FINAL
BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT) BACKGROUND DOCUMENT FOR

F006 WASTEWATERS (ADDENDUM)

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1. INTRODUCTION AND SUMMARY

This document provides the Agency's rationale and technical support for selecting the constituents to be regulated in F006 wastewaters and for developing treatment standards for those regulated constituents. This document is an addendum to the supporting best demonstrated available technology (BDAT) background documents for F006 nonwastewaters. Treatment standards for metal constituents in F006 nonwastewaters were presented in the F006 background document dated August 1988 (USEPA 1988a); treatment standards for cyanides in F006 nonwastewaters were presented in a background document for cyanide wastes dated June 1989 (USEPA 1989a). Information regarding untreated F006 waste and F006 nonwastewater standards can be accessed through these background documents. This addendum contains only information pertaining to the development of treatment standards for F006 wastewaters.

Treatment standards for certain metals contained in F006 nonwastewaters were originally promulgated as part of the First Third rulemaking (53 FR 31152, August 17, 1988). In that rulemaking, the Agency established treatment standards for cadmium, chromium, lead, nickel, and silver, which were found to leach at treatable levels from untreated waste. The treatment standards were based on performance data from stabilization. In the First Third rulemaking, the Agency reserved the nonwastewater cyanide treatment standards for F006 waste.

Treatment standards for amenable and total cyanide in F006 nonwastewaters were promulgated by the Agency as part of the Second Third rulemaking (54 FR 26600, June 23, 1989). The cyanide treatment standards for F006 nonwastewaters were based on performance data from alkaline chlorination followed by chemical precipitation, filtration, and sludge dewatering.

According to 40 CFR 261.32, waste code F006 is listed as "wastewater treatment sludges from electroplating operations except from the following processes: (1) sulfuric acid anodizing of aluminum; (2) tin plating on carbon steel; (3) zinc plating (segregated basis) on carbon steel; (4) aluminum or zinc-aluminum plating on carbon steel; (5) cleaning/stripping associated with tin, zinc, and aluminum plating on carbon steel; and (6) chemical etching and milling of aluminum." F006 waste as typically generated is by BDAT definition a nonwastewater. For the purpose of determining the applicability of 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). Wastes not meeting this definition must comply with the treatment standards for nonwastewaters.

The F006 wastewaters are expected to be generated primarily from the following sources: (1) filtrate and/or clarifier overflow from treated electroplating wastewaters, (2) RCRA corrective actions at RCRA facilities, and (3) spills. F006 wastewater, which results primarily from waste treatment operations in the electroplating or metal finishing industry, is clearly defined in the First Third Final Rule (53 FR 31153), which states that, "the supernatant (from the clarifier) from F006 generation is not considered to be F006, but simply wastewater from the treatment of electroplating wastewater. Filtrate from F006 sludges could be hazardous under the derived from rule, but if the filtrate is similar in terms of identity and concentration of its metal constituents in the influent to the wastewater treatment process, it is not considered to be derived-from F006. Rather it is the original influent wastewater."

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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, 16th Edition (APHA, AWWA, and WPCF 1985).

The resulting filtrate from filtration of F006 nonwastewater sludge can be directly discharged to the POTWs under NPDES permit. It also could be recycled back to the clarifier and discharged as clarifier supernatant to POTWs under a NPDES permit. If the filtrate is recycled to the clarifier, and the concentration of constituents in the normal influent to the clarifier is similar to or higher than the concentration of constituents in the recycled filtrate wastewater from the filter, then the combined filtrate and clarifier overflow are not considered F006 wastewaters. If F006 filtrate wastewater is not recycled back to the clarifier, and subsequently comes in contact with a land disposal unit prior to discharge to POTWs or NPDES discharge, the contents of the land disposal unit, i.e., surface impoundment, must meet the RCRA Land Disposal Restriction standard for F006 wastewaters, regardless of its similarity to the clarifier influent or overflow.

In the First Third Rule, the Agency indicated that it did intend to propose numerical wastewater standards for F006 wastewaters in the Third Third Final Rule as opposed to a No Land Disposal because a facility may wish to store an F006 wastewater in a land disposal unit. Therefore, the Agency is promulgating treatment standards for cadmium, chromium, lead, nickel, and total and amenable cyanide based on technology performance data and similarity of waste streams.

For F006 wastewaters, the Agency is promulgating treatment standards for cadmium, total chromium, lead, nickel, and total and amenable cyanides. The treatment standards for cadmium, total chromium, lead, and nickel are based on treatability data from the performance of hexavalent chromium reduction, followed by chemical precipitation using lime and sulfide, and sludge dewatering. The Agency is transferring metals treatment standards from K062 wastewater performance data. The treatment standards for total and amenable cyanides in wastewater are based on the performance of alkaline chlorination. The Agency is transferring cyanide

treatment standards from F007, F008, and F009 mixed wastewater performance data (Table 4-2).

Table 1-1 summarizes the treatment standards for F006 wastewaters and the existing standards for F006 nonwastewaters.

Table 1-1 BDAT Treatment Standards for F006 Wastes

Constituent	Maximum for any single grab sample		
	Wastewater	Nonwastewater	
	Total composition (mg/l)	Total composition (mg/kg)	TCLP (mg/l)
Cadmium	1.6	NA	0.066
Chromium (total)	0.32	NA	5.2
Lead	0.040	NA	0.51
Nickel	0.44	NA	0.32
Cyanide (amenable)	0.86	30	NA
Cyanide (total)	1.20	590	NA

NA - Not applicable.

2. INDUSTRY AFFECTED AND WASTE CHARACTERIZATION

According to 40 CFR 261.32, waste code F006 is listed as "wastewater treatment sludges from electroplating operations except from the following processes: (1) sulfuric acid anodizing of aluminum; (2) tin plating on carbon steel; (3) zinc plating (segregated basis) on carbon steel; (4) aluminum or zinc-aluminum plating on carbon steel; (5) cleaning/stripping associated with tin, zinc, and aluminum plating on carbon steel; and (6) chemical etching and milling of aluminum." This section discusses F006 wastes, their generation, and the industry affected by the land disposal restrictions that apply to them.

2.1 Industry Affected

F006 wastewaters result primarily from waste treatment operations in the electroplating or metal finishing industries. Using the 1985 Biennial Report Data Base, EPA identified approximately 4,500 facilities as generators of F006 wastes. The process description for generating F006 wastes is outlined in the F006 background document (USEPA 1988a). Since it has not been altered, it is not repeated in this document.

2.2 Waste Characterization

Waste characterization data available to the Agency that are applicable to F006 wastes include data for a metal-bearing F006, K062, D002, and D003 wastewater. The data include information for the toxic metals arsenic, cadmium, chromium, copper, lead, nickel, and zinc and cyanide constituents. These data are presented with the performance data in Section 4 of this document.

Other waste characterization data applicable to F006 wastewaters were collected by EPA's Office of Water for the Effluent Limitations Guidelines for the Metal Finishing Industry (USEPA 1983). These data are presented in Appendix A of this addendum. The waste characterization data in Appendix A include metal finishing industry data for the toxic metals cadmium, chromium, lead, and nickel (Appendix A Tables 5-18 and 5-19), as well as data for silver (Appendix A Table 5-20). Additional EPA Office of Water data applicable to F006 wastewaters are presented in the Best Demonstrated Available Technology (BDAT) Background Document for Wastewaters Containing BDAT List Constituents (USEPA 1989d).

3. APPLICABLE/DEMONSTRATED TREATMENT TECHNOLOGIES

This section describes the applicable and demonstrated treatment technologies for F006 wastewaters. The technologies that are considered applicable to the treatment of F006 wastewaters are those that treat the proposed regulated constituents by reducing their concentration in the wastewater. This section includes discussions of those applicable treatment technologies and those that have been demonstrated (i.e., are used on a full-scale basis).

3.1 Applicable Treatment Technologies

Available information shows that several technologies are applicable for treatment of F006 wastewaters to reduce the concentration of metals. One applicable technology for the removal of metals from plating wastewaters and F006 wastewaters include (1) a chromium reduction step to treat hexavalent chromium, (2) a chemical precipitation step to precipitate metals out of solution, and (3) a sludge dewatering step to remove the precipitated residues from solution. Another applicable technology as BDAT for metals removal is ion exchange. Ion exchange is a treatment technology applicable to metals in wastewaters where the metals are present as soluble ionic species (e.g., Cr^{+3} and CrO_4^{-2}).

EPA has identified four technologies as potentially applicable for treatment of cyanides in F006 wastewaters: (1) electrolytic oxidation; (2) chemical oxidation using any of several oxidizing agents, such as hypochlorite or chlorine (alkaline chlorination), permanganate, ozone, or SO_2/air (Inco process); (3) wet air oxidation; and (4) high-temperature cyanide hydrolysis.

Electrolytic oxidation followed by alkaline chlorination, chemical oxidation (alkaline chlorination or other methods) alone, electrolytic oxidation alone, wet air oxidation, and high-temperature hydrolysis reduce the concentration of cyanide in wastewaters treated. These technologies usually fully destroy the amenable cyanide present in the waste but treat the complexed cyanides to varying degrees, depending on, among other things, the stability of the metal-cyanide complex and the severity of the oxidizing agent and reaction conditions. Iron cyanide complexes are typically the most resistant to oxidation treatment.

Additional information on the technologies identified to be applicable for F006 wastewaters can be found in the Treatment Technology Background Document (USEPA 1989c).

