FINAL
BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT) BACKGROUND DOCUMENT FOR

INORGANIC PIGMENT WASTES

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May 1990

ACKNOWLEDGMENTS

This document was prepared for the U.S. Environmental Protection Agency, Office of Solid Waste, by Versar Inc. under Contract No. 68-W9-0068. Mr. Larry Rosengrant, Chief, Treatment Technology Section, Waste Treatment Branch, served as the EPA Program Manager during the preparation of this document and the development of treatment standards for the inorganic pigment wastes. The technical project officer for the waste was Ms. Monica Chatmon-McEaddy. Mr. Steven Silverman served as legal advisor.

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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 the best demonstrated available technology (BDAT) for wastewater treatment sludges from the production of inorganic pigments. These wastes are identified in 40 CFR 261.32 as K002, K003, K004, K005, K006, K007, and K008. Compliance with these treatment standards is a prerequisite for placement of these wastes in facilities designated as land disposal units according to 40 CFR Part 268. The effective date of these treatment standards is August 8, 1990.

This background document presents the Agency's technical support and rationale for developing regulatory standards for these wastes. Sections 2 through 7 present waste-specific information for the K002, K003, K004, K005, K006, K007, and K008 wastes. Section 2 presents the number and location of facilities affected by the land disposal restrictions, the waste-generating process, and 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 treatment standards are based. Section 5 explains EPA's determination of BDAT, while Section 6 discusses the selection of constituents to be regulated. Section 7 explains the process used for calculation of proposed treatment standards.

The BDAT program and promulgated methodology are more thoroughly described in two additional documents: Methodology for Developing BDAT Treatment Standards (USEPA 1988c) and Generic Quality Assurance Project Plan for the Land Disposal Restrictions Program ("BDAT") (USEPA 1988b). 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 three facilities presently generate K002, K003, and K006 (chrome pigment wastes) as defined. These wastes are the wastewater treatment sludges from the production of chrome inorganic pigments. 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. Six facilities manufacture chrome inorganic pigments but do not generate a listed waste because they either recycle all process waters and solids or discharge the untreated wastewaters to publicly owned treatment works (POTWs). In addition, the Agency believes that the last company generating K005 and K007 ended production of the pigments in June 1987. The Agency also believes, based on RCRA 3007 Questionnaire responses, that nonwastewater forms of K004 and K008 are not currently generated.

The promulgated treatment standards for K002, K003, K004, K005, K006 (from anhydrous chrome oxide green production), K007, and K008 nonwastewaters are based on the performance of chromate reduction, precipitation with lime and sulfide, and sludge dewatering for K062 wastes. The Agency has based the treatment standard for K006 nonwastewaters generated from the production of hydrated chrome oxide green pigments on stabilization. The stabilization data were received from the sole known generator of this waste. The promulgated treatment standards for K002, K003, K004, K006, and K008 wastewaters are based on effluent guidelines regulations for the chrome pigments subcategory of the inorganic chemicals industry.

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

The Agency is currently not promulgating cyanide treatment standards for K005 and K007 nonwastewaters. The Agency realizes the problems involved in the treatment of complex iron cyanides and is further investigating the issue. The Agency reserves the right to promulgate cyanide treatment standards for K005 and K007 nonwastewaters at a future date.

The specific BDAT treatment standards for K002, K003, K004, K005, K006 (from anhydrous chrome oxide green production), K007, and K008 nonwastewaters are shown in Table 1-1.

The specific BDAT treatment standards for K006 nonwastewaters generated from the production of chrome oxide green are described in Table 1-2.

The treatment standards for wastewater forms of K002, K003, K004, K005, K006, K007, and K008 are based on chemical reduction, precipitation, and sludge dewatering. The specific treatment standards for these wastewaters are shown in Tables 1-3 and 1-4. These treatment standards are being transferred directly from the effluent guideines for the chrome pigments subcategory of the inorganic chemicals industry.

Table 1-1 BDAT Treatment Standards for K002, K003, K004, K005, K006 (Anhydrous Chrome Oxide Green), K007, and K008 Nonwastewaters

Constituent	TCLP Concentration in mg/l
Chromium (total)	0.094
Lead (total)	0.37

Table 1-2 BDAT Treatment Standards for K006 Generated from Production of Hydrated Chrome Oxide Green Nonwastewaters

Constituent	TCLP Concentration mg/l
Chromium (total)	5.2

Table 1-3 Treatment Standards for K002, K003, K004, K006 (Anhydrous and Hydrated), and K008 Wastewaters

	Wastewater Concentration in mg/l	
Constituent	30-day average	24-hour maximum
Chromium (total)	1.2	0.9
Lead (total)	1.4	3.4

2824g

Table 1-4 BDAT Treatment Standards for K005 and K007
(Wastewaters)

Regulated Constituent	Total Concentration in (mg/l) 30-day average	24-hour maximum
Chromium (Total)	1.2	0.9
Lead (Total)	1.4	3.4
Cyanides (Total)	0.32	0.74

2824g

2. INDUSTRY AFFECTED AND WASTE CHARACTERIZATION

Wastes listed as K002, K003, K004, K005, K006, and K007 are generated as the wastewater treatment sludges from the production of inorganic pigments. Under 40 CFR 261.32, wastes identified as K002, K003, K004, K005, K006, and K007 are specifically listed as follows:

K002: Wastewater treatment sludge from the production of chrome yellow and orange pigments.

K003: Wastewater treatment sludge from the production of molybdate orange pigments.

K004: Wastewater treatment sludge from the production of zinc yellow pigment.

K005: Wastewater treatment sludge from the production of chrome green pigments.

K006: Wastewater treatment sludge from the production of chrome oxide green pigments (anhydrous and hydrated).

K007: Wastewater treatment sludge from the production of iron blue pigments.

K008: Oven residues from the production of chrome oxide green pigments.

The waste K008 is identified as oven residues from the production of chrome oxide green pigments. The Agency has determined that these listed wastes represent a single broad treatability group based on their similar physical and chemical characteristics. As described later in this section, EPA has examined the sources of the wastes, the specific similarities in the waste composition, applicable and demonstrated treatment technologies, and attainable treatment performance in order to support a simplified regulatory approach for these inorganic wastes.

2.1 Industry Affected and Process Description

The four-digit Standard Industrial Classification (SIC) code associated with the production of inorganic pigments is 2816. These pigments are used extensively in paints, printing ink, floor covering products, and paper. In addition, they may also be used in ceramics, cement, and asphalt roofing.

The Agency believes that two facilities generate both K002 and K003, and two facilities generate K006. This information was obtained from 3,007 questionnaire responses from the industry. It is the Agency's understanding that one chrome oxide green manufacturing facility that generates a K006 waste produces only hydrated chrome oxide green; the second facility, which recycles all wastes,* manufactures anhydrous chrome oxide green. Based on available information, the Agency also believes that the last company in the United States to generate K005 and K007 ended production in June 1987. Table 2-1 lists the names and locations of the current known generators of K002, K003, and K006; the treatment and disposal methods used at these facilities; and the approximate product production levels achieved.

The Agency also identified those facilities that manufacture inorganic pigments but do not generate wastewater treatment sludges. These six facilities either discharge their untreated wastewaters to an NPDES regulated system (i.e., exempted from RCRA regulations) or recycle their solids by blending them with product for subsequent sale. Table 2-2 identifies these facilities.

Below are descriptions of the five pigment manufacturing processes that EPA identified as generating K002, K003, K004, K005, K006, and K007.

2.1.1 K002

Chrome yellow and orange pigments (lead chromate) are produced by reacting sodium dichromate, caustic soda, and lead nitrate as follows. First, lead oxide or elemental lead is dissolved in nitric acid to

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* Neither facility generates any K008 wastes.

Table 2-1 Present Chrome Pigment Manufacturers That Generate K002, K003, and K006 Wastes

		Products Manufactured				
Plant	Location	Chrome yellow	Molybdate orange	Chrome oxide green	Total product production volumes	Wastes generated
Pfizer	Lehigh Gap, PA			(2)	B	K006
Harshaw Filtrol	Louisville, KY	(2)	(2)		A	K002, K003
Heubach	Newark, NJ	(1)	(1)		A	K002, K003

(1) Listed waste generated and sold for feedstock to lead smelter.

(2) Listed waste generated and land disposed offsite.

A = >5,000 TPY

B = <5,000 TPY

Source: 3007 Questionnaire responses and telephone conversations with facilities to clarify responses (10/87 - 1/88).

Table 2-2 Chrome Pigment Manufacturers That Recycle Wastes or Wastewaters or Discharge Untreated Wastewaters to POTW Systems

Plant	Location	Products Manufactured: Chrome yellow and orange	Molybdate orange	Chrome oxide green	Zinc yellow	Reason for no waste generation
NJZ Colors	Brooklyn, NY	X	X			Discharge to POTW
KiKuchi Color	Patterson, NJ	X				Discharge to POTW
American Chrome and Chemical	Corpus Christi, TX			X		Total reuse of waste generated
NL Chemicals	St. Louis, MO	X				Total process water recycle
Wayne Pigments	Milwaukee, WI	X	X		X	Discharge to POTW
Mineral Pigments	Beltsville, MD				X	Consumptive use of wastewater to produce a byproduct

Source: 3007 Questionnaire responses and telephone conversations with facilities to clarify responses (10/87 - 1/88).

generate a lead nitrate solution. This solution is then mixed with an alkaline solution of sodium dichromate. The reaction that occurs can be written as follows:

$$Na_2Cr_2O_7 + 2NaOH + 2Pb(NO_3)_2 \rightarrow 2PbCrO_4 + 4NaNO_3 + H_2O.$$

Lead chromate (a hexavalent species) is formed as a precipitate and is recovered by filtration, then washed, dried, milled, and packaged. The filtrate and wash waters, containing lead and hexavalent chromium compounds, are sent to a wastewater treatment facility. Figure 2-1 presents a general schematic of a typical lead chromate production and waste treatment process.

2.1.2 K003

Molybdate orange pigment is made by the coprecipitation of lead chromate ($PbCrO_4$) and lead molybdate ($PbMoO_4$). Molybdic oxide is first dissolved in aqueous sodium hydroxide, then sodium chromate is added. This solution is mixed with a solution of lead oxide in nitric acid. The product, a mixture of lead chromate and lead molybdate, precipitates from solution.

The precipitate (lead chromate and lead molybdate) is collected by filtration, then washed, dried, milled, and packaged. The filtrate contains unreacted sodium chromate and sodium molybdate, lead ions, and some suspended particulates of unrecovered products. This wastewater stream is usually sent to a wastewater treatment facility. The wastewater treatment sludge produced is the listed waste K003. Figure 2-2 presents a general schematic of a typical molybdate orange production and waste treatment process.

