved) and then treat them by the demonstrated treatment technology identified in Section 7.2.

Of the demonstrated technologies identified in Section 7.2 for inorganic lead wastes, EPA has data, presented in Table 4-9, for treatment of K062 wastewaters by chemical precipitation followed by filtration. EPA has data for treatment of K046 and F006 wastewater treatment sludges by stabilization. Accuracy-adjusted performance data for treatment of lead-containing wastewaters are presented in Table 7-2. Accuracy-adjusted data for treatment of K046 and F006 by stabilization are presented in Table 7-3. These data were analyzed by the analysis of variance (ANOVA) test to determine which data set represented better treatment. Of the K046 data, treatment by cement stabilization was determined to represent better treatment than lime/fly ash or kiln dust stabilization, based on this test. A comparison of the F006 stabilization data with the K046 cement stabilization data shows that the treatment data from K046 represents better performance. However, these data were obtained from stabilization of a lead carbonate treatment sludge generated from chemical deactivation of reactive K046, while F006 treatment data were obtained from stabilization of a hydroxide treatment sludge generated from treatment of mixed electroplating wastewaters. The Agency is basing wastewater treatment standards for these U-code wastes

Table 7-2 Summary of Accuracy Adjustment of Treatment Data for Lead in Treated Wastewaters

	Untreated waste concentration Total (mg/kg)	Measured treated waste concentration TCLP (mg/l)	Percent recovery for matrix spike test	Accuracy-correction factor	Accuracy-adjusted TCLP leachate concentration (mg/l)
Chemical Precipitation of K062					
Sample Set No. 1	64	<0.01	76	1.316	<0.0132
Sample Set No. 2	54	<0.01	76	1.316	<0.0132
Sample Set No. 3	<10	<0.01	76	1.316	<0.0132
Sample Set No. 4	<10	<0.01	76	1.316	<0.0132
Sample Set No. 5	18	0.01	76	1.316	<0.0132
Sample Set No. 6	<10	<0.01	76	1.316	<0.0132
Sample Set No. 7	108	<0.01	76	1.316	<0.0132
Sample Set No. 8	212	<0.01	76	1.316	<0.0132
Sample Set No. 9	<10	<0.01	76	1.316	<0.0132
Sample Set No. 10	<10	<0.01	76	1.316	<0.0132
Sample Set No. 11	136	<0.01	76	1.316	<0.0132

Table 7-3 Summary of Accuracy Adjustment of Treatment Data for Lead in Treated Wastewater Treatment Sludges

	Untreated waste concentration		Measured treated waste concentration TCLP (mg/l)	Percent recovery for matrix spike test	Accuracy-correction factor	Accuracy-adjusted TCLP leachate concentration (mg/l)
	Total (mg/kg)	TCLP (mg/l)				
Stabilization of F006 (Lime/Fly Ash)						
Sample Set No. 2 (0.5[a])	409	10.7	0.36	93	1.075	0.39
Sample Set No. 7 (0.5[a])	113	3.37	0.36	93	1.075	0.39
Sample Set No. 8 (0.5[a])	156	1.0	0.38	93	1.075	0.41
Sample Set No. 9 (0.5[a])	169	4.22	0.37	93	1.075	0.40
Sample Set No. 10 (0.5[a])	24,500	50.2	0.27	93	1.075	0.29
Stabilization of K046 (Cement)						
Sample Set No. 1	967	103	0.072	77.4	1.29	0.093
Sample Set No. 2	967	103	0.10	77.4	1.29	0.129
Sample Set No. 3	967	103	0.061	77.4	1.29	0.079
Stabilization of K046 (Kiln Dust)						
Sample Set No. 1	967	103	0.9	91	1.10	0.99
Sample Set No. 2	967	103	1.1	91	1.10	1.21
Sample Set No. 3	967	103	1.0	91	1.10	1.10
Stabilization of K046 (Lime/Fly Ash)						
Sample Set No. 1	967	103	0.4	69.5	1.44	0.576
Sample Set No. 2	967	103	0.4	69.5	1.44	0.576
Sample Set No. 3	967	103	0.4	69.5	1.44	0.576

[a]Binder-to-waste ratio used.

on hydroxide precipitation treatment of K062 wastes; therefore, the F006 treatment data will be used for development of the nonwastewater standards.

Demonstrated technologies for P110 wastes are those that were identified in Section 7.2 for organic lead wastes. Of the demonstrated technologies identified in Section 7.2, the Agency has data for treatment of K048-K052 wastes by incineration. Incineration generates an ash with a lead leachate concentration below the analytical detection limit, as shown in Table 4-8. Accuracy adjustment of the incineration data for these wastes is presented in Table 7-4.

