FINAL
BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT) BACKGROUND DOCUMENT FOR SILVER-CONTAINING WASTES

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1. INTRODUCTION AND SUMMARY

Pursuant to section 3004(m) of the Hazardous and Solid Waste Amendments (HSWA), enacted on November 8, 1984, the Environmental Protection Agency (EPA) is establishing treatment standards based on best demonstrated available technology (BDAT) for the silver-containing wastes identified in 40 CFR 261.24 as the waste code D011 and for commercial chemical product wastes identified in 40 CFR 261.33 as P099 (potassium silver cyanide) and P104 (silver cyanide). Treatment standards for cyanide in P099 and P104 wastes were promulgated with the Second Third land disposal restriction final rule (54 FR 26614, June 23, 1989). Compliance with treatment standards is a prerequisite for placement of these wastes in facilities designated as land disposal treatment units according to 40 CFR Part 268.

This background document presents the Agency's technical support and rationale for developing regulatory standards for these wastes. Sections 2 through 6 present waste-specific information for the D011 wastes. Section 2 identifies the number and location of facilities affected by the land disposal restrictions for D011 wastes, discusses processes generating these wastes, and presents all available waste characterization data. Section 3 discusses the technologies used to treat the waste (or similar wastes), and Section 4 presents available performance data, including data on which the treatment standards are based. Section 5 explains EPA's determination of BDAT. Promulgated treatment standards are determined in Section 6. Section 7 discusses associated silver-containing P-code wastes and details the development of 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 the 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.

It is EPA's understanding that relatively few facilities presently generate D011 wastes. From a partial analysis of responses to EPA's 1986 National Survey of Hazardous Waste Generators, the Agency has identified 35 facilities that generate D011 wastes. These wastes are primarily the wastewater treatment sludges from the production and use of silver compounds. For the purpose of BDAT these are usually nonwastewaters. A wastewater is defined by the Agency as containing less than 1 percent (weight basis) total suspended solids* and less than 1 percent (weight basis) total organic carbon (TOC). Wastes not meeting this definition must comply with the treatment standards for nonwastewaters.

1.1 D011 Wastes

The Agency is promulgating a treatment standard for D011 wastes at the characteristic level of 5 mg/l. The data available to EPA show that nonwastewater and wastewater treatment standards of 0.072 mg/l and 0.29 mg/l, respectively, are achievable. However, EPA recognizes the diversity of wastes that qualify as hazardous under the D011 classification and is, therefore, promulgating a treatment standard of 5 mg/l for all D011 wastes.

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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 to 105°C) in Standard Methods for the Examination of Water and Wastewater, 15th Edition (APHA, AWWA, and WPCF 1985).

1.2 P099 and P104 Wastes

The promulgated BDAT for nonwastewater forms of P099 and P104 is recovery or stabilization. The Agency realizes that because of its economic value, silver is usually recovered from wastes where it is contained at relatively high concentrations. However, the Agency also realizes that wastes with a silver content of less than about 5 mg/l (Kodak 1989) or with the silver present at low concentrations in complex matrices, e.g., organic sludges, may not be suitable for most recovery technologies.

The data available to EPA show that a treatment standard of 0.072 mg/l for nonwastewater forms of P099 and P104 is achievable (see Section 4.0). This treatment standard was promulgated in Second Thirds final rule.

The data available to EPA show that a treatment standard of 0.29 mg/l for wastewater forms P099 and P104 is achievable (see Section 4.0). Therefore, EPA is promulgating a treatment standard of 0.29 mg/l for wastewater forms of P099 and P104.

Table 1-2 presents BDAT treatment standards for P099 and P104 wastewaters and Table 1-3 presents BDAT treatment standards for P099 and P104 nonwastewaters, which were promulgated in the Second Thirds Final Rule for F006 (USEPA 1988b).