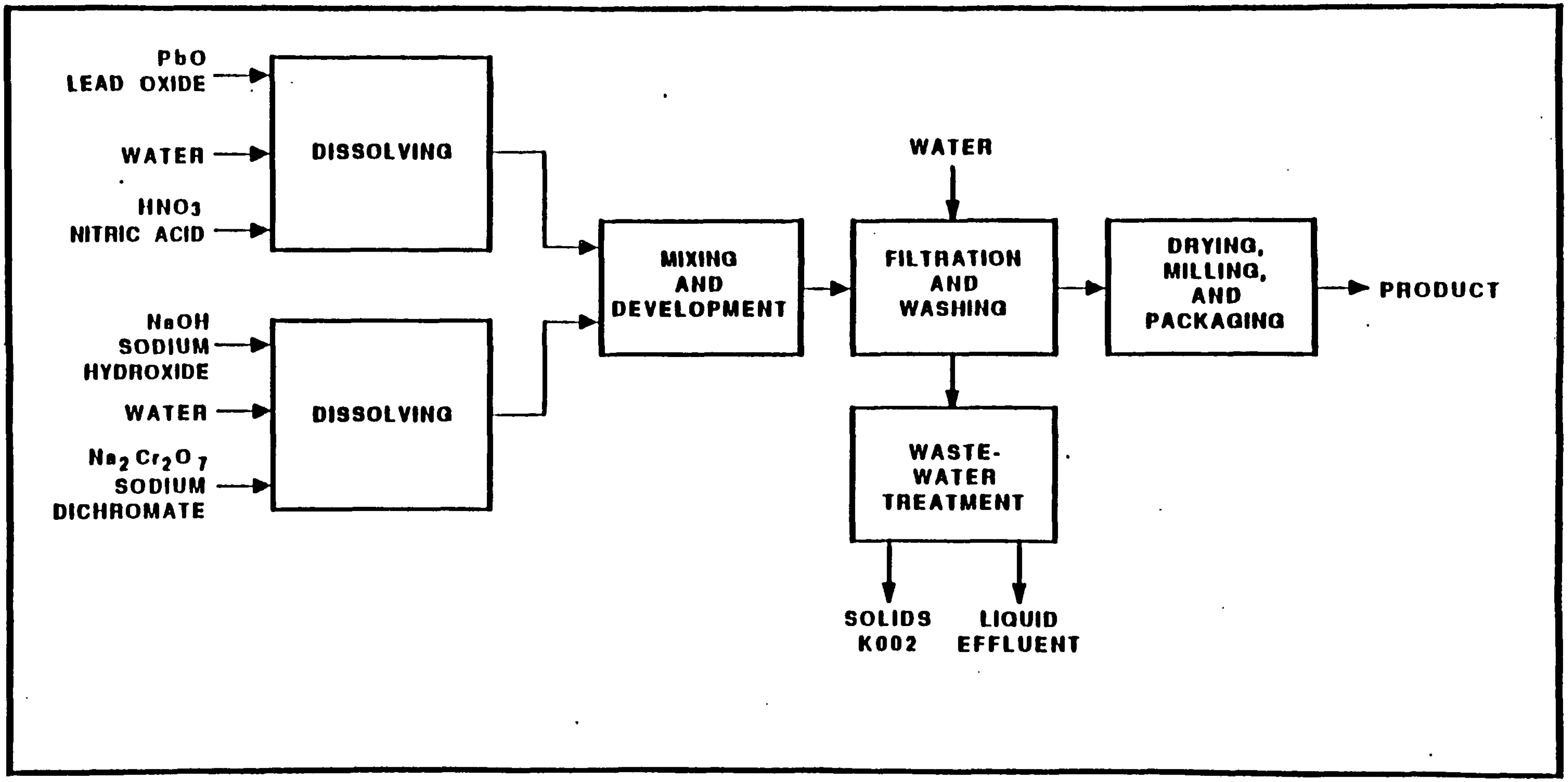

FIGURE 2-1 CHROME YELLOW MANUFACTURE

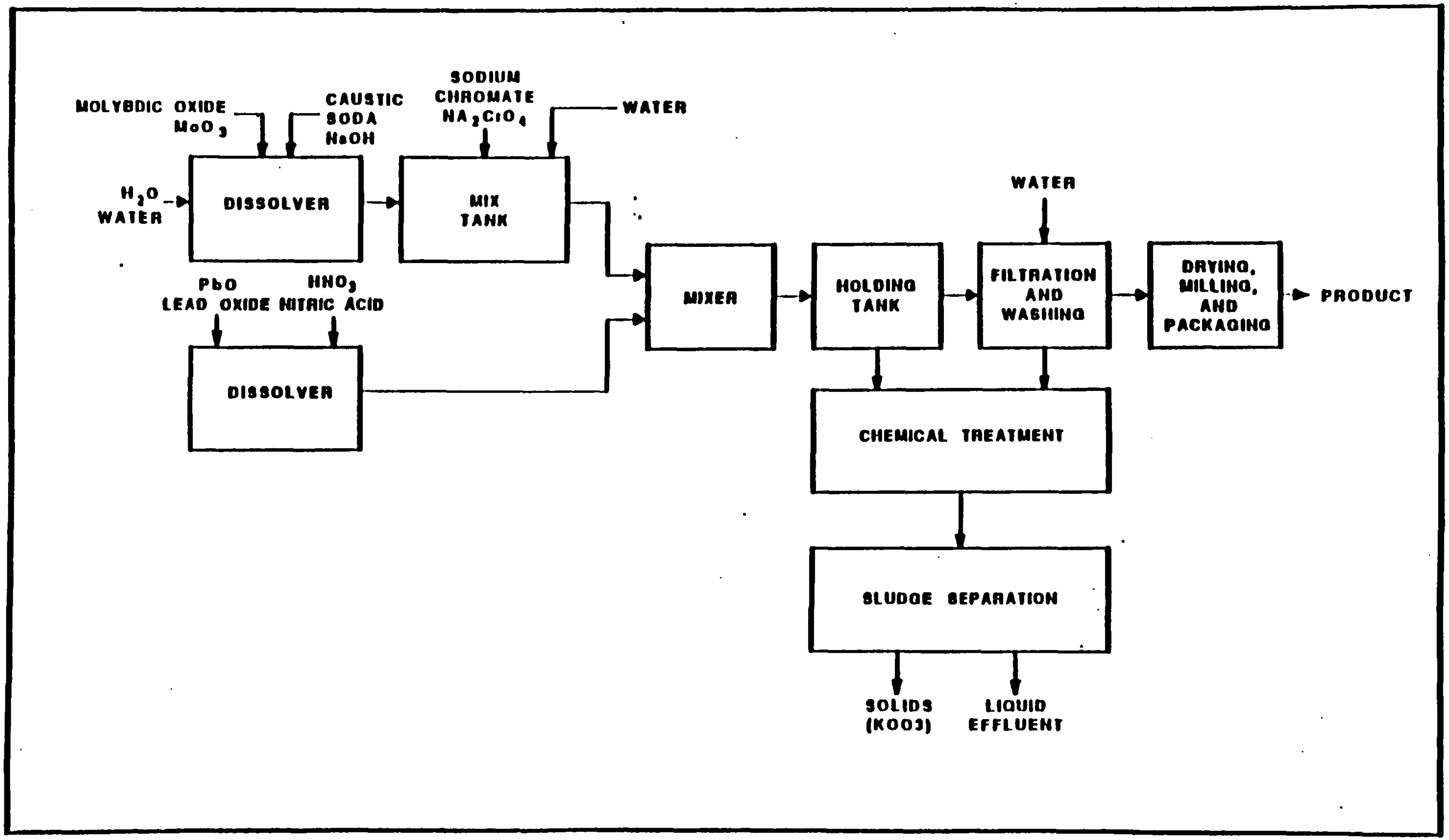

FIGURE 2-2 MOLYBDATE ORANGE MANUFACTURE

2.1.3 K004

Zinc yellow pigments are produced by two methods. In the first method, chromic acid solution is reacted with zinc oxide or zinc carbonate. The product precipitates from solution and is collected by filtration, then washed, dried, and packaged. The spent process liquor and wastewaters are combined and forwarded to a second process, where barium carbonate is added. Barium chromate precipitates, is collected by filtration, is washed, dried, packaged, and then sold. The spent process and wash waters from this second process are combined and used to prepare the chromic acid solutions for the zinc yellow process at the one facility using this process so that no wastewaters are generated, and no K004 wastewater treatment sludges are produced. Figure 2-3 is a diagram of the process.

The second process for zinc yellow pigment products involves reaction of a solution of potassium dichromate with an added zinc salt, such as the nitrate or chloride. The product precipitates from solution. The reaction equation is:

$$2K_2Cr_2O_7 + 4ZnCl_2 + 6H_2O \text{ ---> }$$

$$4ZnO \bullet K_2O \bullet 4CrO_3 \bullet 3H_2O \text{ (zinc yellow)} + 2KCl + 6HCl.$$

The precipitate is then collected by filtration, washed, dried, and packaged. The spent process liquors and wash waters are combined and released to a local POTW. Figure 2-4 shows the process diagram. This facility also does not currently generate K004 waste but would do so if the process wastewaters were treated onsite prior to discharge.