Chemical precipitation, stabilization, and incineration are shown in Tables 7-2 through 7-4, respectively, to provide substantial treatment of lead in inorganic wastewaters, inorganic nonwastewaters, and organo-lead wastes. These technologies are also all commercially available. Therefore, these technologies are determined to be BDAT for U- and P-code lead wastes.

7.4 Selection of Regulated Constituents

EPA is proposing treatment standards for lead in both wastewaters and nonwastewaters for all the P- and U-code wastes listed in Table 7-1. Lead is the only Appendix VIII constituent for which these wastes are listed, and it is the only BDAT list constituent that the Agency expects to find in the wastes on a regular basis (unless these wastes are mixed with other listed hazardous wastes, in which case other treatment standards would also apply).

7.5 Calculation of Proposed Treatment Standards

Treatment standards for lead in the U-code wastes listed in Table 7-1 are based on chemical precipitation followed by settling and filtration

Table 7-4 Summary of Accuracy Adjustment of Treatment Data for Lead in Incinerator Ash from K048-K052

	Untreated waste concentration		Measured treated waste concentration TCLP (mg/l)	Percent recovery for matrix spike test	Accuracy-correction factor	Accuracy-adjusted TCLP leachate concentration (mg/l)
	K048 (mg/kg)	K052 (mg/kg)				
Sample Set No. 1	400	940	<0.05	89	1.12	<0.056
Sample Set No. 2	390	670	<0.05	89	1.12	<0.056
Sample Set No. 3	410	790	<0.05	89	1.12	<0.056
Sample Set No. 4	340	690	<0.05	89	1.12	<0.056
Sample Set No. 5	330	700	<0.05	89	1.12	<0.056
Sample Set No. 6	350	640	<0.05	89	1.12	<0.056

for wastewaters and on stabilization for nonwastewaters. Treatment standards for these wastes were transferred from the performance of the BDAT for the K062 and F006 wastes. The calculation of these treatment standards is summarized in Tables 7-5 and 7-6. The Agency believes that the transfer of the performance data is technically feasible because of the high concentration of lead present in K062 and F006 wastes.

The treatment standards for lead in P110 wastes (both nonwastewaters and wastewaters) are based on incineration, folowed by treatment of the residuals generated. BDAT for the treatment of the scrubber water for lead is chemical precipitation followed by stabilization of the wastewater treatment sludge. BDAT for treatment of the ash is stabilization, although the incineration data presented in Table 7-4 show that the incinerator ash generated from treatment of similar wastes (K048-K052) has a TCLP leachate concentration for lead of less than the detection limit. Thus, the wastewater and nonwastewater treatment standards for P110 are transferred from K062 and F006, respectively. The Agency believes that this transfer is technically feasible because of the high (330 to 960 mg/kg) concentration of lead present in the K048 and K051 wastes that were incinerated. Also, the lead concentration of the wastes was primarily in the form of tetraethyl lead. Incineration residuals generated are expected to contain inorganic lead in an inorganic matrix; therefore, the transfer of standards from K062 and F006 is justified.

All wastewater and nonwastewater residuals from treatment of P and U wastes containing lead must meet the treatment standards presented in Table 7-7.

Table 7-5 Calculation of Wastewater Treatment Standards for U144, U145, U146, and P110

Regulated constituent	Accuracy-adjusted treated waste concentration (mg/l)	Mean treated waste concentration (mg/l)	Variability factor (VF)	Treatment standard (total composition) (mg/l)
Lead	<0.0132	<0.0132	2.8	0.04
	<0.0132			
	<0.0132			
	<0.0132			
	<0.0132			
	<0.0132			

Table 7-6 Calculation of Nonwastewater Treatment Standards for U144, U145, U146, and P110

Regulated constituent	Accuracy-adjusted treated waste TCLP leachate concentration (mg/l)	Mean treated TCLP concentration (mg/l)	Variability factor (VF)	Treatment standard TCLP (mg/l)
Lead	0.39	<0.37	1.37	0.51
	0.39			
	0.41			
	0.40			
	0.29			

Table 7-7 Proposed Treatment Standards for P- and U-Code Lead Wastes

Constituent	Wastewater	Nonwastewater	
	Total composition (mg/l)	Total composition (mg/l)	TCLP (mg/l)
Lead (P110)	0.04	NA	0.51
Lead (U144)	0.04	NA	0.51
Lead (U145)	0.04	NA	0.51
Lead (U146)	0.04	NA	0.51

NA = Not applicable.

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APPENDIX A - QA/QC DATA

Table A-1 Fluidized Bed Incinerator Ash Matrix Spike Recoveries for Lead in K048/K051

	Sample Set No. 5							
	Sample AM-4E Ash				Sample AM-4E Ash Duplicate			
	Original amount found	Amount spiked	Amount recovered	Percent recovery	Amount spiked	Amount recovered	Percent recovery	Relative percent difference
Lead	1380	990	2260	89	1000	2320	94	6

Source: USEPA 1987b.