Table 1-1 BDAT Treatment Standards for D011

Regulated constituent	Nonwastewaters Maximum for any single grab sample TCLP (mg/l)	Wastewaters Maximum for any single grab sample Total composition (mg/l)
Silver	5.0	5.0

Table 1-2 BDAT Treatment Standards for P099 and P104 Wastewaters

Regulated constituent	Maximum (24 hr. composite sample) Total concentration (mg/l)
Silver	0.29
Cyanide (total)*	1.9
Cyanide (amenable)*	0.10

*These constituents were promulgated in the Second Thirds Final Rule.

Table 1-3 BDAT Treatment Standards for P099 and P104 Nonwastewaters

Regulated constituent	Maximum for any single grab sample	
	TCLP (mg/l)	Total concentration (mg/kg)
Silver	0.072	NA
Cyanide (total)*	NA	110
Cyanide (amenable)*	NA	9.1

*These constituents were promulgated in the Second Thirds Final Rule.

2. INDUSTRIES AFFECTED AND WASTE CHARACTERIZATION

The Agency has determined that D011 wastes represent one treatability group for nonwastewaters and another treatability group for wastewaters based on their physical and chemical characteristics. As described later in this report, EPA has examined the sources of the wastes, specific similarities in waste composition, applicable and demonstrated treatment technologies, and attainable treatment performance in order to support a simplified regulatory approach for silver-containing wastes.

2.1 Industries Affected and Process Descriptions

2.1.1 Production of Silver Chemicals

Silver is used in industry in two forms--as the metal and as various silver compounds. Presently, eight silver compounds are produced in commercial quantities. These compounds are discussed below.

Silver nitrate represents the largest volume of silver-containing chemical manufactured. Its production involves digestion of silver in nitric acid to form a silver nitrate solution that is partially evaporated and fed to crystallizers to recover silver nitrate crystals. The mother liquor is recycled. Wastes from this process are in the form of wastewaters. Treatment of these wastewaters generates silver-containing residues that are reclaimed when the silver content is high enough.

Other silver salts are produced from the silver nitrate. Silver chloride, silver bromide, and silver iodide, for example, are produced by reaction of silver nitrate in solution with sodium chloride, sodium bromide, or sodium iodide. The insoluble product precipitates from solution, is recovered by filtration, and then is washed and dried. These processes give rise to waterborne wastes, the treatment of which results in silver-bearing residues. Silver oxide, silver carbonate, and silver sulfide are made by similar processes involving reaction in aqueous solution of silver nitrate with sodium hydroxide, sodium carbonate, or sodium sulfide, respectively. In all cases, the products precipitate from solution and are then collected by filtration and dried.

Silver cyanide is produced by reaction of sodium cyanide and silver nitrate in solution under carefully controlled conditions. Again, the insoluble product precipitates from solution, is collected by filtration, and then is washed, dried, and packaged. Treatment of the wastewaters generated by this process yields silver-bearing residues.

2.1.2 Uses of Silver Chemicals

Table 2-1 lists the major uses of silver and its alloys. The largest use is in the photographic industry, where silver chloride, silver bromide, and silver iodide are used in the manufacture of photographic films. Both the manufacture and subsequent processing (developing) of the films generate a variety of silver-containing nonwastewaters and wastewaters. Wastewater treatments generate silver-bearing sludges, which are mostly reclaimed for silver value.

Brazing solders frequently contain silver chloride as a fluxing agent, and the manufacture and use of these solders generate wastes containing silver chloride. The production of silver oxide-zinc batteries gives rise to wastewaters and nonwastewaters containing silver. The same is true for the production and reclamation of silver oxide catalysts.

Table 2-1 U.S. Industrial Distribution of Silver and Its Compounds

Industry	Silver compounds used	Percent
Photographic film manufacturing	Nitrate, halides	41.2
Electrical contacts	Metal	21.6
Brazing alloys and solders	Chloride	7.4
Sterling silverware	Metal	6.8
Batteries	Oxide	5.3
Jewelry	Metal	4.1
Electroplating	Cyanide	3.5
Coins and medallions	Metals	3.5
Catalysts	Oxide	3.3
Dental and medical supplies	Metal	1.6
Mirrors	Nitrate	0.5
Bearings	Metal	0.2
Other	Metal	1.0
		100.0

Source: Lockhart, H.B. 1981.