2.1.4 K005

Chrome green pigments are no longer manufactured in the United States. These pigments are mixtures of chrome yellow and iron blue (iron

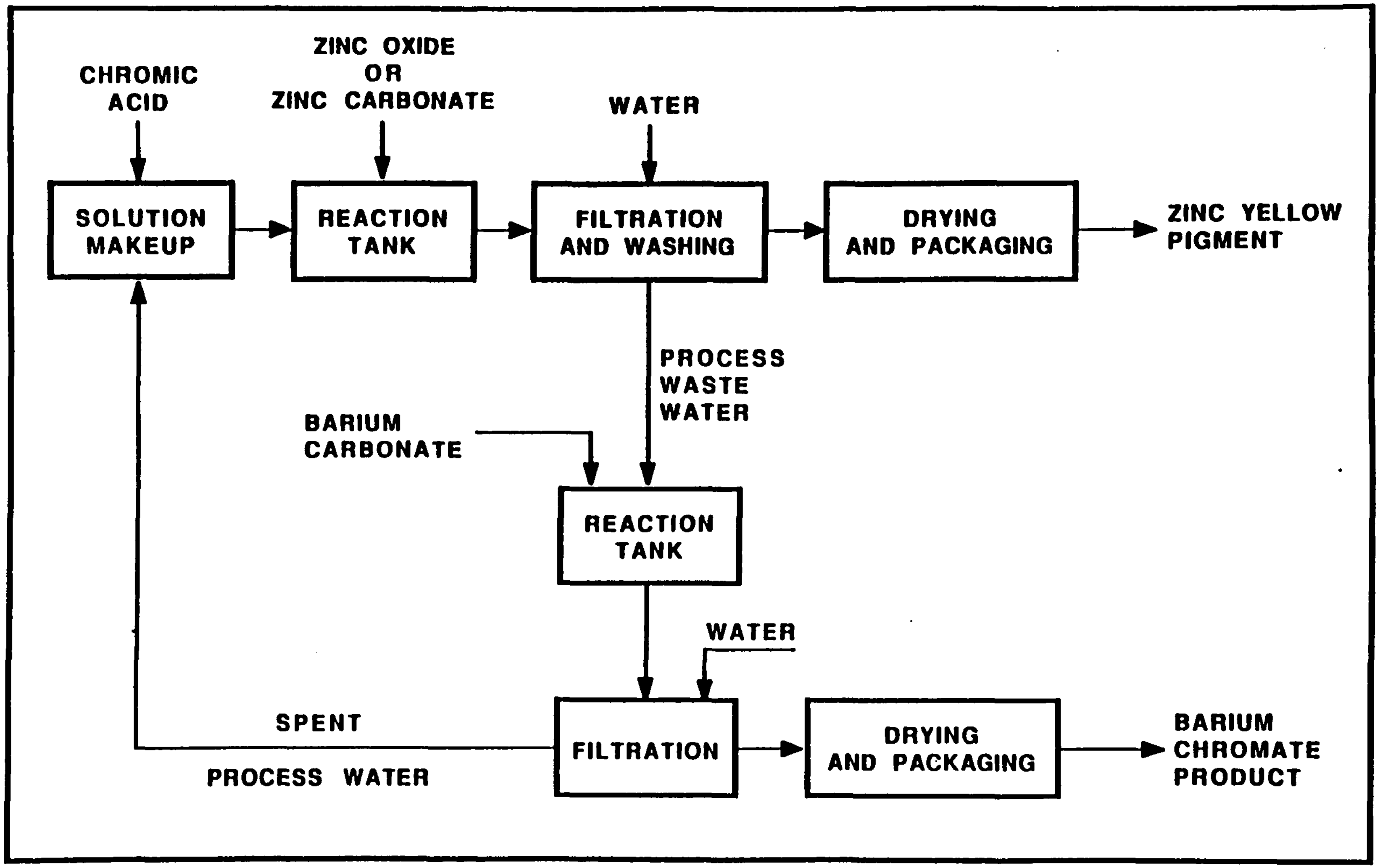

FIGURE 2-3 ZINC YELLOW PIGMENT MANUFACTURE BY THE MINERAL PIGMENTS PROCESS

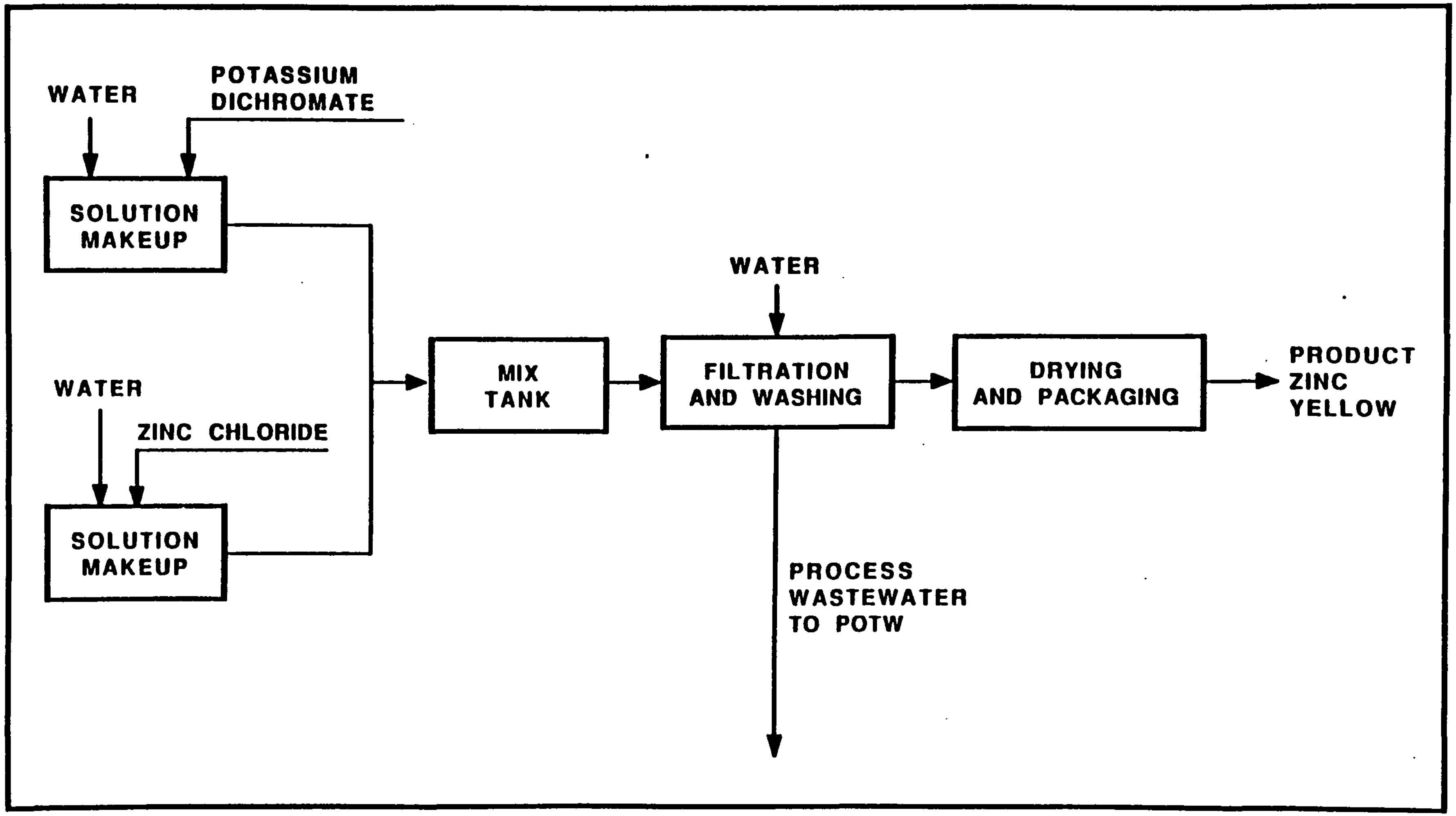

FIGURE 2-4 ZINC YELLOW PRODUCTION BY THE WAYNE PIGMENTS PROCESS

ferrocyanide). They include a wide variety of hues, from very light to very dark green. Chrome green is produced by mechanically mixing aqueous dispersions of chrome yellow and iron blue pigments.

The resulting pigment suspensions are then filtered, dried, ground, blended, and packaged. When the sole facility known to be producing chrome green pigment was operating, the filtrate, which contains unrecovered particulates of chrome yellow and iron blue pigments, was sent to wastewater treatment for removal of suspended particulates prior to release under NPDES permit. The removed particulates were the K005 waste. This production facility closed permanently in 1987.

2.1.5 K006

Chrome oxide green pigments are produced at two facilities by two different processes.

The first process, which produces anhydrous chromic oxide, employs the thermal decomposition of ammonium dichromate. Sodium dichromate solution and ammonium sulfate are mixed together; this mixing results in a solid mass consisting of ammonium dichromate and sodium sulfate decahydrate ($Na_2SO_4 \bullet 10H_2O$).

This mixture is then heated in a kiln to a temperature above 500°C. The ammonium dichromate decomposes according to the following reaction:

$$(NH_4)_2 Cr_2O_7 \rightarrow Cr_2O_3 + N_2 + 4H_2O.$$

The reacted material is recovered from the kiln and leached with water. The sodium sulfate dissolves out of the product mass, and the leached product is then recovered by filtration, washed, dried, and packaged. The sodium sulfate-containing wastewater is treated to reduce any hexavalent chromium compounds present and then is filtered prior to discharge. The K006 waste stream is the filter cake generated from this process, which is collected, reclaimed in a second calciner, and recycled by blending with the product.

In the second process, which manufactures hydrated chrome oxide green pigment, sodium dichromate is reacted with boric acid as follows:

$$2Na_2Cr_2O_7 + 8H_3BO_3 \rightarrow 2Cr_2O_3 \bullet 2H_2O + 2Na_2B_4O_7 + 8O_2.$$

The raw materials are blended in a mixer, then heated in an oven at 550°C. Oven residues, which contain hexavalent and trivalent chromium, are washed out of the oven and sent to a wastewater treatment unit. The reacted material is slurried with water and filtered. The filtered solids are washed, dried, ground, screened, and packaged. The filtrate and wash water are also sent to wastewater treatment where chemical treatment of the wastewater with sodium bisulfite and lime neutralization in series followed by filtration generates the listed waste K006. Figures 2-5 and 2-6 present schematics of the two types of chrome oxide green manufacturing and waste treatment processes.

2.1.6 K007

Iron blue pigments are produced by the reaction of sodium ferrocyanide with an aqueous solution of iron sulfate and ammonium sulfate. The precipitate formed is separated and oxidized with sodium chlorate or sodium chromate, a hexavalent chromium compound, to form iron blues.

The final product is then collected by filtration, washed, dried, milled, and packaged.