3.2 Demonstrated Treatment Technologies

All treatment technologies identified as being applicable for removal of metals in F006 wastewaters are also considered to be demonstrated because they are used on a full-scale commercial basis for treatment of metal-bearing wastewaters. A hexavalent chromium reduction, metals precipitation, and sludge dewatering treatment train are widely practiced metals treatment schemes. Information regarding treatment of precipitated solids (F006 nonwastewaters) from such a treatment train is presented in the F006 background document (USEPA 1988a).

Ion exchange has also been commercially demonstrated for metals in wastewaters similar to F006 wastewaters. However, concentrating the BDAT list metals on the ion exchange resin substrate creates a hazardous nonwastewater requiring treatment to remove the adsorbed metals. This treatment also produces another wastewater residual requiring either chemical precipitation and/or recovery of metals.

The treatment technologies identified as being applicable for treatment of cyanides in F006 wastewaters are also considered to be demonstrated. Available information shows that electrolytic oxidation followed by alkaline chlorination, alkaline chlorination alone, wet air oxidation, high-temperature hydrolysis, and SO_2/air oxidation are demonstrated for treatment of cyanide in wastewaters. The Agency has identified at least one full-scale facility that uses electrolytic oxidation followed by alkaline chlorination to treat cyanides, at least five facilities that use alkaline chlorination to treat cyanide wastes (and believes that there are at least hundreds), at least one facility that treats cyanide-containing wastes by high-temperature cyanide hydrolysis, and one pilot-scale facility that has treated cyanide waste by wet air oxidation. In addition, wet air oxidation and SO_2/air oxidation are used to treat similar wastes in full-scale processes. Information regarding cyanide treatment of F006 nonwastewaters is presented in the background document for cyanide wastes (USEPA 1989a). Performance data for the above technologies are presented and discussed in Section 4.

4. PERFORMANCE DATA

This section discusses the available performance data associated with the demonstrated technologies for F006 wastewaters. The performance data include the constituent concentrations in untreated and treated waste samples and data on waste characteristics that affect performance. Data used to develop treatment standards are incorporated into the body of this addendum. Data that were considered but not used to develop treatment standards are presented as attachments.

4.1 BDAT List Metals Treatment Data

The performance data available to the Agency on treatment of BDAT list metals include 11 data sets from treatment of BDAT list metals in a metal-bearing wastewater by hexavalent chromium reduction followed by chemical precipitation and sludge dewatering. The metal-bearing wastewater included waste codes F006, K062, D002, and D003. These data were previously used in the development of treatment standards promulgated for K062 in the Final Rule for First Third Wastes (53 FR 31164, August 17, 1988). These performance data are presented in Table 4-1 at the end of this section. They reflect total waste concentrations for BDAT list metals in the untreated and treated wastewater.

Performance data collected by EPA's Office of Water for the Effluent Limitations Guidelines for the Metal Finishing Industry (USEPA 1983) are presented in Attachment B. These data contain treated effluent values for wastewaters containing cadmium, chromium, lead, and nickel based on two methods of treatment. One method of treatment, "Option 1," involves cyanide destruction and hexavalent chromium reduction, followed by pH

adjustment with lime or caustic to precipitate these metals, settling to remove the metal hydroxides, and discharge of the treated wastewaters. The other treatment, "Option 2," involves an additional filtration step to act as a polishing step for the effluent prior to discharge. (The metal finishing industry frequently includes a filtration step prior to discharge of the treated effluent.) It should be noted that silver-bearing wastewaters were subjected to various technologies for recovery of silver metal (including evaporation, ion exchange, and electrolytic recovery), unlike the other BDAT list constituents.

The Agency has also evaluated another performance data base that was developed by EPA's Office of Water for hydroxide precipitation, sedimentation, and filtration for wastes from the metal finishing industry. Further information on these data, including the sources of the data and the treatment technologies used, can be found in the Best Demonstrated Available Technology (BDAT) Background Document for Third Third U and P Wastes and Multi-Source Leachates, Volume A (USEPA 1990).

4.2 Cyanide Treatment Data

Applicable and demonstrated treatment technologies for cyanides contained in F006 wastewaters were discussed in Section 3. The Agency has no data demonstrating the performance of cyanide treatment specifically for F006 wastewaters. However, performance data available to the Agency on treatment of cyanides in wastewaters were previously used to develop BDAT treatment standards for F007, F008, and F009 wastewaters. The Agency believes that these wastewaters are similar to F006 wastewater because both originate from plating activities and are likely to contain the same metals and because both may have cyanides. Table 4-2 presents data from alkaline chlorination of various

electroplating wastes consisting of F006, F007, F008, F009, F011, F012, D002, D003, P029, P030, and P106 wastes. A variety of cyanide-containing wastes were treated by this alkaline chlorination process. Fourteen different sample sets are presented. In addition, the Agency's development of categorical wastewater discharge standards for the metal finishing industry set standards at 0.86 mg/l for amenable cyanide and 1.2 mg/l for total cyanide. Data supporting the metal finishing cyanide standards are found in Development Document for Effluent Limitations Guidelines and Standards for the Metal Finishing Point Source Category, EPA 440/1-83/091, June 1983, pp. VII B-126 to VII-153.

Table 4-1 Treatment Performance Data for K062 EPA-Collected Data

Sample Set #1

Constituent	Untreated K062 waste (mg/l) Sample no. 801	Untreated K062 waste (mg/l) Sample no. 802	Untreated waste composite[a] (mg/l) Sample no. 805	Treated waste (wastewater) (mg/l) Sample no. 806
Arsenic	3	<1	<1	<0.1
Cadmium	<5	<5	13	<0.5
Chromium (hexavalent)	I	I	893	0.011
Chromium (total)	1800	7000	2581	0.12
Copper	865	306	138	0.21
Lead	<10	<10	64	<0.01
Nickel	3200	2600	471	0.33
Zinc	<2	<2	116	0.125

Design and Operating Data

	Design value	Operating value
pH	8-10	9

I = Color interference.

[a]The untreated waste composite is a mixture of the untreated K062 waste streams shown on this table, along with other non-K062 waste streams (F006, D002, and D003).

Reference: USEPA 1988b.

Table 4-1 (continued)

Sample Set #2

Constituent	Untreated K062 waste (mg/l) Sample no. 801	Untreated K062 waste (mg/l) Sample no. 802	Untreated waste composite[a] (mg/l) Sample no. 813	Treated waste (wastewater) (mg/l) Sample no. 814
Arsenic	3	<1	<1	<0.1
Cadmium	<5	<5	10	<0.5
Chromium (hexavalent)	I	I	807	0.12
Chromium (total)	1800	7000	2279	0.19
Copper	865	306	133	0.15
Lead	<10	<10	54	<0.01
Nickel	3200	2600	470	0.33
Zinc	<2	<2	4	0.115

Design and Operating Data

	Design value	Operating value
pH	8-10	9

I = Color interference.

[a]The untreated waste composite is a mixture of the untreated K062 waste streams shown on this table, along with other non-K062 waste streams (F006, D002, and D003).

Reference: USEPA 1988b.

Table 4-1 (continued)

Sample Set #3

Constituent	Untreated K062 waste (mg/l) Sample no. 817	Untreated K062 waste (mg/l) Sample no. 802	Untreated waste composite[a] (mg/l) Sample no. 821	Treated waste (wastewater) (mg/l) Sample no. 822
Arsenic	3	<1	<1	<0.1
Cadmium	<5	<5	5	<0.5
Chromium (hexavalent)	I	I	775	I
Chromium (total)	1700	7000	1990	0.20
Copper	425	306	133	0.21
Lead	<10	<10	<10	<0.01
Nickel	100310	2600	16330	0.33
Zinc	7	<2	3.9	0.140

Design and Operating Data

	Design value	Operating value
pH	8-10	10

I = Color interference.

[a]The untreated waste composite is a mixture of the untreated K062 waste streams shown on this table, along with other non-K062 waste streams (F006, D002, and D003).

Reference: USEPA 1988b.

Table 4-1 (continued)

Sample Set #4

Constituent	Untreated K062 waste (mg/l) Sample no. 827	Untreated K062 waste (mg/l) Sample no. 802	Untreated K062 waste (mg/l) Sample no. 817	Untreated waste composite[a] (mg/l) Sample no. 829	Treated waste (wastewater) (mg/l) Sample no. 830
Arsenic	2	<1	3	<1	<1
Cadmium	<5	<5	5	<5	<0.5
Chromium (hexavalent)	1	I	I	0.6	0.042
Chromium (total)	142	7000	1700	556	0.10
Copper	42	306	425	88	0.07
Lead	<10	<10	<10	<10	<0.01
Nickel	650	2600	41000	6610	0.33
Zinc	3	<2	7	84	1.62

Design and Operating Data

	Design value	Operating value
pH	8-10	9

I = Color interference.

[a]The untreated waste composite is a mixture of the untreated K062 waste streams shown on this table, along with other non-K062 waste streams (F006, D002, and D003).

Reference: USEPA 1988b.

Table 4-1 (continued)

Sample Set #5

Constituent	Untreated K062 waste (mg/l) Sample no. 801	Untreated K062 waste (mg/l) Sample no. 802	Untreated K062 waste (mg/l) Sample no. 817	Untreated waste composite[a] (mg/l) Sample no. 837	Treated waste (wastewater) (mg/l) Sample no. 838
Arsenic	3	<1	3	<1	<0.1
Cadmium	<5	<5	5	<5	<0.5
Chromium (hexavalent)	I	I	I	917	0.058
Chromium (total)	1800	7000	1700	2236	0.11
Copper	865	306	425	91	0.14
Lead	<10	<10	<10	18	0.01
Nickel	3200	2600	41000	1414	0.31
Zinc	<2	<2	7	71	0.125

Design and Operating Data

	Design value	Operating value
pH	8-10	8

I = Color interference.