Electroplating operations consume considerable quantities of silver cyanide and complex silver cyanide salts such as potassium silver cyanide. The listed wastes generated by these operations (F006, F007, F008, and F009) are discussed in EPA's Best Demonstrated Available Technology (BDAT) Background Document for F006 (USEPA 1988b) and Best Demonstrated Available Technology (BDAT) Background Document for Cyanide Wastes (USEPA 1989c).

In the production of mirrors, two separate solutions, one of an ammonia-complexed silver nitrate and the other containing an organic compound such as formaldehyde, are reacted on the glass surface to be coated. A coating of silver forms on the glass surface. The mirror is then rinsed, and a silicone coating may be applied to protect the silvered surface. This process generates waterborne wastes containing silver. Subsequent treatment of the wastewaters generates silver-bearing residues.

2.2 Waste Characterization

The Agency has data from EPA's National Survey of Hazardous Waste Generators (USEPA 1986) on the approximate composition of the types of D011 wastes currently generated. The nonwastewater forms of D011 contain from 0.1 up to 100,000 parts per million (ppm) of silver. Other metals are typically present at comparable concentrations. Most nonwastewaters contain very low levels of organics. The wastewater forms of D011 contain from 0.1 to 10,000 ppm of silver. Frequently, other metals are also present. In a few cases, organics may be present at concentrations up to 1 percent. Cyanides are usually not present because most silver-cyanide electroplating wastes are reclaimed rather than disposed of.

Most of the facilities reporting D011 wastes in the Generator Survey were plants producing photographic chemicals, electronics equipment, or aerospace-related products. The nature of the individual processes generating the waste streams is quite varied and includes most of the operations identified as significant consumers of silver salts.

3. APPLICABLE AND DEMONSTRATED TREATMENT TECHNOLOGIES

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

3.1.1 Treatment Technologies for Nonwastewaters

Two types of technologies are applicable to nonwastewater forms of D011: silver recovery and stabilization.

(1) Silver recovery technologies. Three types of silver recovery technologies are in use today: electrolytic recovery, cementation processes, and high-temperature recovery processes (Lockhart 1981). Electrolytic recovery involves digestion of the waste to solubilize the silver present followed by electrolysis of the silver-bearing solution generated. This is the process most frequently used to recover silver from photographic film. The silver recovered by electrolysis is generally sent to precious metals refineries for purification prior to reuse.

Cementation is an oxidation/reduction process for recovery of metallic silver. Cementation processes involve initial digestion of the waste to solubilize the silver. The silver-containing solution is filtered to remove insoluble residues, and a finely divided non-noble metal, such as zinc dust, is added. Zinc dissolves in the solution, replacing the silver, which precipitates as silver metal. The silver metal is recovered and sent to a precious metal refinery.

Recovery of silver in residues generated by chemical precipitation or reduction processes also involves an initial digestion of the waste to solubilize the silver, followed by wastewater treatment as described in the next section. Residues from the wastewater treatment processes (nonwastewaters) are collected by filtration and sent to a precious metals reclaimer, where the impure silver recovered is purified by high-temperature processes to yield a 99.9 percent purity product. The reclamation process involves roasting of the silver sulfide filter cake to thermally convert it to the metal and subsequent refining of the metal.

(2) **Stabilization**. Residues generated by chemical treatment processes such as chemical reduction and sulfide precipitation may be treated for silver recovery as described in Section 3.1.1(1) or stabilized with lime, cement, or fly ash formulations prior to land disposal. Stabilization technologies are discussed in the Treatment Technology Background Document (USEPA 1989b).

3.1.2 Treatment Technologies for Wastewaters

The silver recovery and chemical treatment processes described above are applicable to wastewaters as well as nonwastewaters. The chemical treatment processes will either reduce silver salts to the metal for recovery or precipitate silver as insoluble silver salts such as silver sulfide or silver chloride.