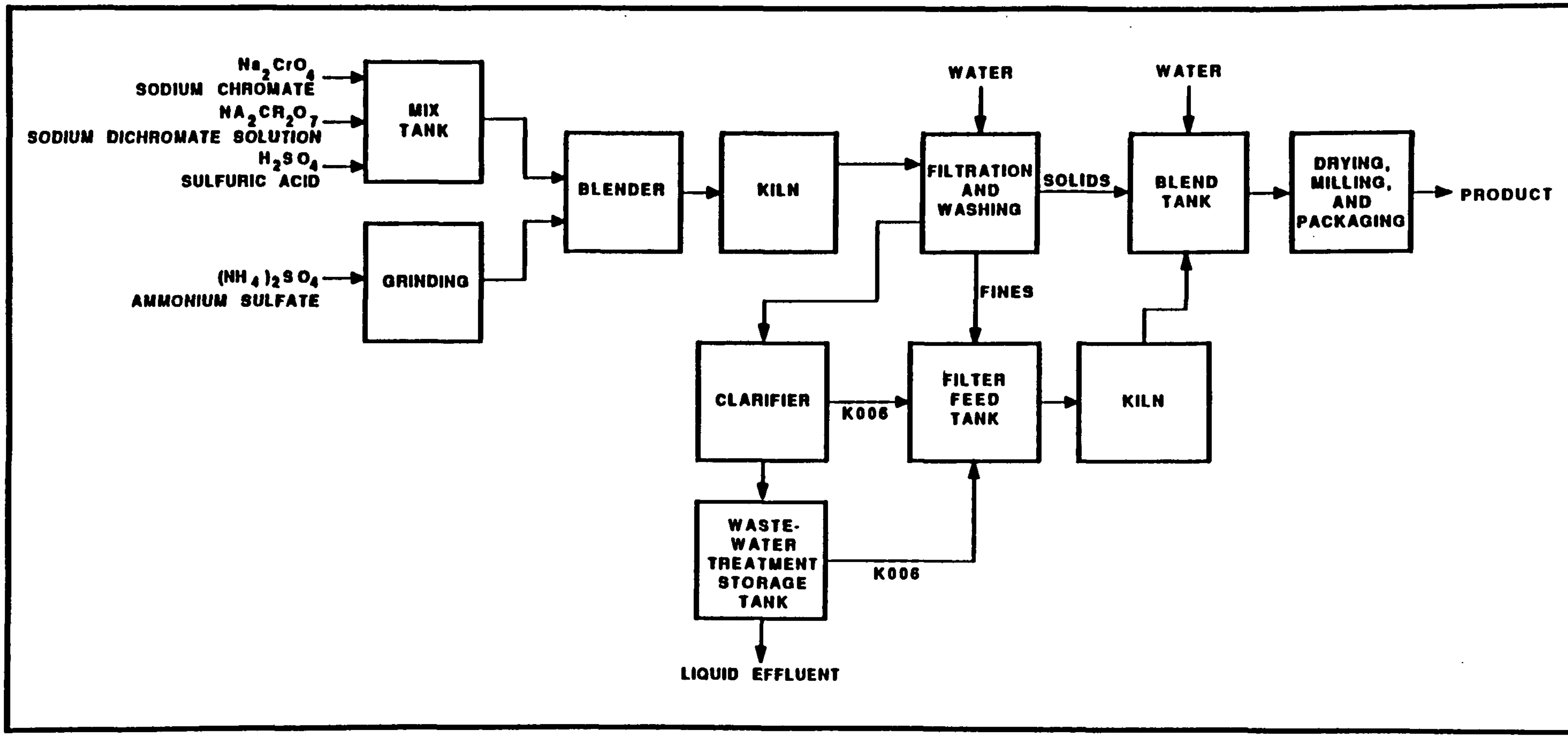

FIGURE 2-5 ANHYDROUS CHROME OXIDE GREEN MANUFACTURE BY THE AMMONIUM DICHROMATE PROCESS

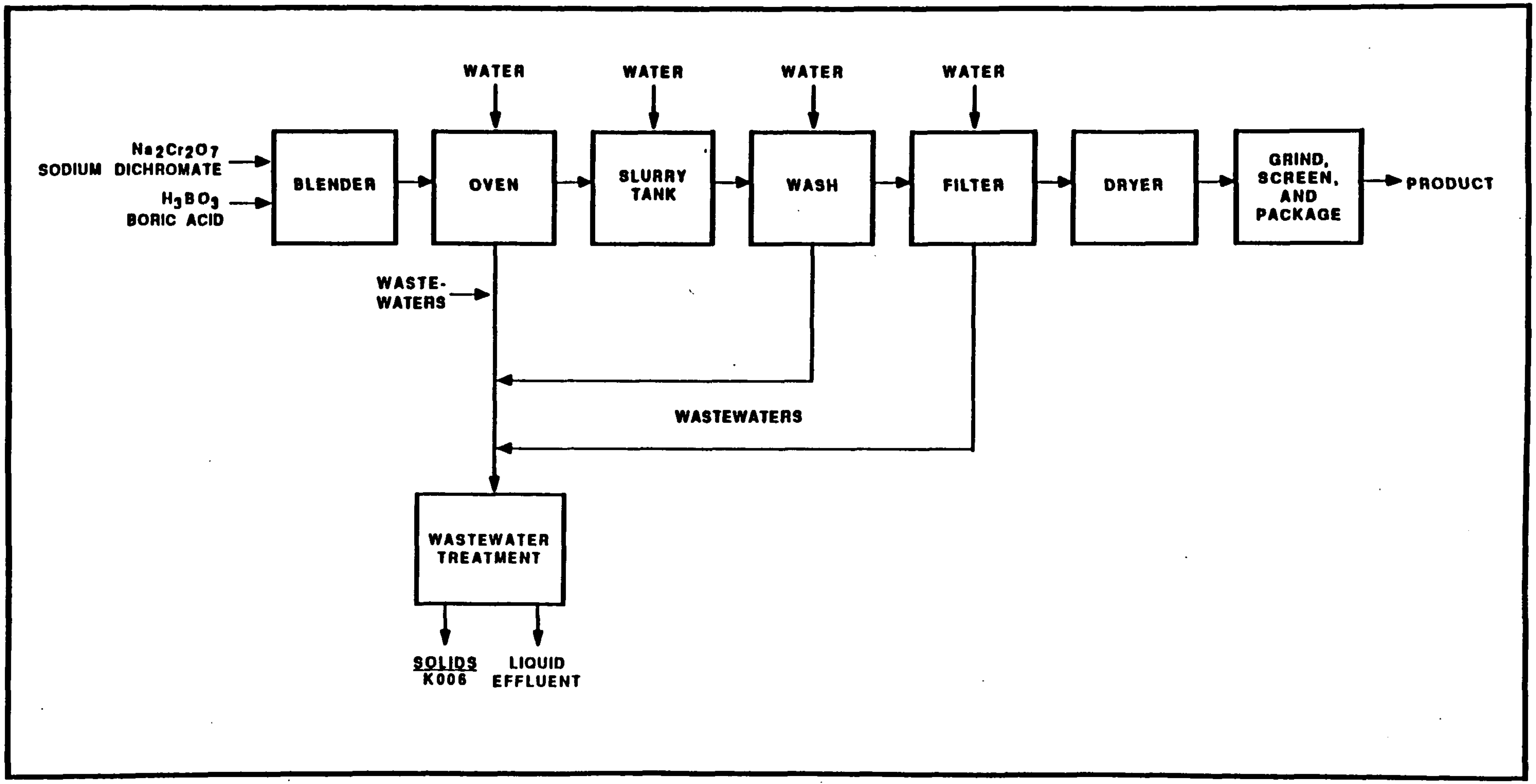

FIGURE 2-6 HYDRATED CHROME OXIDE GREEN MANUFACTURE BY THE BORIC ACID PROCESS

The wastewaters contain all of the chemicals used in the process, along with some unrecovered product. Subsequent treatment of the wastewaters generates a sludge containing complex iron cyanides. This sludge is considered the listed waste K007. EPA believes that the last facility producing iron blues in the United States closed permanently in June 1987.

2.1.7 K008

The two processes described previously as the sources of generation of K006 waste are the potential generators of K008 wastes if the reaction kiln or oven is cleaned by dry methods. Presently, both K006 generation facilities employ wet cleaning methods. The wastewater generated is combined with other process wastewaters prior to treatment. The wastewater treatment sludges generated as a result of this waste treatment become K006. They contain all of the chromium values that would have been removed from the kiln or oven as dry solids had dry cleanout methods been used.

2.2 Waste Characterization

Waste characterization data for waste codes K002, K003, K004, K005, K006, K007, and K008 are provided below. Tables 2-3 and 2-4 contain waste characterization data obtained by the Agency for two plants generating a mixed K002, K003, and K004 wastewater treatment sludge. Table 2-5 shows waste characterization data for the K006 waste generated from the one facility producing hydrated chrome oxide green. Table 2-6 presents data for the major contaminants in wastes K002, K003, K004, K005, K006, K007, and K008 along with their approximate concentrations from the original listing documents. No data are presently available for characterization of wastewater forms of K002, K003, K004, K005, K006, K007, or K008. These wastewaters would consist of leachates from landfills containing these pigment wastes or filtrates from dewatering nonwastewater sludges.

Table 2-3 Waste Characterization of Data for Mixed K002, K003, and K004

BDAT constituent (ppm)	K002/K003 Yellow chromate sludge	Mixture of K002, K003, and K004 carbonate sludge	K002/K003 Orange chromate sludge
Antimony	ND	ND	ND
Arsenic	ND	ND	ND
Barium	530	ND	700
Beryllium	ND	ND	ND
Cadmium	ND	ND	ND
Chromium (T)	108,000	850	74,000
Copper	ND	ND	ND
Lead	670,000	750,000	610,000
Mercury	0.27	ND	ND
Nickel	ND	ND	ND
Selenium	ND	ND	ND
Silver	ND	ND	ND
Thallium	ND	ND	ND
Vanadium	ND	ND	ND
Zinc	290	85,000	710
Total cyanide	ND	ND	ND
Sulfide	NA	NA	ND
Other constituents	balance	balance	balance

ND = Not detected.
NA = Not analyzed.

Source: USEPA 1987.

Table 2-4 Waste Characterization Data for a Mixed K002/K003 Waste Generated at a Chrome Pigments Production Facility

	Total composition[1] (kg/kg)		EP-Toxicity leachate (mg/l)			
Constituent	Sample 1	Sample 2	Sample 1	Sample 2	Sample 3	Sample 4
Cadmium	1,476	-	18	0.98	3.75	3.81
Chromium	61,800	-	13	<.01	<0.1	<0.1
Lead	54,700	-	64.5	<.01	308	150
Zinc	2,400	-	-	-	-	-
Barium	1,093	-	-	-	-	-
Water	393,000	-	-	-	-	-
Total Solids	607,000	602,000	-	-	-	-

[1]Sample 1 was obtained on April 25, 1988 and Sample 2 was obtained on March 3, 1989. Samples 3 and 4 were obtained on unspecified dates in August and September, 1988, respectively.

Source: Engelhard 1989.

Table 2-5 Waste Characterization Data for K006 Waste Generated from Facility Producing Hydrated Chrome Oxide Green Pigment

Constituent	Concentration (mg/kg) (dry weight basis)
Arsenic	<2.0
Barium	<20
Cadmium	<0.6
Chromium	81,000
Lead	9.7
Mercury	<0.6
Selenium	<2.0
Silver	<0.6

Source: Pfizer Inc. Communication to EPA, June 22, 1989; Comment # LD12-00063.