[a]The untreated waste composite is a mixture of the untreated K062 waste streams shown on this table, along with other non-K062 waste streams (F006, D002, and D003).

Reference: USEPA 1988b.

Table 4-1 (continued)

Sample Set #6

Constituent	Untreated K062 waste (mg/l) Sample no. 801	Untreated K062 waste (mg/l) Sample no. 802	Untreated waste composite[a] (mg/l) Sample no. 845	Treated waste (wastewater) (mg/l) Sample no. 846
Arsenic	3	<1	<1	<0.1
Cadmium	<5	<5	<5	<0.5
Chromium (hexavalent)	I	I	734	I
Chromium (total)	1800	7000	2548	0.10
Copper	865	306	149	0.12
Lead	<10	<10	<10	<0.01
Nickel	3200	2600	588	0.33
Zinc	<2	<2	4	0.095

Design and Operating Data

	Design value	Operating value
pH	8-10	8

I = Color interference.

[a]The untreated waste composite is a mixture of the untreated K062 waste streams shown on this table, along with other non-K062 waste streams (F006, D002, and D003).

Reference: USEPA 1988b.

Table 4-1 (continued)

Sample Set #7

Constituent	Untreated K062 waste (mg/l) Sample no. 801	Untreated K062 waste (mg/l) Sample no. 802	Untreated waste composite[a] (mg/l) Sample no. 853	Treated waste (wastewater) (mg/l) Sample no. 854
Arsenic	3	<1	<1	<0.1
Cadmium	<5	<5	10	<0.5
Chromium (hexavalent)	I	I	769	0.12
Chromium (total)	1800	7000	2314	0.12
Copper	865	306	72	0.16
Lead	<10	<10	108	<0.01
Nickel	3200	2600	426	0.40
Zinc	<2	<2	171	0.115

Design and Operating Data

	Design value	Operating value
pH	8-10	9

I = Color interference.

[a]The untreated waste composite is a mixture of the untreated K062 waste streams shown on this table, along with other non-K062 waste streams (F006, D002, and D003).

Reference: USEPA 1988b.

Table 4-1 (continued)

Sample Set #8

Constituent	Untreated K062 waste (mg/l) Sample no. 859	Untreated K062 waste (mg/l) Sample no. 801	Untreated waste composite[a] (mg/l) Sample no. 861	Treated waste (wastewater) (mg/l) Sample no. 862
Arsenic	<1	3	<1	<0.1
Cadmium	<5	<5	<5	<0.5
Chromium (hexavalent)	0.220	I	0.13	<0.01
Chromium (total)	15	1800	831	0.15
Copper	151	865	217	0.16
Lead	<10	<10	212	<0.01
Nickel	90	3200	669	0.36
Zinc	7	9	151	0.13

Design and Operating Data

	Design value	Operating value
pH	8-10	9

I = Color interference.

[a]The untreated waste composite is a mixture of the untreated K062 waste streams shown on this table, along with other non-K062 waste streams (F006, D002, and D003).

Reference: USEPA 1988b.

Table 4-1 (continued)

Sample Set #9

Constituent	Untreated K062 waste (mg/l) Sample no. 867	Untreated K062 waste (mg/l) Sample no. 801	Untreated K062 waste (mg/l) Sample no. 802	Untreated waste composite[a] (mg/l) Sample no. 869	Treated waste (wastewater (mg/l) Sample no. 870
Arsenic	<0.1	3	<1	<1	<0.1
Cadmium	<0.5	<5	<5	<5	<0.5
Chromium (hexavalent)	0.079	I	I	0.07	0.041
Chromium (total)	6	1800	7000	939	0.10
Copper	5	865	306	225	0.08
Lead	<1	<10	<10	<10	<0.01
Nickel	4	3200	2600	940	0.33
Zinc	0.4	<2	<2	5	0.06

Design and Operating Data

	Design value	Operating value
pH	8-10	10

I = Color interference.

[a]The untreated waste composite is a mixture of the untreated K062 waste streams shown on this table, along with other non-K062 waste streams (F006, D002, and D003).

Reference: USEPA 1988b.

Table 4-1 (continued)

Sample Set #10

Constituent	Untreated K062 waste (mg/l) Sample no. 801	Untreated waste composite[a] (mg/l) Sample no. 885	Treated waste (wastewater) (mg/l) Sample no. 862
Arsenic	<3	<1	<0.10
Cadmium	<5	<5	<0.5
Chromium (hexavalent)	I	0.08	0.106
Chromium (total)	1800	395	0.12
Copper	865	191	0.14
Lead	<10	<10	<0.01
Nickel	3200	712	0.33
Zinc	<2	5	0.070

Design and Operating Data

	Design value	Operating value
pH	8-10	9

I = Color interference.

[a]The untreated waste composite is a mixture of the untreated K062 waste streams shown on this table, along with other non-K062 waste streams (F006, D002, and D003).

Reference: USEPA 1988b.

Table 4-1 (continued)

Sample Set #11

Constituent	Untreated K062 waste (mg/l) Sample no. 801	Untreated K062 waste (mg/l) Sample no. 859	Untreated waste composite[a] (mg/l) Sample no. 893	Treated waste (wastewater) (mg/l) Sample no. 894
Arsenic	3	<1	<1	<0.10
Cadmium	<5	<5	23	<5
Chromium (hexavalent)	I	0.220	0.30	<0.01
Chromium (total)	1800	15	617	0.18
Copper	865	151	137	0.24
Lead	<10	<10	136	<0.01
Nickel	3200	90	382	0.39
Zinc	<2	7	135	0.100

Design and Operating Data

	Design value	Operating value
pH	8-10	9

I = Color interference.

[a]The untreated waste composite is a mixture of the untreated K062 waste streams shown on this table, along with other non-K062 waste streams (F006, D002, and D003).

Reference: USEPA 1988b.

Table 4-2 Alkaline Chlorination Data Submitted by Plant C During the Public Comment Period

Sample Set No. 1[a] for Treatment of F007, F008, D003, and P106

Constituent/parameter	Concentration		
	Untreated waste (mg/l)	Treated wastewater (mg/l)	Treated nonwastewater (mg/l)
BDAT Inorganics Other Than Metals			
Cyanide (total)	71,759	0.95	357
BDAT List Metals			
Copper	4,193		
Nickel	136	-	-
Cadmium	2,995	-	
Chromium	323		-
Lead	184		
Zinc	2,319		
Non-BDAT List Metals			
Iron	2,936		
Other Parameters			
pH	11.2		
TOC	<2%	-	

- = Not analyzed.

[a]Batch consisted of a mixture of liquids and drummed solids including waste codes F007, F008, D003, and P106.

Reference: CyanoKEM 1989.

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Table 4-2 (continued)

Sample Set No. 2[a] for Treatment of F009, F012

Constituent/parameter	Concentration		
	Untreated waste (mg/l)	Treated wastewater (mg/l)	Treated nonwastewater (mg/l)
BDAT Inorganics Other Than Metals			
Cyanide (total)	12,000	0.95	153
BDAT List Metals			
Copper	1,339		-
Nickel	4,088	-	-
Cadmium	300		
Chromium	592	-	
Lead	327		-
Zinc	750		-
Non-BDAT List Metals			
Iron	6,200	-	
Other Parameters			
pH	11.0	-	
TOC	<2%		-

- = Not analyzed.

[a]Batch consisted of a mixture of liquids and drummed solids including waste codes F009 and F012.

Reference: CyanoKEM 1989.

Table 4-2 (continued)

Sample Set No. 3[a] for Treatment of F009, D002, D003, and P030

Constituent/parameter	Concentration		
	Untreated waste (mg/l)	Treated wastewater (mg/l)	Treated nonwastewater (mg/l)
BDAT Inorganics Other Than Metals			
Cyanide (total)	17,206	<0.014	351
BDAT List Metals			
Copper	8,400		-
Nickel	1,290	-	
Cadmium	7,610	-	
Chromium	239	-	
Lead	129	-	
Zinc	5,150		
Non-BDAT List Metals			
Iron	5,520		
Other Parameters			
pH	11.2		
TOC	<2%		

- = Not analyzed.

[a]Batch consisted of a mixture of liquids and drummed solids including waste codes F009, D002, D003, and P030.

Reference: CyanoKEM 1989.

Table 4-2 (continued)

Sample Set No. 4[a] for Treatment of F007, F009, and D002

Constituent/parameter	Concentration		
	Untreated waste (mg/l)	Treated wastewater (mg/l)	Treated nonwastewater (mg/l)
BDAT Inorganics Other Than Metals			
Cyanide (total)	25,936	<0.014	374
BDAT List Metals			
Copper	3,266	-	
Nickel	7,172		
Cadmium	1,482	-	-
Chromium	707		-
Lead	173	-	-
Zinc	2,389	-	
Non-BDAT List Metals			
Iron	11,917		-
Other Parameters			
pH	11.5		
TOC	<2%	-	-

- = Not analyzed.

[a]Batch consisted of a mixture of liquids and drummed solids including waste codes F007, F009, and D002.

Reference: CyanoKEM 1989.