(1) Chemical reduction. In chemical reduction technologies, the waste is treated with a solution containing a reducing agent such as ferrous salt or sodium bisulfite. The reducing agent reacts with the soluble silver compounds present to generate elemental silver, which precipitates from solution. Chemical reduction technologies are discussed in greater detail in the Treatment Technology Background Document (USEPA 1989b).

(2) Chemical precipitation. Sulfide precipitation converts soluble silver salts to insoluble silver sulfide. Chloride compounds may also be used to remove silver from wastewaters as insoluble silver chloride. Chemical precipitation technologies are discussed in greater detail in the Treatment Technology Background Document (USEPA 1989b).

3.2 Demonstrated Treatment Technologies

Silver recovery technologies (e.g., electrolysis, cementation, and high-temperature recovery) have been in widespread use in the photographic chemicals and photographic processing industries for over a decade. A 1977 study, for example, showed extensive use of these technologies at photographic processing facilities (Haderer and DeFilippi 1977). These technologies were installed primarily for economic reasons (i.e., to maximize silver recovery and minimize silver losses).

Chemical reduction, chemical precipitation, and stabilization are demonstrated technologies that have been in full-scale use for many years in industry. In fact, effluent limitations guidelines for several segments of the inorganic chemicals industry are based on the use of chemical reduction and chemical precipitation technologies (USEPA 1982).

4. PERFORMANCE DATA

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). 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 covered by this background document 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.

The Agency has data on the effectiveness of recovery technologies in those industries using silver salts, such as the photographic processing industries. Most of these data have been accumulated from earlier Agency studies aimed at developing effluent limitations guidelines for the photographic industry (USEPA 1976). The data basically show that with the use of one or more of the silver recovery systems, photographic processing plants could meet the 1977 effluent limitations guidelines for silver (as a time-weighted average) of 0.45 mg/l in their wastewaters. Table 4-1 presents a summary of the silver standard for photographic processing.

The Agency also has extensive data on the use of chemical precipitation and stabilization of the waste F006. These data are included in Table 4-2.

Additional wastewater treatment data, primarily from EPA's Office of Water, have been analyzed for the development of concentration-based treatment standards for and other wastewaters. These data are presented in Table 4-3. Available data from the Office of Water's Industrial Technology Division (ITD) and the Hazardous Waste Engineering Research Laboratory (WERL) data bases were used, and a treatment standard of 0.29 mg/l for P099 and P104 wastewaters was calculated. Further information on these data, including the sources of the data and the treatment technologies used, can be found in the preamble to the proposed rule and in the Best Demonstrated Available Technology (BDAT) Background Document for Wastewaters Containing BDAT List Constituents (USEPA 1989d).

Table 4-1 EPA Effluent Guidelines and Standards for Photographic Processing for Silver

Plant No.	Type of operation	Influent concentration Raw waste load Silver kg/1000 m^2 (lbs/1000 ft^2(mg/l)
32	Black and white	0.10 (0.02)
33	Black and white	0.08 (0.016)
32	Color (0.013)	0.06
33	Color	0.05 (0.011)
34	Color	0.08 (0.016)
Raw waste load average		0.07 (0.015)[1]
Raw waste load concentration (mg/l)		0.45

[1]Plant 32 - black and white not included in raw waste load average.

Source: USEPA 1976.