Table 2-6 Estimated Composition of Wastewater Treatment Sludges from Inorganic Pigments Manufacturing Processes

Sludge source	Estimated contaminants in sludge
K002 Production of chrome yellow and orange pigments	30,000 ppm $PbCrO_4$ lead chromate 10,400 ppm $Cr(OH)_3$ chromium hydroxide 2,500 ppm $Pb(OH)_2$ lead hydroxide
K003 Production of molybdate orange pigments	20,000 ppm $PbCrO_4$ -$PbMoO_4$ (molybdate orange) 10,000 ppm $Cr(OH)_3$ chromium hydroxide 2,500 ppm $Pb(OH)_2$ lead hydroxide
K004 Production of zinc yellow pigments	20,000 zinc yellow pigment 48,000 chromic hydroxide
K005 Production of chrome green pigments	5,000 ppm $PbCrO_4Fe\ (NH_4)[Fe(CN)_6]$
K006 Production of anhydrous chrome oxide green pigments	22,000 ppm $Cr(OH)_3$ chromium hydroxide
K006 Production of hydrated chrome oxide green pigments	66,000 ppm $Cr(OH)_3$ chromium hydroxide
K007 Production of iron blue pigments	25,000 ppm $Fe_4(Fe(CN)_6)_3$ ferric ferrocyanide
K008 Production of chrome oxide green pigments	10,000 chromium oxides

Source: USEPA 1980a.

2.3 Determination of Waste Treatability Group

In some cases EPA believes that wastes with different waste codes produced in similar processes in an industry or in similar industries, can be treated to similar concentrations by using the same technologies. In these instances, the Agency may combine the codes into a single treatability group. Based on careful review of the generators of inorganic pigments and available waste characterization data, the Agency has determined that wastes K002, K003, K004, K005, K006, K007, and K008 represent a single treatability group. The concentration and type of metal constituents in the various wastes are dependent upon the waste type, the particular production process employed, and the specifics of the treatment process. Also, the presence of minor constituents such as boron may depend on the exact process used. However, all the wastes contain similar constituents and are expected to be treatable to similar levels by using the same technology for metals. The same complex cyanides are present in two of the wastes, K005 and K007, and are treatable by cyanide destruction processes such as alkaline chloromate. Lead and/or chromium are present in K002, K003, K004, K006, and K008 wastes.

With respect to wastes K005 and K007, EPA has determined that the pigments from which these wastes were generated are no longer produced in the United States. However, some firms could wish to produce these pigments again at some future date.

Process changes occurring in the last decade have eliminated the generation of K008 nonwastewaters from the manufacture of both hydrated and anhydrous chrome oxide green pigments. Dry cleaning of ovens and kilns has been eliminated. Presently, washout waters from oven or kiln cleaning are combined with other chrome oxide green process wastewaters and treated to generate a K006 waste.

Wastewater treatment sludges from the production of zinc yellow pigment (K004) are not generated at either of the two facilities producing this product. One facility sends its untreated wastewater to a POTW for treatment. The second plant uses a new process chemistry and is thereby able to recycle all wastewater and to generate a co-product barium chromate pigment for sale. Both of these wastewater management methods could change in future years because of changes in POTW regulations and demand for barium chromate.

Another reason for grouping all of the waste codes into a single treatability group is that inorganic pigments plants often produce more than one of the chrome pigments. These facilities have wastewater treatment systems, which manage the wastewaters generated by all of the individual processes operated. As a result, the wastewater treatment, sludges produced can be a mixture of K002, K003, K004, K005, K006, and K007, which vary in composition with the production schedules for the individual pigments produced.

3. APPLICABLE AND DEMONSTRATED TREATMENT TECHNOLOGIES

Section 2 established a single treatability group for the management of K002, K003, K004, K005, K006, K007, and K008 wastes. This section identifies the treatment technologies that are applicable to this group 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 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 1988d)). To be demonstrated, the technology must be employed in full-scale operation for the treatment of the waste in question or a similar waste.

3.1 Applicable Treatment Technologies

3.1.1 Treatment Technologies for Nonwastewaters

Initial data gathering on the treatment of these wastes included review of the technical literature, review of RCRA 3007 Questionnaires, and contacts with industry representatives. As a result of these efforts, EPA has identified three technologies as potentially applicable for treatment of these wastes. These technologies are stabilization, high temperature metals recovery (HTMR), and reuse/recycle.

With respect to nonwastewaters, stabilization reduces the leachability of the metals, HTMR reduces both the total concentration and the leachability of the metals through the production of slag, and product reuse/recycle eliminates the waste stream entirely.

The Agency believes that stabilization with prior chemical treatment can be used to treat inorganic pigment wastes; this belief is based on the chemical and physical similarity of these wastes to F006 (wastewater treatment sludges from electroplating operations) and also the similarity of the untreated pigment production wastewaters to the waste K062 (waste pickle liquor). Also, the Agency is of the opinion that HTMR can be used to treat K002 and K003 because of the chemical and physical similarities of these wastes to K061 (electric arc furnace dust); all are solid wastes with a high metal content.

Stabilization and high-temperature metals recovery are discussed fully in the F006 Background Document (USEPA 1988a) and in the Treatment Technology Background Document (USEPA 1988d). Product reuse/recycle involves the elimination of the nonwastewater streams by reuse in the manufacture of another product or recycle of all nonwastewater process residuals in the production cycle.

The Agency believes that the wastes K004 and K008 are similar to K002, K003, and K006 with respect to concentrations of specific toxic metals present because K004 and K008 contain comparable concentra- tions of chromates. Therefore K004 and K008 nonwastewaters can be managed by the same technologies as K002, K003, K004, and K006. The Agency also believes, based on the data in Table 2-6, that the wastes K005 and K007 will contain complex cyanides and chromates. The wastes F006 and F007 contain comparable forms and higher concentrations of cyanides and chromates and hence should be more difficult to treat than the K005 and K007 wastes.

3.1.2 Treatment Technologies for Wastewaters

Wastewater forms of K002, K003, K004, K005, K006, K007, and K008 consist primarily of leachates from monofills or filtrates from dewatering of waste sludges. All of these wastes were originally generated by treatment of process wastewaters from the production of the chrome and iron blue colors. As a result, the leachates are expected to contain those constituents originally removed from the wastewaters [i.e., chromium, lead, and complex cyanides). The treatments, first discussed in the Development Document for Effluent Limitations Guidelines (i.e., Best Available Technology Economically Achievable (BATEA)), New Source Performance Standards and Pretreatment Standards for the Inorganic Chemicals Manufacturing Point Source Category (USEPA 1982), were chemical reduction and hydroxide and lime precipitation. These technologies are also discussed in more detail in the Treatment Technology Background Document (USEPA 1988d).

3.2 Demonstrated Treatment Technologies

3.2.1 Demonstrated Technologies for Nonwastewaters

Of the above-mentioned applicable technologies, all have been demonstrated on the pigment production wastes or similar wastes. Stabilization has been demonstrated on F006 wastes (wastewater treatment sludges from electroplating operations) and on K061 wastes (electric arc furnace dust). HTMR has been demonstrated on K061. Chemical reduction has also been demonstrated on K062 waste pickle liquor from iron and steel manufacturing. The sole generator of K006 wastes has provided stabilization data to the Agency on wastes generated by the production of hydrated chrome oxide green pigments. The Agency has data from a facility that is recycling, in conjunction with HTMR, for a mixed K002/K003 waste, and also has stabilization data for this waste. Finally, the Agency is aware of a facility that recycles its solids (K006) resulting from the manufacture of anhydrous chrome oxide green.

Product reuse/recycle of mixed K002/K003 involves the addition of lead salts to the process wastewater; the lead salts act as a precipitating agent and raise the lead content of the sludge. The sludge is subsequently sold to a lead smelter to be used as a feedstock substitute for the smelter's raw material (lead-bearing scrap materials). This sludge consists primarily of lead chromate and lead carbonate, which occur in nature as the lead-bearing minerals crocoite and cerussite, respectively.

According to information supplied to the Agency, the recycle of K006 nonwastewaters from production of anhydrous chrome oxide green pigment results in the reduction of BDAT metals in the wastewater residuals generated from the production of chrome oxide green. Solids from the wastewater treatment system are recycled back to the production process for inclusion in the finished product. The solids are chemically identical to the product chrome oxide green.

The Agency, however, believes these reuse/recycle technologies may be plant- and product-grade-specific and hence not applicable to all potential generators of K006 nonwastewaters. The Agency also acknowledges that reuse and recycle are demonstrated for some K002 and K003 nonwastewaters but also feels that these technologies may only be applicable only under certain specialized conditions. The Agency notes that processing of the wastes at lead smelters may generate residues requiring treatment and disposal. It appears that K006 wastes originating from the production of hydrated chrome oxide green may not be easily recycled because of their low chromium content. Therefore, based on analysis of data available on the stabilized K006 waste from this source, stabilization is a treatment technology that is applicable in this case.

K002 and K003 wastes will vary in their TCLP toxic metal content, depending on the wastewater treatment methods used. Two facilities presently generate mixed K002 and K003 wastes. One facility generates a sludge containing lead chromate and lead carbonate which it then sells to a lead smelter; this is the waste whose composition was given in

Table 2-3. The second facility treats its wastewater with ferrous sulfate and lime in series to generate a waste containing considerable amounts of iron oxides and hydroxide, trivalent chromium hydroxide, and sparingly soluble lead salts, which have much lower lead content. Because recycle of this waste may be problematic, the Agency considers that chemical reduction of chromate followed by precipitation and filtration in series is an applicable treatment train for this type of K002 and K003 waste.

Treatment of cyanides by alkaline chlorination has been demonstrated for F007 wastes. However, the cyanides present in K005 and K007 are complex iron cyanides, which may be more difficult to treat. Therefore, the Agency is further evaluating whether alkaline chlorination is truly applicable to K005 and K007 nonwastewaters.

3.2.2 Demonstrated Technologies for Wastewater

The use of chromate reduction, cyanide oxidation, and chemical precipitation technologies by the inorganic pigments industry is discussed in detail in the Development Document for Effluent Limitations Guidelines, New Source Performance Standards and Pretreatment Standards for the Inorganic Chemicals Manufacturing Point Source Category (USEPA 1982). Extensive documentation is presented on the use of these technologies by the pigments industry and on the results normally obtained with these technologies. The techniques discussed in detail include chemical reduction of chromates with bisulfite, ferrous ion, and sulfide; alkaline chlorination for cyanide oxidation; lime and sulfide precipitation for metals removal; and filtration.