Table 4-2 (continued)

Sample Set No. 5[a] for Treatment of F007, F008, D003, and P029

Constituent/parameter	Concentration		
	Untreated waste (mg/l)	Treated wastewater (mg/l)	Treated nonwastewater (mg/l)
BDAT Inorganics Other Than Metals			
Cyanide (total)	16,914	<0.014	235
BDAT List Metals			
Copper	5,343		
Nickel	151		
Cadmium	3,412	-	-
Chromium	408		
Lead	99		
Zinc	3,483	-	
Non-BDAT List Metals			
Iron	3,670		
Other Parameters			
pH	11.0		
TOC	<2%		

- = Not analyzed.

[a]Batch consisted of a mixture of liquids and drummed solids including waste codes F007, F008, D003, and P029.

Reference: CyanoKEM 1989.

Table 4-2 (continued)

Sample Set No. 6[a] for Treatment of F011, F012, D002, and P106

Constituent/parameter	Concentration		
	Untreated waste (mg/l)	Treated wastewater (mg/l)	Treated nonwastewater (mg/l)
BDAT Inorganics Other Than Metals			
Cyanide (total)	59,421	0.028	245
BDAT List Metals			
Copper	922		-
Nickel	259		
Cadmium	3,223		
Chromium	180		-
Lead	142	-	-
Zinc	5,143		
Non-BDAT List Metals			
Iron	3,810		-
Other Parameters			
pH	11.3	-	
TOC	<2%	-	

- Not analyzed.

[a]Batch consisted of a mixture of liquids and drummed solids including waste codes F011, F012, D002, and P106.

Reference: CyanoKEM 1989.

Table 4-2 (continued)

Sample Set No. 7[a] for Treatment of F007 and F009

Constituent/parameter	Concentration		
	Untreated waste (mg/l)	Treated wastewater (mg/l)	Treated nonwastewater (mg/l)
BDAT Inorganics Other Than Metals			
Cyanide (total)	31,994	0.028	169
BDAT List Metals			
Copper	15,739		
Nickel	1,897		
Cadmium	944		
Chromium	100		
Lead	124		
Zinc	3,187		
Non-BDAT List Metals			
Iron	403	-	-
Other Parameters			
pH	11.2		
TOC	<2%		

- = Not analyzed.

[a]Batch consisted of a mixture of liquids and drummed solids including waste codes F007 and F009.

Reference: CyanoKEM 1989.

Table 4-2 (continued)

Sample Set No. 8 for Treatment of F007

Constituent/parameter	Concentration		
	Untreated waste (mg/l)	Treated wastewater (mg/l)	Treated nonwastewater (mg/l)
BDAT Inorganics Other Than Metals			
Cyanide (total)	41,900	<0.014	189
BDAT List Metals			
Copper	19,510	-	
Nickel	2,683	-	
Cadmium	1,350		-
Chromium	100		-
Lead	138	-	-
Zinc	4,708	-	
Non-BDAT List Metals			
Iron	498	-	
Other Parameters			
pH	11.5		-
TOC	<2%		-

- Not analyzed.

Reference: CyanoKEM 1989.

Table 4-2 (continued)

Sample Set No. 9[a] for Treatment of F006, F009, F011, D002, and D003

Constituent/parameter	Concentration		
	Untreated waste (mg/l)	Treated wastewater (mg/l)	Treated nonwastewater (mg/l)
BDAT Inorganics Other Than Metals			
Cyanide (total)	18,882	<0.014	106.3
BDAT List Metals			
Copper	11,654	-	
Nickel	1,925		
Cadmium	792		
Chromium	3,658		
Lead	289		
Zinc	5,357		
Non-BDAT List Metals			
Iron	6,713		
Other Parameters			
pH	10.3		
TOC	<2%		

- = Not analyzed.

[a]Batch consisted of a mixture of liquids and drummed solids including waste codes F006, F009, F011, D002, and D003.

Reference: CyanoKEM 1989.

Table 4-2 (continued)

Sample Set No. 10[a] for Treatment of F006 and F012

Constituent/parameter	Concentration Untreated waste (mg/l)	Treated wastewater (mg/l)	Treated nonwastewater (mg/l)
BDAT Inorganics Other Than Metals			
Cyanide (total)	1,270	0.17	143
BDAT List Metals			
Copper	2,319	-	-
Nickel	6,739	-	
Cadmium	1,903		-
Chromium	14,079	-	
Lead	662		
Zinc	19,163		-
Non-BDAT List Metals			
Iron	7,786	-	
Other Parameters			
pH	10.0	-	
TOC	<2%		

= Not analyzed.

[a]Batch consisted of a mixture of liquids and drummed solids including waste codes F006 and F012.

Reference: CyanoKEM 1989.

Table 4-2 (continued)

Sample Set No. 11[a] for Treatment of F007, F009, D002, P029, and P030

Constituent/parameter	Concentration		
	Untreated waste (mg/l)	Treated wastewater (mg/l)	Treated nonwastewater (mg/l)
BDAT Inorganics Other Than Metals			
Cyanide (total)	22,820	1.16	114.1
BDAT List Metals			
Copper	7,910		
Nickel	450		
Cadmium	3,109		
Chromium	<100		
Lead	124		
Zinc	4,695	-	-
Non-BDAT List Metals			
Iron	832		
Other Parameters			
pH	11.2		
TOC	<2%		

- = Not analyzed.

[a]Batch consisted of a mixture of liquids and drummed solids including waste codes F007, F009, D002, P029, and P030.

Reference: CyanoKEM 1989.

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Table 4-2 (continued)

Sample Set No. 12[a] for Treatment of F007, F009, F012, and D003

Constituent/parameter	Concentration		
	Untreated waste (mg/l)	Treated wastewater (mg/l)	Treated nonwastewater (mg/l)
BDAT Inorganics Other Than Metals			
Cyanide (total)	12,085	<0.014	252.4
BDAT List Metals			
Copper	8,165		-
Nickel	138		
Cadmium	128		
Chromium	<116		
Lead	105		
Zinc	325		
Non-BDAT List Metals			
Iron	248	-	
Other Parameters			
pH	10.7	-	
TOC	<2%		

- = Not analyzed.

[a]Batch consisted of a mixture of liquids and drummed solids including waste codes F007, F009, F012, and D003.

Reference: CyanoKEM 1989.

Table 4-2 (continued)

Sample Set No. 13 for Treatment of D002

Constituent/parameter	Concentration		
	Untreated waste (mg/l)	Treated wastewater (mg/l)	Treated nonwastewater (mg/l)
BDAT Inorganics Other Than Metals			
Cyanide (total)	10,902	0.07	203.1
BDAT List Metals			
Copper	355		
Nickel	160	-	
Cadmium	7,050	-	
Chromium	120	-	
Lead	125		
Zinc	9,940		
Non-BDAT List Metals			
Iron	1,530		
Other Parameters			
pH	11.8		
TOC	<2%		

- Not analyzed.

Reference: CyanoKEM 1989.

Table 4-2 (continued)

Sample Set No. 14[a] - for Treatment of F009, F011, D002, and D003

Constituent/parameter	Concentration		
	Untreated waste (mg/l)	Treated wastewater (mg/l)	Treated nonwastewater (mg/l)
BDAT Inorganics Other Than Metals			
Cyanide (total)	16,010	0.07	94.4
BDAT List Metals			
Copper	6,272		
Nickel	223	-	
Cadmium	4,063		-
Chromium	133		-
Lead	124	-	
Zinc	6,012	-	
Non-BDAT List Metals			
Iron	3,511	-	-
Other Parameters			
pH	11.5	-	-
TOC	<2%	-	-

- = Not analyzed.

[a]Batch consisted of a mixture of liquids and drummed solids including waste codes F009, F011, D002, and D003.

Reference: CyanoKEM 1989.

5. DETERMINATION OF BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT)

This section presents the rationale for the determination of best demonstrated available technology (BDAT) for F006 wastewaters. The Agency examines all the available data for the demonstrated technologies to determine whether one of the technologies performs significantly better than the others. Next, the "best" performing treatment technology is evaluated to determine whether the resulting treatment is "available." To be "available," a technology (1) must provide substantial treatment and (2) must be commercially available to the affected industry. If the "best" technology is "available," then the technology represents BDAT.

Based on available performance data for metals and cyanides, the Agency has identified treatment by alkaline chlorination for cyanides as BDAT for F006 wastewaters, and hexavalent chromium reduction, chemical precipitation using lime and sulfides, and sludge dewatering as BDAT for metals for F006 wastewaters. The rationale is provided below.

5.1 BDAT Treatment for Metals

For metals in F006 wastewaters, the Agency has identified hexavalent chromium reduction, followed by chemical precipitation using lime and sulfides, and sludge dewatering as BDAT. This determination is based on performance data used to develop metals treatment standards for K062 wastewaters. The Agency believes that K062 wastewaters are more difficult to treat than F006 wastewaters because of the higher acidity of K062 and the higher concentrations of dissolved metals as compared to F006. Individual metal concentrations in K062 range up to 7,000 ppm. Therefore, the same level of performance achievable for K062 wastewaters

is expected to be achievable for F006 wastewaters. When these data were previously used to set K062 treatment standards, it was established that the data are from a well designed and well operated system and meet the BDAT Program QA/QC requirements. Specific information on these data is included in Section 4 of the K062 background document (USEPA 1988b). Therefore, the same level of performance achievable for K062 wastewaters is expected to be achievable for F006 wastewaters.