Table 4-2 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)						
Silver	2.3	0.01	0.03	NR	NR	NR
Oil and grease	1,520	-	-	-	-	-
TOC	14,600	-	-	-	-	-
Sample Set #2 (Source-auto parts manufacturing)						
Silver	6.62	0.14	0.03	0.05	NR	NR
Oil and grease	60	-	-	-	-	-
TOC	1,500	-	-	-	-	-
Sample Set #3 (Source-aircraft over-hauling facility)						
Silver	39.0	0.02	0.20	0.05	NR	NR
Oil and grease	37,000	-	-	-	-	-
TOC	137,000	-	-	-	-	-
Sample Set #4 (Source-aerospace manufacturing-mixture of F006 & F007)						
Silver	6.26	1.64	NR	NR	0.09	0.15
Oil and grease	3,870	-	-	-	-	-
TOC	8,280	-	-	-	-	-
Sample Set #5 (Source-zinc plating)						
Silver	9.05	0.16	0.03	0.04	NR	NR
Oil and grease	1,150	-	-	-	-	-
TOC	21,200	-	-	-	-	-
Sample Set #6 (Source-unknown)						
Silver	5.28	0.08	0.04	0.06	NR	NR
Oil and grease	20,300	-	-	-	-	-
TOC	28,600	-	-	-	-	-

Table 4-2 (continued)

Constituent	Untreated waste: Total (mg/kg)	Untreated waste: TCLP (mg/l)	Treated waste - TCLP (mg/l), Binder-to-waste ratio[a]: 0.2	0.5	1.0	1.5
Sample Set #7 (Source-small engine manufacturing)						
Silver	4.08	0.12	0.03	0.05	NR	NR
Oil and grease	2,770	-	-	-	-	-
TOC	6,550	-	-	-	-	-
Sample Set #8 (Source-circuit board manufacturing[b])						
Silver	12.5	0.05	0.03	0.05	NR	NR
Oil and grease	130	-	-	-	-	-
TOC	550	-	-	-	-	-
Sample Set #9 (Source-unknown)						
Silver	8.11	0.31	0.03	0.05	NR	NR
Oil and grease	30	-	-	-	-	-
TOC	10,700	-	-	-	-	-
Sample Set #10 (Source-unknown)						
Silver	19.1	<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.

Table 4-3 Wastewater Treatment Performance Data for Silver

Technology	Technology size	Facility	Detection limit (ppb)	Range Influent concentration	No. of Data points	Average Effluent concentration	Recovery (%)	Removal (%)	Reference
AL	Full	1B		0-100	6	2.000		60.00	WERL
AS	Full	975B		0-100		15.000		50.00	WERL
AS	Full	1B		0-100	6	2.000		94.10	WERL
As	Full	201B		0-100	35	1.000		88.00	WERL
As	Full	1B		0-100	6	5.000		50.00	WERL
AS	Full	1B		0-100	6	2.000		78.00	WERL
As	Full	1B		0-100	6	3.000		87.00	WERL
AS	Full	1B		0-100	6	1.000		88.00	WERL
AS	Full	1B		0-100	6	1.000		86.00	WERL
AS	Full	1B		0-100	6	1.000		80.00	WERL
AS	Full	1B		0-100	6	5.000		71.00	WERL
AS	Full	1B		0-100	6	3.000		85.00	WERL
AS	Full	1B		0-100	6	5.000		67.00	WERL
AS	Full	1B		0-100	6	2.000		90.50	WERL
AS	Full	1B		0-100	6	3.000		81.00	WERL
AS	Full	1B		0-100	6	5.000		72.00	WERL
AS	Full	1B		0-100	6	1.000		90.90	WERL
L+Sed	Full			4700		100.000			ITD-CMDB
L+Sed+Fil	Full			4700		70.000			ITD-CMDB
Pt+Sed	Full		10	0-600000	21	96.000			ITD-MF
Sed+Fil	Full					50.000			ITD-CMDB
TF	Full	1B		0-100	6	2.000		90.00	WERL
TF	Full	1B		0-100	6	7.000		63.00	WERL
TF	Full	1B		0-100	6	8.000		47.00	WERL
TF	Full	1B		0-100	6	3.000		73.00	WERL

Source: USEPA 1989d.

5. DETERMINATION 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 D011.

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 accuracy-adjusted 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, silver recovery eliminates the D011 waste streams in many cases. This is especially true for wastewaters, where most if not all of the silver can be recovered from these waste streams as metal. For nonwastewater forms of D011, recovery technologies also reduce the concentrations of silver present in wastes to be land disposed.