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), for selecting constituents to be regulated (Section 6), and for developing treatment standards (Section 7). 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 for the treatment technology 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 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 stabilization data for a mixed untreated and treated K002/K003/K004 waste generated from a wastewater treatment system that does not utilize hexavalent chromium reduction.* This waste was obtained from a facility that produced chrome yellow, molybdate orange, and zinc yellow pigments in 1985 and 1986. The facility phased out production of zinc yellow in early 1987, but still produces the other two pigments. The untreated leachate data are presented in Table 4-1 and the treated leachate data are presented in Table 4-2. The Agency also has received data from the one facility producing hydrated chrome oxide green pigment. Table 4-3 shows the results of TCLP tests conducted on five samples of stabilized K006 wastes from the one facility.

The Agency does not have data on stabilization of the K002/K003 wastes generated from the facility using ferrous sulfate treatment of its process wastewaters. However, the Agency expects that this waste will behave similar to both F006 and treated K062 wastes with respect to stabilization because the same constituents are present at comparable levels. Data on stabilization of F006 wastes are in the F006 Background Document (USEPA 1988a). A summary of these data is presented in Table 4-4. Data on the treatment and subsequent lime stabilization of K062 wastes are presented in the K062 background document (USEPA 1988f).

Table 4-5 shows a summary of the K062 treatment data. With respect to reuse/recycle, the Agency has documentation from three facilities recycling K002, K003, and/or K006 nonwastewaters and has noted the special circumstances accompanying use of these technologies.

The Agency does not have cyanide treatment data for K005 and K007 nonwastewaters; however, the Agency has a considerable volume of treatment information on various cyanide-containing wastes. These

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* Use of chromate reduction technologies will convert any chromates present to trivalent chromium hydroxide. Chromates are generally soluble. Trivalent chromium hydroxide, however, is essentially insoluble, and thus more easily managed by stabilization.

Table 4-1 BDAT TCLP Metal Values for Untreated Inorganic Pigment Sludges

BDAT constituent	K002/K003 Yellow chromate sludge (mg/l)	K002/K003/K004 Carbonate sludge (mg/l)	K002/K003 Orange chromate sludge (mg/l)
Arsenic	ND	ND	ND
Barium	ND	0.09	ND
Cadmium	ND	0.047	ND
Chromium (TOT)	1.2	1.3	2.7
Lead	320	5400	1600
Mercury	ND	ND	ND
Selenium	ND	ND	ND
Silver	ND	ND	ND

ND = None detected at practical quantitation limit.

Source: USEPA 1987.

Table 4-2 TCLP Analytical Results for the Treated (Stabilized) Combined Wastewater Treatment Sludge Samples K002/K003/K004

	Treated waste (cement binder)		
	TCLP sample number		
	A	B	C
	mg/l	mg/l	mg/l
Antimony	ND	ND	ND
Arsenic	ND	ND	ND
Barium	0.2	0.26	0.47
Beryllium	ND	ND	ND
Cadmium	ND	ND	ND
Chromium (Total)	9.9	1.9	ND
Copper	ND	ND	ND
Lead	0.13	0.16	1.34
Mercury	ND	ND	ND
Nickel	ND	ND	ND
Selenium	ND	ND	ND
Silver	ND	ND	ND
Thallium	ND	ND	ND
Vanadium	ND	ND	ND
Zinc	0.094	0.24	ND
	Kiln dust binder		
Antimony	ND	ND	ND
Arsenic	ND	ND	ND
Barium	0.088	0.024	0.18
Beryllium	ND	ND	ND
Cadmium	ND	ND	ND
Chromium (Total)	39.1	1.6	ND
Copper	ND	ND	ND
Lead	6.6	13.5	1.5
Mercury	ND	ND	ND
Nickel	ND	ND	ND
Selenium	ND	ND	ND
Silver	ND	ND	ND
Thallium	ND	ND	ND
Vanadium	ND	ND	ND
Zinc	2.3	1.7	ND

Table 4-2 (continued)

	Treated waste (lime flyash binder)		
	TCLP sample number		
	A mg/l	B mg/l	C mg/l
Antimony	ND	ND	ND
Arsenic	ND	ND	ND
Barium	0.14	0.055	0.16
Beryllium	ND	ND	ND
Cadmium	ND	ND	ND
Chromium (Total)	45.4	4.5	ND
Copper	ND	ND	ND
Lead	6.3	14	73.4
Mercury	ND	ND	ND
Nickel	ND	ND	ND
Selenium	ND	ND	ND
Silver	ND	ND	ND
Thallium	ND	ND	ND
Vanadium	ND	ND	ND
Zinc	2.6	2.1	0.96

Note: Wastes A, B, and C were three individual samples of mixed K002/K003/K004 wastes of the same composition.

ND = Not detected.

Source: USEPA 1987.

Table 4-3 Stabilization Test Results for K006 Wastes Generated from Production of Chrome Oxide Green Pigment

Test number	TCLP extract total chromium (ppm)	TCLP extract hexavalent chromium (ppm)
1	0.95	0.53
2	0.26	<0.02
3	0.89	<0.02
4	4.25	0.33
5	1.08	0.23

Source: Pfizer Inc. 1989.

Table 4-4 Performance Data for Untreated and Treated F006 Wastes
Metal Concentrations (ppm)

Source	Mix* Ratio	Barium	Cadmium	Chromium	Copper	Lead	Nickel	Silver	Zinc
Unknown									
Unstabilized									
As received		----	----	----	----	----	435	----	1560
TCLP	----	----	----	----	----	----	0.71	----	0.16
Stabilized									
TCLP	0.2	----	----	----	----	----	0.04	----	0.03
Autopart manufacture									
Unstabilized									
As received		----	31.3	755	7030	409	989	6.62	4020
TCLP		----	2.21	0.76	368	10.7	22.7	0.14	219
Stabilized									
TCLP	0.2	----	0.50	0.40	5.4	0.40	1.5	0.03	36.9
TCLP	0.5	----	0.01	0.39	0.25	0.36	0.03	0.05	0.01
Aircraft overhaul facility									
Unstabilized									
As received		85.5	67.3	716	----	257	259	38.9	631
TCLP		1.41	1.13	0.43	----	2.26	1.1	0.20	5.41
Stabilized									
TCLP	0.2	0.33	0.06	0.08	----	0.30	0.23	0.20	0.05
TCLP	0.5	0.31	0.02	0.20	----	0.41	0.15	0.05	0.03
Zinc plating									
Unstabilized									
As received		----	1.31	----	1510	88.5	374	9.05	90200
TCLP		----	0.02	----	4.62	0.45	0.52	0.16	2030
Stabilized									
TCLP	0.2	----	0.01	----	0.30	0.30	0.10	0.03	32
TCLP	1.0	0.23	<0.01	----	0.15	0.21	0.02	0.03	0.01
Unknown									
Unstabilized									
As received		14.3	720	12200	160	52	701	5.28	35900
TCLP		0.38	23.6	25.3	1.14	0.45	9.78	0.08	867
Stabilized									
TCLP	0.2	0.31	3.23	0.25	0.20	0.24	0.53	0.04	3.4
TCLP	0.5	0.23	0.01	0.30	0.27	0.34	0.03	0.04	0.04

Table 4-4 (continued)

Source	Mix* Ratio	Barium	Cadmium	Chromium	Copper	Lead	Nickel	Silver	Zinc
Small engine manufacture									
Unstabilized									
As received		----	7.28	3100	1220	113	19400	4.08	27800
TCLP		----	0.3	38.7	31.7	3.37	730	0.12	1200
Stabilized									
TCLP	0.2	----	0.02	0.21	0.21	0.30	16.5	0.03	36.3
TCLP	0.5	----	0.01	0.38	0.29	0.36	0.04	0.06	0.03
Circuit board manufacture									
Unstabilized									
As received		----	5.39	42900	10600	156	13000	12.5	120
TCLP		----	0.06	360	8.69	1.0	152	0.05	0.62
Stabilized									
TCLP	0.2	----	0.01	3.0	0.40	0.30	0.40	0.03	0.02
TCLP	0.5	----	0.01	1.21	0.42	0.38	0.10	0.05	0.02
Unknown									
Unstabilized									
As received		15.3	5.81	----	17600	1.69	23700	8.11	15700
TCLP		0.53	0.18	----	483	4.22	644	0.31	650
Stabilized									
TCLP	0.2	0.32	0.01	----	0.50	0.31	15.7	0.03	4.54
TCLP	0.5	0.27	0.01	----	0.32	0.37	0.04	0.05	0.02
Unknown									
Unstabilized									
As received		19.2	----	----	27400	24500	5730	----	322
TCLP		0.28	----	----	16.9	50.2	16.1	----	1.29
Stabilized									
TCLP	0.2	0.19	----	----	3.18	2.39	1.09	----	0.07
TCLP	0.5	0.08	----	----	0.46	0.27	0.02	----	<0.01

*Mix ratio = $\frac{\text{weight of reagent}}{\text{weight of waste}}$

Source: USEPA 1988(a).

Table 4-5 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	Treated waste K062 (nonwastewater) Total (mg/kg) Sample no. 807	Treated waste K062 (nonwastewater) TCLP (mg/l) Sample no. 807
Arsenic	3	<1	<1	<0.1	<1	<0.010
Chromium (hexavalent)	I	I	893	0.011	1.43	-
Chromium (total)	1800	7000	2581	0.12	7300	<0.050
Copper	865	306	138	0.21	380	-
Lead	<10	<10	64	<0.01	2800	<0.10
Nickel	3200	2600	471	0.33	1400	-
Zinc	<2	<2	116	0.125	1300	-

Design and Operating Data

	Design value	Operating value
pH	8-10	9

I = Color interference.
- = Not analyzed.

[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.

Source: USEPA (1988f).

Table 4-5 (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	Treated waste K062 Total (mg/kg) Sample no. 815	Treated waste K062 TCLP (mg/l) Sample no. 815
Arsenic	3	<1	<1	<0.1	1	<0.010
Chromium (hexavalent)	I	I	807	0.12	1.04	-
Chromium (total)	1800	7000	2279	0.19	7400	<0.050
Copper	865	306	133	0.15	400	-
Lead	<10	<10	54	<0.01	1200	<0.10
Nickel	3200	2600	470	0.33	1200	-
Zinc	<2	<2	4	0.115	2100	-

Design and Operating Data

	Design value	Operating value
pH	8-10	9

I = Color interference.
- = Not analyzed.

[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.

Source: USEPA (1988f).

Table 4-5 (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	Treated waste K062 Total (mg/kg) Sample no. 823	Treated waste K062 TCLP (mg/l) Sample no. 823
Arsenic	3	<1	<1	<0.1	2	0.012
Chromium (hexavalent)	I	I	775	I	I	-
Chromium (total)	1700	7000	1990	0.20	4000	<0.050
Copper	425	306	133	0.21	445	-
Lead	<10	<10	<10	<0.01	118	<0.10
Nickel	100310	2600	16330	0.33	3900	-
Zinc	7	<2	3.9	0.140	112	-

Design and Operating Data

	Design value	Operating value
pH	8-10	10

I = Color interference.
- = Not analyzed.