The performance data used by the Agency are for treatment of a metal-bearing F006, K062, D002, and D003 wastewater by hexavalent chromium reduction using sodium bisulfite, chemical precipitation using lime and sulfides, and sludge dewatering, as discussed in Section 4. The Agency does not expect the use of other treatment chemicals to improve the level of performance. Thus, the treatment train of hexavalent chromium reduction using sodium bisulfite, chemical precipitation using lime and sulfides, and sludge dewatering is considered "best." The data in Section 4 show that there were statistically significant reductions in the concentrations of cadmium, chromium, lead, and nickel in the metal-bearing F006, K062, D002, and D003 wastewater for which performance data were available.

The Agency believes that the performance data for the metal-bearing F006, K062, D002, and D003 wastewater are better data for the developing of F006 wastewater metals treatment standards than the data collected by EPA's Office of Water for the Effluent Limitation Guidelines (USEPA 1983), presented in Appendix A and the Background Document for Third Third U and P Wastes and Multi-Source Leachates, Volume A (USEPA 1990). The Agency did not use these data because the waste characterization data indicated that the concentration of metals in the untreated wastewater was low compared to the concentration in F006 wastewaters. Individual

metal concentrations in F006 wastewaters ranged up to 400 ppm and overall were typically orders of magnitude higher than the concentrations in the wastewaters from EPA's Office of Water data. Additionally, the Agency believes that the data on the F006, K062, D002, and D003 wastewater are better because they have already been used to develop metals treatment standards (for K062 wastewaters) and because metal-bearing K062 wastewaters contain higher concentrations of dissolved metals and, therefore, represent a more difficult waste to treat.

Since hexavalent chromium reduction followed by chemical precipitation and sludge dewatering is demonstrated, best, and available, this treatment is considered BDAT for metals in F006 wastewaters. A detailed discussion pertaining to the use of this technology for treatment of K062 wastewaters is included in Section 5 of the K062 background document (USEPA 1988b).

5.2 BDAT Treatment for Cyanides

For cyanides in F006 wastewaters, the Agency has identified alkaline chlorination as BDAT, based on performance data used to develop treatment standards for F007, F008, and F009 wastewaters. Based on the waste characteristics that affect performance of the demonstrated treatment technologies, such as cyanide concentration, the Agency believes that F007, F008, and F009 wastewaters are more difficult to treat for cyanides than F006 wastewaters because F006 wastewaters contain lower or similar concentrations of amenable and total cyanides. Therefore, the Agency used the performance data used for F007, F008, and F009 wastewaters to develop cyanide treatment standards for F006 wastewaters. The Agency believes that the F006 wastewaters contain concentrations of amenable and total cyanides lower than or similar to those in F007, F008, and F009

wastewaters and that they are therefore less difficult to treat. Based on this information, alkaline chlorination is considered "best." This technology is also "available" because such treatment is commercially available and would provide substantial treatment for cyanides in F006 wastewaters.

Since alkaline chlorination is demonstrated, best, and available, this treatment is considered BDAT for cyanides in F006 wastewaters. A detailed discussion pertaining to the selection of alkaline chlorination as BDAT for F007, F008, and F009 wastewaters is included in Section 5 of the background document for cyanides (USEPA 1989a).

6. SELECTION OF REGULATED CONSTITUENTS

This section describes the process used to select the constituents to be regulated in F006 wastewaters. The process involves developing a list of potential regulated constituents and then eliminating those constituents that would not be treated by the chosen BDAT or that would be controlled by regulation of the remaining constituents.

As discussed in the original background document for F006, the Agency has developed a list of hazardous constituents from which the constituents to be regulated are selected. EPA may revise this list as additional data and information become available. The list is divided into the following categories: volatile organics, semivolatile organics, metals, inorganics other than metals, organochlorine pesticides, phenoxyacetic acid herbicides, organophosphorous insecticides, PCBs, and dioxins and furans.

6.1 Identification of BDAT List Constituents

As discussed in Sections 2 and 4, the Agency has performance and waste characterization data applicable to F006 wastewaters. These data were used to determine which BDAT list constituents may be present in the waste and thus which ones are potential candidates for regulation in F006 wastewaters. The data show that no organic BDAT constituents are present at detectable levels. Also, the Agency would not expect to find BDAT organic constituents based on knowledge of the process. In contrast, F006 wastewaters contain detectable levels of cadmium, chromium, lead, nickel, and cyanides (see Appendix A). Typically, the above-mentioned metals are found at concentrations above 0.1 ppm in F006 waste streams.

6.2 Constituents Selected for Regulation

For F006 wastewaters, the Agency is regulating total and amenable cyanides, cadmium, total chromium, lead, and nickel. These constituents were also regulated in F006 nonwastewaters. However, the Agency is not regulating silver (which was regulated for F006 nonwastewaters) because available performance and waste characterization data indicate that silver is typically present only at untreatable concentrations in F006 wastewaters. Additionally, the Agency believes that if silver is present in high concentrations in a F006 wastewater, silver recovery will be utilized because of the value of silver. Other BDAT list metal constituents that are not being regulated are expected to be treated along with the regulated metals by a well-designed and well-operated BDAT treatment system.

7. CALCULATION OF BDAT TREATMENT STANDARDS

In this section, the Agency presents its determination of treatment standards using the performance and waste characterization data previously presented. EPA's methodology for developing treatment standards is presented in Section 1 of the original F006 background document (USEPA 1988a). The methodology requires the Agency to first delete any performance data that do not represent a well-designed and well-operated treatment system. Additionally, all data must be adjusted for analytical recoveries.

As described in Section 4, EPA is transferring the metals treatment standards developed for K062 wastewaters to F006 wastewaters. In developing BDAT treatment standards for metal constituents to be regulated, the Agency evaluated performance and waste characterization data from the treatment of a metal-bearing F006, K062, D002, and D003 wastewater (as described in Section 4). These data include 11 sample sets that represent treatment of F006 wastewaters using a well-designed and well-operated treatment system. One data set for cadmium was deleted (Sample Set No. 11) because of an artificially high detection limit of 5 ppm, which deviated from the other 10 data points having detection limits of 0.5. The remaining data sets were adjusted for analytical recoveries as described in EPA's Methodology for Developing BDAT Treatment Standards (USEPA 1989b). Using the accuracy-corrected data, EPA developed treatment standards by averaging the performance data for each constituent and then multiplying the average value by a variability factor that accounts for variations in technology performance, waste characteristics, and laboratory analysis.

The corrected values for the F006 wastewater regulated constituents are presented in Table 7-1. Table 7-2 shows the calculations for the four metals being regulated for F006 wastewaters. These standards

Table 7-1 Calculation of Corrected Values for Regulated Constituents Treated Wastewater

Constituent	Treated waste (mg/l)	Percent recovery[a]	Correction factor	Corrected value (mg/l)
Cadmium	<0.5	87	1.15	<0.575
	<0.5			<0.575
	<0.5			<0.575
	<0.5			<0.575
	<0.5			<0.575
	<0.5			<0.575
	<0.5			<0.575
	<0.5			<0.575
	<0.5			<0.575
	<0.5			<0.575
Chromium (total)	0.12	68	1.47	0.1764
	0.12			0.1764
	0.20			0.294
	0.10			0.147
	0.11			0.162
	0.10			0.147
	0.12			0.1764
	0.15			0.2205
	0.10			0.147
	0.12			0.1764
	0.18			0.2646
Lead	<0.01	76	1.316	<0.0132
	<0.01			<0.0132
	<0.01			<0.0132
	<0.01			<0.0132
	0.01			0.0132
	<0.01			<0.0132
	<0.01			<0.0132
	<0.01			<0.0132
	<0.01			<0.0132
	<0.01			<0.0132
	<0.01			<0.0132
Nickel	0.33	93	1.075	0.35
	0.33			0.35
	0.33			0.35
	0.33			0.35
	0.31			0.33
	0.33			0.35
	0.40			0.43
	0.36			0.39
	0.33			0.35
	0.33			0.35
	0.39			0.42

[a]The percent recovery has been taken from Table 7-14 of the Onsite Engineering Report from Horsehead Resource Development Company for K061 (USEPA 1987).

Source: USEPA 1988b.

Table 7-2 Calculation of the Treatment Standards for the Regulated Constituents - Treated Wastewater

Constituent	Conc.	Mean	VF	Treatment standard total concentration (mg/l)
Cadmium	<0.575	0.575	2.8 [a]	1.6
	<0.575			
	<0.575			
	<0.575			
	<0.575			
	<0.575			
	<0.575			
	<0.575			
	<0.575			
	<0.575			
Chromium (total)	0.1765	0.1898	1.69	0.32
	0.1765			
	0.2941			
	0.1471			
	0.1618			
	0.1471			
	0.1765			
	0.2206			
	0.1471			
	0.1765			
	0.2647			
Lead	<0.0132	0.0132	2.8[a]	0.04
	<0.0132			
	<0.0132			
	<0.0132			
	0.0132			
	<0.0132			
	<0.0132			
	<0.0132			
	<0.0132			
	<0.0132			
	<0.0132			
Nickel	0.3548	0.3685	1.20	0.44
	0.3548			
	0.3548			
	0.3548			
	0.3333			
	0.3548			
	0.4301			
	0.3871			
	0.3548			
	0.3548			
	0.4194			

[a]For cases in which all values are at or below the detection limit, the variability factor is taken as 2.8 (USEPA 1989b).

represent instantaneous maximum concentrations that must be achieved as a prerequisite for land disposal. The concentrations are in mg/l (parts per million on a weight-per-volume basis). A detailed discussion on the calculation of these metals treatment standards can be found in Section 7 of the K062 background document (USEPA 1988b).