The Agency realizes, however, that not all nonwastewater and wastewater forms of D011 may be readily amenable to recovery processes. Silver may be present in refractory solid matrices from which it cannot be easily extracted, or it may be present in solution in the form of complex ions that cannot easily be treated by recovery processes. For nonwastewater forms of D011 wastes from which silver cannot be recovered, the best technology has been determined to be stabilization, based on data on stabilization of wastewater treatment sludges (F006) with significant concentrations of leachable silver (up to 1.64 mg/l in the untreated waste TCLP leachate). Stabilization has been shown to reduce the leachability of silver in these wastes. Accordingly, the Agency has determined that either recovery or stabilization represents BDAT for nonwastewater forms of D011.

For wastewaters where silver recovery is not viable, chemical treatment is the best technological treatment option. Chemical treatment (either chemical reduction or chemical precipitation) removes soluble silver salts either as the metal or as insoluble silver compounds. EPA has data that show that chemical precipitation followed by filtration is used for treatment of most D011 wastewaters from which silver is not recovered and that the use of this technology results in the generation of wastewater residuals in which the silver concentration is substantially reduced from the concentration in the untreated waste. Accordingly, the Agency has determined that chemical precipitation followed by filtration represents BDAT for D011 wastewaters.

EPA has determined that the best demonstrated technologies specified above for the D011 treatability groups (i.e., recovery or chemical precipitation followed by sedimentation and filtration for wastewaters and recovery or stabilization for nonwastewaters) are also commercially available and provide substantial treatment. Hence, these technologies represent BDAT for D011 wastewaters and nonwastewaters.

6. DEVELOPMENT OF BDAT TREATMENT STANDARDS

In Section 5, the Agency chose the best demonstrated available technologies for both nonwastewaters and wastewaters based on the treatment data available to the Agency. In this section, BDAT treatment standards are verified based on the performance of these technologies. Silver is selected as the only regulated constituent because it is the only constituent for which this waste is listed. If D011 wastes are mixed with other listed or characteristic hazardous wastes and thus contain other constituents, other treatment standards 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.

6.1 BDAT Treatment Standards for Nonwastewaters

EPA recognizes the diversity of wastes that qualify as hazardous under the D011 classification. Because of this diversity, EPA has chosen to regulate D011 nonwastewaters at the characteristic level of 5 mg/l in the TCLP leachate. Data available show that the characteristic level can be met.

6.2 BDAT Treatment Standards for Wastewaters

EPA recognizes the diversity of wastes that qualify as hazardous under the D011 classification. Because of this diversity, EPA has chosen to regulate D011 wastewaters at the characteristic level of 5 mg/l in the TCLP leachate.

Tables 6-1 and 6-2 show the promulgated treatment standards for D011 nonwastewasters and wastewaters, respectively.

Table 6-1 BDAT Treatment Standards for D011
Nonwastewaters

Regulated Constituent	Maximum for any single grab sample TCLP (mg/l)
Silver	5.0

Table 6-2 BDAT Treatment Standards for D011
Wastewaters

Regulated constituent	Maximum for any single grab sample Total composition (mg/l)
Silver	5.0

7. P WASTE CODES

This section addresses regulation of P-code wastes that are listed for silver. These wastes, P099 (potassium silver cyanide) and P104 (silver cyanide), are identified in 40 CFR 261.33 as "discarded commercial chemical products, off-specification species, container residues, and spill residues thereof." Treatment standards for cyanide in P099 and P104 wastes were promulgated with the Second Third Land Disposal Restrictions Final Rule (54 FR 26614, June 23, 1989). Therefore, this section will address only the development of a treatment standard for silver in P099 and P104 wastes. Detailed information on the development of cyanide treatment standards for P099 and P104 wastes is included in the Best Demonstrated Available Technology (BDAT) Background Document for Cyanide Wastes (USEPA 1989c).