[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.

Source: USEPA (1988f).

Table 4-5 (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	Treated waste K062 Total (mg/kg) Sample no. 831	Treated waste K062 TCLP (mg/l) Sample no. 831
Arsenic	2	<1	3	<1	<1	2	0.015
Chromium (hexavalent)	1	I	I	0.6	0.042	0.92	-
Chromium (total)	142	7000	1700	556	0.10	2400	0.068
Copper	42	306	425	88	0.07	292	-
Lead	<10	<10	<10	<10	<0.01	99	<0.10
Nickel	650	2600	41000	6610	0.33	2700	-
Zinc	3	<2	7	84	1.62	1200	-

Design and Operating Data

	Design value	Operating value
pH	8-10	9

I = Color interference.
- = Not analyzed.

[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.

Source: USEPA (1988f).

Table 4-5 (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	Treated waste K062 Total (mg/kg) Sample no. 839	Treated waste K062 TCLP (mg/l) Sample no. 839
Arsenic	3	<1	3	<1	<0.1	1	<0.010
Chromium (hexavalent)	I	I	I	917	0.058	0.741	-
Chromium (total)	1800	7000	1700	2236	0.11	11500	<0.050
Copper	865	306	425	91	180.14	375	-
Lead	<10	<10	<10	18	0.01	525	<0.10
Nickel	3200	2600	41000	1414	0.31	3300	-
Zinc	<2	<2	7	71	0.125	410	-

Design and Operating Data

	Design value	Operating value
pH	8-10	8

I = Color interference.
- = Not analyzed.

[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.

Source: USEPA (1988f).

Table 4-5 (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	Treated waste K062 Total (mg/kg) Sample no. 847	Treated waste K062 TCLP (mg/l) Sample no. 847
Arsenic	3	<1	<1	<0.1	1	<0.010
Chromium (hexavalent)	I	I	734	I	1.775	-
Chromium (total)	1800	7000	2548	0.10	10000	<0.050
Copper	865	306	149	0.12	432	-
Lead	<10	<10	<10	<0.01	42	<0.10
Nickel	3200	2600	588	0.33	1600	-
Zinc	<2	<2	4	0.095	68	-

Design and Operating Data

	Design value	Operating value
pH	8-10	8

I = Color interference.
\- = Not analyzed.

[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.

Source: USEPA (1988f).

Table 4-5 (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	Treated waste K062 Total (mg/kg) Sample no. 855	Treated waste K062 TCLP (mg/l) Sample no. 855
Arsenic	3	<1	<1	<0.1	1	<0.010
Chromium (hexavalent)	I	I	769	0.12	I	-
Chromium (total)	1800	7000	2314	0.12	16300	<0.050
Copper	865	306	72	0.16	330	-
Lead	<10	<10	108	<0.01	375	<0.10
Nickel	3200	2600	426	0.40	1700	-
Zinc	<2	<2	171	0.115	375	-

Design and Operating Data

	Design value	Operating value
pH	8-10	9

I = Color interference.
- = Not analyzed.

[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.

Source: USEPA (1988f).

Table 4-5 (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	Treated waste K062 Total (mg/kg) Sample no. 863	Treated waste K062 TCLP (mg/l) Sample no. 863
Arsenic	<1	3	<1	<0.1	4	0.011
Chromium (hexavalent)	0.220	I	0.13	<0.01	0.116	-
Chromium (total)	15	1800	831	0.15	2800	<0.050
Copper	151	865	217	0.16	688	-
Lead	<10	<10	212	<0.01	300	<0.10
Nickel	90	3200	669	0.36	2600	-
Zinc	7	9	151	0.130	420	-

Design and Operating Data

	Design value	Operating value
pH	8-10	9

I = Color interference.
- = Not analyzed.

[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.

Source: USEPA (1988f).

Table 4-5 (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	Treated waste K062 Total (mg/kg) Sample no. 871	Treated waste K062 TCLP (mg/l) Sample no. 871
Arsenic	<0.1	3	<1	<1	<0.1	3	0.011
Chromium (hexavalent)	0.079	I	I	0.07	0.041	I	-
Chromium (total)	6	1800	7000	939	0.10	3400	<0.050
Copper	5	865	306	225	0.08	775	-
Lead	<1	<10	<10	<10	<0.01	85	<0.10
Nickel	4	3200	2600	940	0.33	3500	-
Zinc	0.4	<2	<2	5	0.06	150	-

Design and Operating Data

	Design value	Operating value
pH	8-10	10

I = Color interference.
- = Not analyzed.

[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.

Source: USEPA (1988f).

Table 4-5 (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	Treated waste K062 Total (mg/kg) Sample no. 863	Treated waste K062 TCLP (mg/l) Sample no. 863
Arsenic	<3	<1	<0.10	5	0.016
Chromium (hexavalent)	I	0.08	0.106	0.078	-
Chromium (total)	1800	395	0.12	4400	<0.050
Copper	865	191	0.14	758	-
Lead	<10	<10	<0.01	28	<0.10
Nickel	3200	712	0.33	4700	-
Zinc	<2	5	0.070	43	-

Design and Operating Data

	Design value	Operating value
pH	8-10	9

I = Color interference.
- = Not analyzed.

[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.

Source: USEPA (1988f).

Table 4-5 (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	Treated waste K062 Total (mg/kg) Sample no. 895	Treated waste K062 TCLP (mg/l) Sample no. 895
Arsenic	3	<1	<1	<0.10	3	<0.010
Chromium (hexavalent)	I	0.220	0.30	<0.01	1.240	-
Chromium (total)	1800	15	617	0.18	2100	<0.050
Copper	865	151	137	0.24	388	-
Lead	<10	<10	136	<0.01	200	<0.10
Nickel	3200	90	382	0.39	1600	-
Zinc	<2	7	135	0.100	325	-

Design and Operating Data

	Design value	Operating value
pH	8-10	9

I = Color interference.
- = Not analyzed.

[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.

Source: USEPA (1988f).

wastes, like those from the chrome pigments industry also contain high levels of toxic metals. Table 4-6 shows alkaline chlorination data for a variety of metal- and cyanide-containing wastes (USEPA 1989). The data show substantial treatment for cyanides. However, the Agency realizes that complex iron cyanides may be more difficult to treat than cyanides normally present in F007 nonwastewaters. The Agency is currently further evaluating this question with the aim of determining whether any of the treatment technologies for cyanide wastes are truly applicable to K005 and K007 nonwastewaters.

The Agency also has a considerable amount of wastewater treatment data, applicable to wastewater forms of K002, K003, K004, K005, K006, K007, and K008 which are presented in the Development Document for Effluent Limitations Guidelines for the inorganic chemicals industry (USEPA 1982). These data show the results achievable using various methods for reduction of hexavalent chromium and precipitation of trivalent chromium and lead from wastewaters. The data also show the results of treatment for simple and complex cyanides. Table 4-7 shows data obtained by sampling of a chrome pigments production facility as presented in the Effluent Guidelines Development Document (USEPA 1982). The wastewater treatment system used at the facility included equalization, reduction of hexavalent chromium lime addition to precipitate metals, sedimentation, biological oxidation, and filtration prior to discharge (USEPA 1982).

The data in Table 4-7 were obtained at a facility that at the time produced a variety of chrome pigments, iron blue and chrome green. These data were only a part of the data base EPA used to develop the Effluent Guidelines.

Table 4-6 Alkaline Chlorination Data Submitted by Plant C for Various Wastes

Sample Set No. 1[a] - for Treatment of D003 and F007

Constituent/parameter	Concentration (units) Untreated waste (mg/l)	Treated wastewater (mg/l)
BDAT Inorganics Other Than Metals		
Cyanide (amenable)	-	<1.0
Cyanide (total)	60,000	-
BDAT List Metals		
Cadmium	117	-
Chromium (total)	<100	-
Copper	4,000	-
Lead	<100	-
Nickel	1,500	-
Zinc	1,800	-
Non-BDAT List Metals		
Iron	1,700	-

Note: Design and operating parameters are as follows:

Parameter	Design value	Operating value
Alkaline chlorination reactor pH	12.5-13.0	12.9
Retention time for alkaline chlorination	2-6 hr minimum[b]	96 hr
ORP for alkaline chlorination	>200 mV	380 mV

- = Not analyzed.

[a]Batch consisted of a mixture of waste codes D003 and F007.
[b]Actual retention time is based on a "not detected" result for the analysis of the waste for amenable cyanide.

Source: USEPA (1989).

Table 4-6 (continued)

Sample Set No. 2[a] - for Mixed F006-F012, P030

Constituent/parameter	Concentration (units) Untreated waste (mg/l)	Treated wastewater (mg/l)
BDAT Inorganics Other Than Metals		
Cyanide (amenable)	-	<0.1
Cyanide (total)	11,400	-
BDAT List Metals		
Cadmium	25	-
Chromium (total)	1,300	-
Copper	3,400	-
Lead	250	-
Nickel	7,300	-
Zinc	18,500	-
Non-BDAT List Metals		
Iron	3,000	-

Note: Design and operating parameters are as follows:

Parameter	Design value	Operating value
Alkaline chlorination reactor pH	12.5-13.0	12.45
Retention time for alkaline chlorination	2-6 hr minimum[b]	24 hr
ORP for alkaline chlorination	>200 mV	345 mV

- = Not analyzed.

[a]Batch consisted of a mixture of liquids and drummed solids including waste codes F006, F007, F008, F009, F011, F012, and P030.

[b]Actual retention time is based on a "not detected" result for the analysis of the waste for amenable cyanide.

Source: USEPA (1989).

Table 4-6 (continued)

Sample Set No. 3[a] - for Treatment of F007

Constituent/parameter	Concentration (units) Untreated waste (mg/l)	Treated wastewater (mg/l)
BDAT Inorganics Other Than Metals		
Cyanide (amenable)	-	<0.1
Cyanide (total)	100	-
BDAT List Metals		
Cadmium	-	-
Chromium (total)	780	-
Copper	440	-
Lead	<100	-
Nickel	1,740	-
Zinc	<100	-
Non-BDAT List Metals		
Iron	470	-

Note: Design and operating parameters are as follows:

Parameter	Design value	Operating value
Alkaline chlorination reactor pH	12.5-13.0	12.65
Retention time for alkaline chlorination	2-6 hr minimum[b]	5.5 hr
ORP for alkaline chlorination	>200 mV	350 mV

- = Not analyzed.