The amenable and total cyanide treatment standards were transferred from the cyanide treatment standards developed for F007, F008, and F009 wastewaters based on alkaline chlorination. Because F006 wastewaters contain concentrations of amenable and total cyanides lower than or similar to those in these wastewaters, the Agency believes that F006 wastewaters are less difficult to treat. The Agency is promulgating treatment standards for amenable and total cyanide in F006 wastewaters based on the performance of alkaline chlorination treatment of electroplating wastes. For wastewaters, the extensive data used in the development of metal finishing categorical wastewater discharge standards were used as the basis for BDAT.

Because of analytical difficulties in analyzing for amenable cyanides in F019 nonwastewaters, the amenable cyanide treatment standards for nonwastewaters are based on 5 percent of the total cyanide standard. Based on the data available to the Agency, it was determined that the precision of SW-846, Method 9010, for amenable cyanide is 5 percent of the total cyanide concentration. The basis for this estimate is discussed in Standard Methods for the Examination of Water and Wastewater, in which the precision for the analytical method is estimated to be 5 percent. Since the Standard Methods for the Examination of Water and Wastewater procedure is essentially identical to the precision of SW-846, Method 9010, EPA believes that the 5 percent value is transferrable to the analysis performed using SW-846, Method 9010. The data used in the development of treatment standards for these wastes represent the performance of well-designed, well-operated treatment systems.

As described in the methodology, analytical accuracy-corrected constituent concentrations were calculated for all regulated BDAT list constituents. An arithmetic average of concentration levels for each constituent and a variability factor for each constituent were then determined. The variability factor represents the variability inherent in the treatment process and the sampling and analytical methods. Variability factors are calculated based on the treatment data for each of the regulated constituents. The general methodology for calculating variability factors is presented in Appendix A of the methodology document.

The BDAT treatment standard for each constituent to be regulated in this rulemaking was determined by multiplying the average accuracy-corrected total composition by the appropriate variability factor, with the exception of cyanide in wastewaters, for which the standards were transferred from Metal Finishing categorical wastewater discharge standards.

Table 7-3 is a summary of accuracy adjustment data for total cyanides. Table 7-4 shows the calculation of the treatment standards for cyanides in F006 wastewaters. To calculate the treatment standard for amenable cyanides, the Agency has taken into account the precision of the analytical methods for cyanide analysis based on the performance of alkaline chlorination.

Table 7-3 Summary of Accuracy Adjustment of Treatment Data for Total Cyanide in Electroplating Wastes

	Untreated waste concentration (mg/l)	Measured treated waste concentration (mg/l)	Percent recovery for matrix spike test	Accuracy-correction factor	Accuracy-adjusted concentration (mg/l)
Alkaline Chlorination					
Sample Set No. 1	71,759	0.95	94	1.06	1.01
Sample Set No. 2	12,000	0.95	94	1.06	1.01
Sample Set No. 3	17,206	<0.014	94	1.06	<0.015
Sample Set No. 4	25,936	<0.014	94	1.06	<0.015
Sample Set No. 5	16,914	<0.014	94	1.06	<0.015
Sample Set No. 6	59,421	0.028	94	1.06	0.030
Sample Set No. 7	31,994	0.028	94	1.06	0.030
Sample Set No. 8	41,900	<0.014	94	1.06	<0.015
Sample Set No. 9	18,882	<0.014	94	1.06	<0.015
Sample Set No. 10	1,270	0.17	94	1.06	0.18
Sample Set No. 12	12,085	<0.014	94	1.06	<0.015
Sample Set No. 13	10,902	0.070	94	1.06	0.074
Sample Set No. 14	16,010	0.070	94	1.06	0.074

Table 7-4 Calculation of Wastewater Treatment Standards for Total and Amenable Cyanide Based on Alkaline Chlorination

Regulated constituent	Mean effluent concentration (mg/l)	Variability factor	Treatment standard (mg/l)
Cyanide (total)	0.18	6.68	1.20
Cyanide (amenable)	0.06	14.31	0.86

Source: USEPA 1983, pp. VII B-126 to VII-153.

8. REFERENCES

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APPENDIX A

WASTE CHARACTERIZATION DATA FOR F006 WASTEWATERS
COLLECTED BY EPA'S OFFICE OF WATER FOR THE
EFFLUENT LIMITATIONS GUIDELINES FOR THE
METAL FINISHING INDUSTRY (USEPA 1983)

TABLE 5-18

POLLUTANTS FOUND IN TOTAL PLANT RAW WASTE
DISCHARGED TO END-OF-PIPE TREATMENT

PARAMETER		Flow Proportioned Mean Concentration, mg/l
114.	Antimony	0.009
115.	Arsenic	0.008
117.	Beryllium	0.001
118.	Cadmium	0.283
119.	Chromium	27.46
	Chromium, Hexavalent	0.931
120.	Copper	12.63
121.	Cyanide	1.856
	Cyanide, Amenable to Chlorination	1.168
122.	Lead	0.331
123.	Mercury	0.001
124.	Nickel	15.47
125.	Selenium	0.001
126.	Silver	0.023
127.	Thallium	0.009
128.	Zinc	12.47
	Oil and Grease	391.60
	Total Suspended Solids	539.09

TABLE 5-19
POLLUTANT CONCENTRATIONS FOUND IN THE
COMMON METALS RAW WASTE STREAM
(Average Daily Values (mg/liter)

Toxic Pollutant	Minimum	Maximum	Mean	Median	# Zeros	# Points	Flow Proportioned Mean Concentration
114 Antimony	0.0	0.430	0.007	0.0	84	106	.0007
115 Arsenic	0.0	0.064	0.005	0.0	75	105	0.015
117 Beryllium	0.0	0.044	0.008	0.005	4	27	0.016
118 Cadmium	0.0	21.5	0.613	0.001	48	119	0.070
119 Chromium	0.0	35.4	2.10	0.105	16	116	1.39
120 Copper	0.0	500.	14.2	0.175	3	119	1.84
121 Cyanide	0.0	2370.	42.1	0.016	29	99	0.834
122 Lead	0.0	42.3	1.25	0.053	35	122	0.738
123 Mercury	0.0	0.400	0.005	0.0	67	109	0.001
124 Nickel	0.0	415.	19.4	0.078	20	111	4.16
125 Selenium	0.0	0.060	0.007	0.005	5	26	0.003
126 Silver	0.0	0.080	0.006	0.0	59	103	0.001
127 Thallium	0.0	0.062	0.008	0.003	5	26	0.003
128 Zinc	0.0	16,500.	312.	0.393	1	122	41.3
Aluminum	0.0	200.	27.4	1.27	2	16	85.6
Barium	0.0	0.017	0.032	0.029	1	4	0.031
Boron	1.67	4.0	31.4	3.76	0	3	3.13
Calcium	25.0	76.2	51.4	52.2	0	4	58.5
Cobalt	0.0	0.023	0.007	0.0	4	7	0.010
Fluorides	0.0	36.1	4.31	0.876	9	99	6.15
Iron	0.0	13,100.	500.	2.44	1	102	84.7
Magnesium	5.6	31.1	16.1	13.8	0	4	17.4
Manganese	0.059	0.500	0.233	0.085	0	7	0.337
Molybdenum	0.0	0.300	0.102	0.018	1	6	0.109
Phosphorus	0.0	76.7	7.72	3.06	1	98	8.00
Sodium	16.7	310.	151.	138.	0	4	211.
Tin	0.0	14.7	1.04	0.0	60	98	3.35
Titanium	0.0	4.30	0.493	0.006	4	9	0.046
Vanadium	0.0	0.216	0.066	0.023	1	4	0.069
Yttrium	0.0	0.020	0.010	0.010	1	4	0.010
Oil and Grease	4.70	802,000.	40,700.	6,060.	0	37	11,600.

TABLE 5-20
POLLUTANT CONCENTRATIONS FOUND IN THE
PRECIOUS METALS RAW WASTE STREAM

Toxic Pollutant	Average Daily Values (mg/liter) Minimum	Maximum	Mean	Median	# Zeros	# Points	Flow Proportioned Mean Concentration
126 Silver	0.0	600.	69.0	0.243	3	15	8.09
Gold	0.0	42.7	9.27	0.560	6	15	6.11
Palladium	0.0	0.120	0.023	0.0	10	13	0.003
Rhodium	0.0	0.220	0.018	0.0	11	12	0.005

TABLE 5-21
POLLUTANT CONCENTRATIONS FOUND IN THE
COMPLEXED METALS RAW WASTE STREAM

Toxic Pollutant	Average Daily Values (mg/liter) Minimum	Maximum	Mean	Median	# Zeros	# Points	Flow Proportioned Mean Concentration
118 Cadmium	0.0	3.65	0.247	0.0	22	31	0.173
120 Copper	0.0	62.6	10.3	5.90	3	31	9.68
122 Lead	0.0	3.61	0.372	0.0	21	31	0.240
124 Nickel	0.0	294.	22.5	0.550	6	31	18.8
128 Zinc	0.023	17.6	3.05	0.210	0	31	2.52

APPENDIX B

PERFORMANCE DATA FOR F006 WASTEWATERS COLLECTED BY EPA'S OFFICE OF WATER FOR THE EFFLUENT LIMITATIONS GUIDELINES FOR THE METAL FINISHING INDUSTRY