7.1 Industries Affected

Silver cyanide is prepared by the reaction of silver nitrate and sodium cyanide under carefully controlled conditions. Potassium silver cyanide is prepared by reacting silver nitrate with potassium cyanide. Silver cyanide and potassium silver cyanide are used in the metal finishing industry in electroplating operations as a source of soluble silver. Additional information on the industries affected by the land disposal restrictions for silver wastes is presented in Section 2.1.

7.2 Applicable and Demonstrated Treatment Technologies

The treatment technologies described in Section 3 as being applicable and demonstrated for D011 silver wastes are also considered to be applicable and demonstrated for P099 and P104 wastes. EPA has no data suggesting that other treatment technologies are applicable or demonstrated for silver in P099 and P104 wastes.

7.3 Determination of Best Demonstrated Available Technology

Silver cyanide is a relatively insoluble compound (approximately 0.2 ppm silver). Therefore, these wastes will be generated primarily as nonwastewaters. However, these wastes may have to be dissolved in order to treat them for cyanide by aqueous chemical oxidation treatment methods.

Based on performance data on the treatment of silver-containing wastes, as presented in Section 4, the Agency has identified chemical precipitation followed by sedimentation and filtration as the "best" treatment for P099 and P104 wastewaters. For P099 and P104 nonwastewaters, the Agency has identified recovery or stabilization as the "best" treatment.

EPA has also determined that the best demonstrated technologies specified above for P099 and P104 wastewaters and nonwastewaters are commercially available and provide substantial treatment. Hence, these technologies represent BDAT for P099 and P104 wastewaters and nonwastewaters.

7.4 Selection of Regulated Constituents

EPA is promulgating a treatment standard for silver in P099 and P104 wastes. Silver and cyanide are the only Appendix VIII constituents for which P099 and P104 wastes are listed, and they are the only BDAT list constituents 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 Treatment Standards

The Agency is promulgating recovery or stabilization as BDAT for P099 and P104 wastewaters. The Agency is also promulgating a treatment standard for silver based on the performance of chemical precipitation followed by sedimentation and filtration. The calculation of this treatment standard is presented in the Best Demonstrated Available Technology (BDAT) Background Document for Wastewaters Containing BDAT List Constituents (USEPA 1989d). The promulgated treatment standard for P099 and P104 wastewaters is summarized in Table 7-1, and the calculation of this standard is shown in Table 7-3.

For P099 and P104 nonwastewaters, the Agency is promulgating recovery or stabilization as BDAT for these wastes. The promulgated treatment standard is based on the performance of stabilization for F006 wastes. This treatment standard is summarized in Table 7-2, and the calculation of this standard is shown in Table 7-4.

Table 7-1 BDAT Treatment Standards for P099 and P104 Wastewaters

Regulated Constituent	Maximum for any 24-hour composite sample Total composition (mg/l)
Silver	0.29

Table 7-2 BDAT Treatment Standards for P099 and P104 Nonwastewaters

Regulated Constituent	Maximum for any single grab sample TCLP (mg/l)
Silver*	0.072

*This constituent was promulgated in the Second Thirds Final Rule.

Table 7-3 Calculation of Treatment Standard for P099 and P104 Wastewaters

Regulated constituent	Average effluent concentration (ppb)	Accuracy correction factor	Variability factor	BDAT Treatment standard (ppb)
Silver	100			
	70			
	96			
	50			
	70	NA	4.1	290

Table 7-4 Calculation of Treatment Standard for P099 and P104 Nonwastewaters

Regulated constituent	Accuracy-adjusted treated waste leachate concentration (mg/l) (1)	Mean treated waste leachate concentration (mg/l) (2)	Variability factor (VF)[a] (3)	Treatment standard (TCLP) (mg/l) (4) = (2)x(3)
Silver	0.03	0.04	1.8	0.072
	0.09			
	0.03			
	0.03			
	0.03			
	0.03			

[a]See Methodology Document (USEPA 1989a) for details of the method of calculation of variability factor.

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