TABLE 7-4

METAL FINISHING CATEGORY PERFORMANCE DATA FOR CADMIUM

OPTION 1

Data Point	Raw Waste Concentration (mg/ℓ)	Effluent Concentration (mg/ℓ)	Plant ID
1.	0.012	0.006	20083-1-5
2.	0.012	0.006	20083-1-6
3.	0.012	0.006	19063-1-2
4.	0.013	0.005	6083-1-2
5.	0.013	0.005	19063-1-3
6.	0.013	0.010	15070-1-1
7.	0.015	0.008	6731-1-1
8.	0.017	0.006	6731-1-2
9.	0.019	0.007	6731-1-3
10.	0.021	0.010	6074-1-1
11.	0.021	0.018	31020-1-1
12.	0.022	0.013	6087-1-3
13.	0.022	0.019	27044-1-0
14.	0.024	0.005	20080-1-1
15.	0.030	0.014	6087-1-1
16.	0.032	0.005	4065-8-1
17.	0.033	0.011	6074-1-1
18.	0.037	0.005	20073-1-1
19.	0.037	0.005	20073-1-2
20.	0.042	0.006	36041-1-2
21.	0.042	0.006	36041-1-3
22.	0.053	0.009	36041-1-1
23.	0.068	0.017	21003-15-2
24.	0.077	0.005	33024-6-0
25.	0.084	0.027	21003-15-0
26.	0.087	0.024	21003-15-1
27.	0.113	0.028	6051-6-0
28.	0.250	0.008	15070-1-2
29.	0.925	0.012	20086-1-1
30.	1.00	0.015	20086-1-3
31.	1.88	0.018	20086-1-2
Mean Concentration	0.162 (n=31)	0.011 (n=31)	

TABLE 7-5

METAL FINISHING CATEGORY PERFORMANCE DATA FOR CHROMIUM (TOTAL)

OPTION 1

Data Point	Raw Waste Concentration (mg/ℓ)	Effluent Concentration (mg/ℓ)	Plant ID
1.	0.65	0.052	6087-1-3
2.	1.09	0.128	6731-1-2
3.	1.20	1.12	15010-12-3
4.	1.30	0.013	19068-15-1
5.	1.31	0.014	4069-8-1
6.	1.51	0.150	44062-15-0
7.	1.56	0.255	6051-6-0
8.	1.60	0.120	44062-15-1
9.	1.70	1.16	15010-12-2
10.	2.00	0.040	11477-22-2
11.	2.43	0.070	33024-6-0
12.	4.34	0.039	44062-15-2
13.	7.00	0.020	11477-22-1
14.	12.2	0.556	6083-1-2
15.	12.2	0.611	36041-1-2
16.	14.0	0.250	33065-9-1
17.	21.6	0.005	19068-14-0
18.	24.7	0.333	36040-1-1
19.	25.0	0.333	36041-1-3
20.	25.3	0.533	36040-1-1
21.	28.6	0.667	36041-1-1
22.	29.4	0.733	36040-1-1
23.	32.2	0.0	19068-15-2
24.	58.2	0.833	20086-1-2
25.	69.3	1.06	20086-1-3
26.	70.3	0.833	20086-1-1
27.	76.7	1.64	20078-1-7
28.	85.3	0.143	6074-1-1
29.	98.0	0.333	6074-1-1
30.	104.	0.714	6074-1-1
31.	116.	0.018	31020-1-1
32.	117.	0.400	20078-1-2
33.	117.	0.500	20078-1-3
34.	142.	0.195	20080-1-1
35.	162.	1.47	20073-1-1
36.	175.	1.89	20073-1-2
37.	190.	2.36	40062-8-0
38.	393.	2.14	40062-8-0
Mean Concentration	58.6 (n=38)	0.572 (n=38)	

TABLE 7-13
EFFLUENT CADMIUM SELF-MONITORING PERFORMANCE DATA
FOR PLANTS WITH OPTION 1 SYSTEMS

Plant ID	Number OF Points	Mean Effluent Concentration (mg/ℓ)	Variability Factor Daily	Variability Factor 10-Day
1067	222	0.13	3.08	2.04
6002	6	0.05	7.48	--
6035	9	0.01	--	--
6051	13	0.04	--	1.14
11008	185	0.12	3.14	2.01
47025	50	0.21	7.49	8.54
OVERALL	485(Total)	0.13(Mean)	5.31(Median)	2.02(Median)

TABLE 7-14
EFFLUENT TOTAL CHROMIUM SELF-MONITORING PERFORMANCE DATA
FOR PLANTS WITH OPTION 1 SYSTEMS

Plant ID	Number OF Points	Mean Effluent Concentration (mg/ℓ)	Variability Factor Daily	Variability Factor 10-Day
1067	230	0.17	3.07	2.27
5020	228	0.03	--	10.52
6002	6	0.74	13.66	--
6035	12	0.18	7.52	1.89
6051	13	0.27	3.97	1.78
6053	12	0.14	8.72	3.02
6087	12	0.02	--	--
6107	10	0.10	5.58	--
6111	3	0.12	5.57	--
11008	185	0.09	5.97	4.08
17030	344	0.20	6.84	5.56
19063	238	0.16	3.51	4.80
20080	269	0.29	4.58	2.63
20082	253	0.60	5.20	3.70
20116	243	0.21	2.76	1.65
22735	35	0.15	4.64	1.39
23076	242	0.40	4.79	4.41
30050	289	0.01	3.80	3.07
30090	49	0.04	4.90	2.12
36040	224	0.24	1.67	1.30
44150	42	0.01	--	37.26
45741	358	0.06	4.47	2.98
47025	255	0.06	5.57	2.81
OVERALL	3552(Total)	0.19(Mean)	4.85(Median)	2.98(Median)

TABLE 7-16
EFFLUENT LEAD SELF-MONITORING PERFORMANCE DATA
FOR PLANTS WITH OPTION 1 SYSTEMS

Plant ID	Number OF Points	Mean Effluent Concentration (mg/ℓ)	Variability Factor Daily	Variability Factor 10-Day
5020	229	0.242	4.50	2.11
19063	238	0.10	3.15	3.18
30165	65	0.45	2.66	1.93
44045	49	0.14	3.89	2.26
OVERALL	581(Total)	0.20(Mean)	3.52(Median)	2.19(Median)

TABLE 7-17
EFFLUENT NICKEL SELF-MONITORING PERFORMANCE DATA
FOR PLANTS WITH OPTION 1 SYSTEMS

Plant ID	Number OF Points	Mean Effluent Concentration (mg/ℓ)	Variability Factor Daily	Variability Factor 10-Day
1067	230	0.21	4.05	2.39
5020	231	0.40	4.48	2.54
6002	6	0.09	4.72	--
6035	9	0.06	5.37	--
6051	13	0.04	6.55	6.12
6087	12	0.66	--	6.30
11008	185	0.44	2.79	1.62
19063	10	0.07	2.90	--
20082	253	0.32	3.72	2.77
20116	243	0.67	2.26	1.31
23076	241	0.50	6.38	4.29
30050	75	0.03	3.78	2.37
33092	27	0.25	4.38	2.51
36040	178	0.32	1.73	1.27
44045	49	0.32	10.13	2.66
44150	42	0.12	--	--
OVERALL	1804(Total)	0.39(Mean)	4.22(Median)	2.52(Median)

TABLE 7-7

METAL FINISHING CATEGORY PERFORMANCE DATA FOR LEAD

OPTION 1

Data Point	Raw Waste Concentration (mg/ℓ)	Effluent Concentration (mg/ℓ)	Plant ID
1.	0.052	0.048	15070-1-3
2.	0.054	0.033	36040-1-1
3.	0.064	0.025	20078-1-3
4.	0.067	0.013	6731-1-3
5.	0.071	0.0	19068-15-1
6.	0.072	0.044	15070-1-1
7.	0.072	0.048	15070-1-2
8.	0.075	0.010	20080-1-1
9.	0.084	0.025	20078-1-2
10.	0.102	0.025	20078-1-4
11.	0.103	0.077	4065-8-1
12.	0.125	0.050	20083-1-3
13.	0.136	0.032	36041-1-2
14.	0.136	0.040	20078-1-7
15.	0.144	0.032	20083-1-6
16.	0.145	0.038	20073-1-1
17.	0.154	0.044	20086-1-3
18.	0.160	0.036	20086-1-1
19.	0.164	0.040	20086-1-2
20.	0.168	0.032	20083-1-5
21.	0.174	0.0	19068-15-2
22.	0.182	0.044	6074-1-1
23.	0.212	0.036	36041-1-3
24.	0.218	0.044	6074-1-1
25.	0.226	0.025	20073-1-2
26.	0.233	0.0	36623-15-2
27.	0.270	0.160	4071-15-3
28.	0.364	0.067	27044-1-0
29.	0.394	0.021	33065-9-1
30.	0.474	0.043	40062-8-0
31.	0.567	0.0	36623-15-0
32.	0.600	0.036	40062-8-0
33.	0.800	0.068	31020-1-1
34.	0.909	0.073	15010-12-2
35.	1.000	0.064	36041-1-1

(Continued)

TABLE 7-7 (Continued)

METAL FINISHING CATEGORY PERFORMANCE DATA FOR LEAD

OPTION 1

Data Point	Raw Waste Concentration (mg/ℓ)	Effluent Concentration (mg/ℓ)	Plant ID
36.	1.000	0.085	6087-1-1
37.	1.000	0.133	15010-12-3
38.	1.120	0.065	6087-1-3
39.	2.500	0.160	6083-1-2
40.	2.540	0.0	12061-15-2
41.	6.928	0.165	19063-1-1
42.	6.930	0.0	12061-15-0
43.	8.362	0.098	19063-1-2
44.	9.701	0.143	19063-1-3
Mean Concentration	1.11 (n=44)	0.0505 (n=44)	

TABLE 7-8

METAL FINISHING CATEGORY PERFORMANCE DATA FOR NICKEL

OPTION 1

Data Point	Raw Waste Concentration (mg/ℓ)	Effluent Concentration (mg/ℓ)	Plant ID
1.	1.07	0.076	19063-1-1
2.	1.44	1.11	6731-1-1
3.	1.48	0.150	21003-15-1
4.	1.69	0.060	19063-1-2
5.	2.14	0.342	4069-8-1
6.	2.22	1.00	6731-1-2
7.	2.23	0.190	19063-1-3
8.	2.57	0.044	36041-1-2
9.	3.20	0.726	27044-1-0
10.	3.24	0.700	36623-15-2
11.	3.87	0.122	4069-8-1
12.	3.89	1.89	6731-1-3
13.	4.49	0.571	36041-1-3
14.	5.00	0.320	36041-1-1
15.	5.42	1.20	36623-15-0
16.	5.60	0.414	5020-1-6
17.	5.80	1.03	36623-15-1
18.	6.80	0.414	5020-1-5
19.	7.31	0.759	5020-1-4
20.	8.56	0.0	19068-15-2
21.	9.33	2.27	6083-1-2
22.	11.8	0.294	5020-1-3
23.	27.5	0.120	31020-1-1
24.	33.9	0.536	20086-1-2
25.	36.7	0.464	20086-1-3
26.	42.9	0.786	20086-1-1
27.	50.0	7.30	6087-1-1
28.	52.5	0.478	20073-1-2
29.	53.8	0.448	20073-1-1
30.	73.0	6.39	6087-1-3
31.	76.9	0.381	20078-1-7
32.	78.7	0.106	20078-1-3
33.	78.7	0.427	20078-1-4
34.	80.6	1.84	40062-8-0
35.	85.3	0.144	20078-1-2

(Continued)

TABLE 7-8 (Continued)

METAL FINISHING CATEGORY PERFORMANCE DATA FOR NICKEL

OPTION 1

Data Point	Raw Waste Concentration (mg/ℓ)	Effluent Concentration (mg/ℓ)	Plant ID
36.	94.3	0.600	6074-1-1
37.	94.4	1.52	40062-8-0
38.	97.1	0.808	20083-1-5
39.	108.	0.778	36040-1-1
40.	108	1.78	36040-1-1
41.	111.	0.462	20083-1-6
42.	128.	0.571	6074-1-1
43.	142.	1.56	36040-1-1
44.	153.	0.907	20083-1-3
45.	167.	0.304	6074-1-1
Mean Concentration	46.1 (n=45)	0.942 (n=45)	

TABLE 7-11

TREATMENT OF COMMON METALS - VISITED PLANTS
SUMMARY OF OPTION 1 MEAN EFFLUENT CONCENTRATIONS

Parameter	Mean Concentration (mg/ℓ)
Cadmium	0.011
Chromium, Total	0.572
Copper	0.815
Lead	0.051
Nickel	0.942
Zinc	0.549
Total Suspended Solids	16.8

TABLE 7-23
TREATMENT OF COMMON METALS
VISITED PLANT OPTION 2 MEAN EFFLUENT CONCENTRATIONS

Parameter	mg/l
Total Suspended Solids	12.8
Cadmium	.014
Chromium, Total	.319
Copper	.367
Lead	.031
Nickel	.459
Zinc	.247

TABLE 7-24
EFFLUENT TSS SELF-MONITORING PERFORMANCE DATA
FOR PLANTS WITH OPTION 2 SYSTEMS

Plant ID	Number Of Points	Mean Effluent Concentration (mg/ℓ)
03043	94	10.07
15193	12	13.58
20483	357	5.90
38223	234	5.74
OVERALL	697 (TOTAL)	6.54 (MEAN)

TABLE 7-25
EFFLUENT CADMIUM SELF-MONITORING PERFORMANCE DATA
FOR PLANTS WITH OPTION 2 SYSTEMS

Plant ID	Number Of Points	Mean Effluent Concentration (mg/ℓ)
38223	234	0.08

TABLE 7-26
EFFLUENT CHROMIUM SELF-MONITORING PERFORMANCE DATA
FOR PLANTS WITH OPTION 2 SYSTEMS

Plant ID	Number Of Points	Mean Effluent Concentration (mg/ℓ)
03043	91	0.60
15193	12	0.11
31021	86	0.25
38223	234	0.06
OVERALL	423 (TOTAL)	0.22 (MEAN)

TABLE 7-27
EFFLUENT COPPER SELF-MONITORING PERFORMANCE DATA
FOR PLANTS WITH OPTION 2 SYSTEMS

Plant ID	Number Of Points	Mean Effluent Concentration (mg/ℓ)
11125	29	1.11
15193	12	0.06
31021	121	1.44
OVERALL	225 (TOTAL)	1.32 (MEAN)

TABLE 7-28
EFFLUENT LEAD SELF-MONITORING PERFORMANCE DATA
FOR PLANTS WITH OPTION 2 SYSTEMS

Plant ID	Number Of Points	Mean Effluent Concentration (mg/ℓ)
38223	234	0.04

TABLE 7-29
EFFLUENT NICKEL SELF-MONITORING PERFORMANCE DATA
FOR PLANTS WITH OPTION 2 SYSTEMS

Plant ID	Number Of Points	Mean Effluent Concentration (mg/ℓ)
03043	91	0.42
11125	29	1.75
15193	12	0.27
31021	120	0.93
OVERALL	252 (TOTAL)	0.81 (MEAN)

TABLE 7-30
EFFLUENT ZINC SELF-MONITORING PERFORMANCE DATA
FOR PLANTS WITH OPTION 2 SYSTEMS

Plant ID	Number Of Points	Mean Effluent Concentration (mg/ℓ)
03043	91	0.35
15193	12	0.14
31021	121	0.77
38223	234	0.11
OVERALL	252 (TOTAL)	0.81 (MEAN)

Table 7-32 presents the daily maximum, 10-day average, and long term average effluent performance for common metals Option 2. Performance was obtained by multiplying the visited plant mean concentrations of Table 7-23 by the respective variability factors shown in Table 7-31 (except for cadmium and lead, where the weighted mean Option 2 self-monitoring data concentrations were used in place of the visited plant mean effluent concentrations). The allowable daily effluent concentrations for each of the parameters have been shown on Figures 7-10 through 7-16.

TABLE 7-32
OPTION 2 COMMON METAL PERFORMANCE LEVELS

Pollutant	Daily Max.	10-Day Average	Long Term Average
Total suspended solids	46	24	12.8
Cadmium	0.42	0.16	0.08
Chromium, total	1.55	0.95	0.32
Copper	1.52	0.93	0.37
Lead	0.14	0.09	0.04
Nickel	1.94	1.16	0.46
Zinc	1.13	0.67	0.25

Table 7-33 summarizes the percentage of the metal finishing data base below the Option 2 daily maximum concentration limitation for the EPA sampled plants.

TABLE 7-33
PERCENTAGE OF THE MFC DATA BASE BELOW THE DAILY MAXIMUM CONCENTRATIONS FOR OPTION 2

Pollutant	EPA Sampled Plants Daily Maximum
Total suspended solids	100.0
Cadmium	100.0
Chromium, total	100.0
Copper	100.0
Lead	100.0
Nickel	100.0
Zinc	94.1

Summary tables are provided to show a direct comparison of the mean, daily maximum, and 10-day average concentrations for Options 1 and 2. Table 7-34 presents a comparison of the mean concentrations and Table 7-35 lists the daily maximum and maximum monthly average concentrations for each.

TABLE 7-34
OPTION 1 AND OPTION 2 MEAN CONCENTRATION COMPARISON

Pollutant	CONCENTRATION (mg/ℓ) Option 1	Option 2
Total suspended solids	16.8	12.8
Cadmium	0.19	0.08
Chromium, total	0.572	0.319
Copper	0.815	0.367
Lead	0.20	0.04
Nickel	0.942	0.459
Zinc	0.549	0.247

TABLE 7-35
OPTION 1 AND OPTION 2 PERFORMANCE COMPARISON

Pollutant	CONCENTRATION (mg/ℓ) Option 1		Option 2	
	Daily Max.	Maximum Monthly Ave.	Daily Max.	Maximum Monthly Ave.
Total Suspended Solids	60	31	46	24
Cadmium	0.69	0.26	0.42	0.16
Chromium, total	2.77	1.71	1.55	0.95
Copper	3.38	2.07	1.52	0.93
Lead	0.69	0.43	0.14	0.09
Nickel	3.98	2.38	1.94	1.16
Zinc	2.61	1.48	1.17	0.67

TABLE 7-44

METAL FINISHING CATEGORY

PERFORMANCE DATA FOR SILVER

VISITED OPTION 1 PLANTS

Data Point	Raw Waste Concentration (mg/ℓ)	Effluent Concentration (mg/ℓ)	Plant ID
1.	0.1780	0.1670	6087-1-1
2.	0.1780	0.1190	6087-1-3
3.	0.2100	0.0610	21003-15-2
4.	0.2700	0.0640	21003-15-0
5.	0.2900	0.0690	21003-15-1
Mean Concentration =	0.2252 (n=5)	0.0960 (n=5)	

Effluent Silver Self-Monitoring Performance Data for Plants with Option 1 Systems

Plant ID	No. of Points	Concentration (mg/ℓ)
6087	12	0.04
11125	5	1.66
Overall	17	0.52