[a]Batch was waste code F007.

[b]Actual retention time is based on a "not detected" result for the analysis of the waste for amenable cyanide.

Source: USEPA (1989).

Table 4-6 (continued)

Sample Set No. 4[a] - for Treatment of D003

Constituent/parameter	Concentration (units) Untreated waste (mg/l)	Treated wastewater (mg/l)
BDAT Inorganics Other Than Metals		
Cyanide (amenable)	-	<0.1
Cyanide (total)	13,000	-
BDAT List Metals		
Cadmium	-	-
Chromium (total)	-	-
Copper	<100	-
Lead	-	-
Nickel	<100	-
Zinc	-	-
Non-BDAT List Metals		
Iron	320	-

Note: Design and operating parameters are as follows:

Parameter	Design value	Operating value
Alkaline chlorination reactor pH	12.5-13.0	11.8
Retention time for alkaline chlorination	2-6 hr minimum[b]	2 hr
ORP for alkaline chlorination	>200 mV	520 mV

- = Not analyzed.

[a]Batch consisted of solid sodium and potassium cyanide salts of 130,000 ppm cyanide concentration (D003).

[b]Actual retention time is based on a "not detected" result for the analysis of the waste for amenable cyanide.

Source: USEPA (1989).

Table 4-6 (continued)

Sample Set No. 5[a] - for Treatment of F009

Constituent/parameter	Concentration (units) Untreated waste (mg/l)	Treated wastewater (mg/l)
BDAT Inorganics Other Than Metals		
Cyanide (amenable)	-	<1.0
Cyanide (total)	27,200	-
BDAT List Metals		
Cadmium	-	-
Chromium (total)	-	-
Copper	270	-
Lead	-	-
Nickel	1,050	-
Zinc	3,070	-
Non-BDAT List Metals		
Iron	3,320	-

Note: Design and operating parameters are as follows:

Parameter	Design value	Operating value
Alkaline chlorination reactor pH	12.5-13.0	12.6
Retention time for alkaline chlorination	2-6 hr minimum[b]	20 hr
ORP for alkaline chlorination	>200 mV	460 mV

- = Not analyzed.

[a]Waste tested was F009.
[b]Actual retention time is based on a "not detected" result for the analysis of the waste for amenable cyanide.

Source: USEPA (1989).

Table 4-6 (continued)

Sample Set No. 6[a] - for Treatment of F011 and D002

Constituent/parameter	Concentration (units) Untreated waste (mg/l)	Treated wastewater (mg/l)
BDAT Inorganics Other Than Metals		
Cyanide (amenable)	-	<1.0
Cyanide (total)	6,000	-
BDAT List Metals		
Cadmium	-	-
Chromium (total)	-	-
Copper	-	-
Lead	-	-
Nickel	-	-
Zinc	11,000	-
Non-BDAT List Metals		
Iron	4,000	-

Note: Design and operating parameters are as follows:

Parameter	Design value	Operating value
Alkaline chlorination reactor pH	12.5-13.0	12.8
Retention time for alkaline chlorination	2-6 hr minimum[b]	48 hr
ORP for alkaline chlorination	>200 mV	424 mV

- = Not analyzed.

[a]Batch consisted of a mixture of F011 and D002.
[b]Actual retention time is based on a "not detected" result for the analysis of the waste for amenable cyanide.

Source: USEPA (1989).

Table 4-6 (continued)

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

Constituent/parameter	Concentration (units) Untreated waste (mg/l)	Treated wastewater (mg/l)
BDAT Inorganics Other Than Metals		
Cyanide (amenable)	-	<1.0
Cyanide (total)	30,000	-
BDAT List Metals		
Cadmium	-	-
Chromium (total)	-	-
Copper	-	-
Lead	-	-
Nickel	-	-
Zinc	19,250	-
Non-BDAT List Metals		
Iron	-	-

Note: Design and operating parameters are as follows:

Parameter	Design value	Operating value
Alkaline chlorination reactor pH	12.5-13.0	12.8
Retention time for alkaline chlorination	2-6 hr minimum[b]	12 hr
ORP for alkaline chlorination	>200 mV	400 mV

- = Not analyzed.

[a]Batch consisted of a mixture of F009 (zinc plating waste) and a waste hypochlorite solution.

[b]Actual retention time is based on a "not detected" result for the analysis of the waste for amenable cyanide.

Source: USEPA (1989).

Table 4-6 (continued)

Sample Set No. 8[a] - for Treatment of F007

Constituent/parameter	Concentration (units) Untreated waste (mg/l)	Treated wastewater (mg/l)
BDAT Inorganics Other Than Metals		
Cyanide (amenable)	-	<1.0
Cyanide (total)	6,000	-
BDAT List Metals		
Cadmium	-	-
Chromium (total)	<100	-
Copper	1,500	-
Lead	-	-
Nickel	-	-
Zinc	580	-
Non-BDAT List Metals		
Iron	490	-

Note: Design and operating parameters are as follows:

Parameter	Design value	Operating value
Alkaline chlorination reactor pH	12.5-13.0	12.9
Retention time for alkaline chlorination	2-6 hr minimum[b]	8 hr
ORP for alkaline chlorination	>200 mV	380 mV

- = Not analyzed.

[a]Batch was F007 waste.

[b]Actual retention time is based on a "not detected" result for the analysis of the waste for amenable cyanide.

Source: USEPA (1989).

Table 4-7. Monitoring and Verification Sampling of a Chrome Pigments Plant

Verification Sampling:*

Pollutant	Influent mg/l	Influent kg/kkg	Effluent mg/l	Effluent kg/kkg
Total Suspended Solids, TSS	780	78	3.9	0.39
Chromium, CR	78	7.8	0.32	0.032
Chromium VI, Cr^{+6}	<0.01	<0.001	<0.03	<0.003
Iron, FE	49	4.9	0.30	0.03
Lead, Pb	15.2	1.52	0.11	0.011
Zinc, Zn	4.2	0.42	0.058	0.0058
Cyanide, CN	5.1	0.51	<0.066	<0.0066
Cyanide (Free)	<0.94	<0.094	<0.011	<0.0011
Antimony, Sb	0.74	0.074	0.30	0.030
Cadmium, Cd	0.90	0.090	0.0084	0.00084
Copper, Cu	3.56	0.36	0.04	0.004
Nickel, Ni	0.017	0.0017	<0.024	<0.0024

Monitoring Data - Treated Effluent

	Avg Concentration (mg/l)	30 day Avg Concentration (mg/l)	Waste Load (Avg) (kg/kkg)
Total Suspended Solids, TSS	11.2	23.5	1.92
Chromium VI, Cr^{+6}	0.11	0.3	0.018
Chromium, Cr	0.44	0.73	0.074
Copper, Cu	0.13	0.25	0.023
Lead, Pb	0.41	0.87	0.069
Zinc, Zn	0.044	0.075	0.0072
Cyanide (Free), CN	<0.012	0.044	0.0019
Cyanide (Total), CN	0.12	0.31	0.019
Arsenic	0.08	0.16	0.0125
Cadmium	0.08	0.12	0.013
Mercury	<0.001	0.0017	0.00007

*The average flow from the facility is 153 m^3/kkg.

Source: USEPA (1982).

5. DETERMINATION OF BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT)

This section presents the Agency's rationale for determining best demonstrated available technology (BDAT) for K002, K003, K004, K005, K006, K007, and K008 nonwastewaters and wastewaters. EPA notes, however, that this applies only to wastes from current management, and not to materials such as leachate, contaminated environmental media, or other residues derived from historic management of these wastes.

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.

Chemical reduction of chromates, followed by chemical precipitation and stabilization of the precipitated solids has been determined to be the most viable treatment method for K006 nonwastewaters. The waste does not contain significant levels of lead or zinc, which could be recovered, and the levels of chromium present are far too low to make the material useful either as recycled material or as a feedstock to a process using chrome ore.

Chemical reduction of chromates followed by chemical precipitation and stabilization of the precipitated solids has been determined to be the most viable treatment technology for K002 and K003 nonwastewaters. Such wastes will contain relatively low levels of lead and will also contain high levels of calcium, making them undesirable for high-temperature treatment processes that might recover the lead.

Presently, there are two plants that generate K002/K003 nonwastewaters. The one facility that sends its lead-rich waste to a smelter does not use chromate reduction as part of its wastewater treatment train. As a result, this waste contains lead chromate. Tables 4-1 and 4-2 show that this waste, when stabilized with alkaline materials, sometimes shows unacceptable chromium levels in TCLP leachates. The waste generated by the second facility is the result of a treatment process that reduces all hexavalent chromium compounds to trivalent chromium hydroxide. The waste from this second facility should behave like the sludges from K062 treatment, i.e., wastes from wastewater treatments that included chromium reduction. Such K062 sludges, when stabilized, showed TCLP leachate levels for chromium and lead well below characteristic levels, as is evidenced by data presented in the K062 Background Document (USEPA 1988f).

Also, stabilization has been determined by the Agency to be BDAT for the waste K046, wastewater treatment sludge from the production of lead-based initiating compounds, which contains high levels of lead (USEPA 1988e).

The wastes K002, K003, K004, K005, K006, K007, and K008 are expected to contain chromium as a hazardous constituent. Some of the wastes, for example, K002, K003, and K005, will also contain lead. As a result, chemical treatment for chromate reduction followed by stabilization of the solids generated should also be applicable to these wastes.

Nonwastewater forms of K005 and K007 are expected to contain complex cyanides based on the data in Table 2-6. However, the two pigments, chrome green and iron blue, whose production results in the generation of these wastes, are no longer believed to be produced in the United States. As a result, the Agency does not have cyanide treatment data on K005 or K007 nonwastewaters. The Agency does, however, have data on several proven treatment technologies for the oxidation of free cyanide. Data for treatment of cyanide and metal-containing wastes are shown in Table 4-6. The Agency believes that alkaline chlorination technology may be applicable to K005 and K007 wastes because total cyanides are present in K005 and K007 wastes at concentrations comparable to those observed in wastes shown in Table 4-6. The Agency realizes that complex iron cyanides are more difficult to treat than other cyanide complexes present in these nonwastewaters and is, therefore, studying this issue further. K005 and K007 nonwastewaters also contain hexavalent chromium compounds. Reduction of hexavalent chromium to trivalent form and subsequent precipitation of the trivalent chromium with lime are part of the overall treatment process for K062 wastes.

Treatment of wastewater forms of K002, K003, K004, K005, K006, K007, and K008 by chemical treatment and precipitation for metals and biological treatment or chemical oxidation for cyanides will convert wastewater forms of these wastes into nonwastewater forms. These residuals are expected to be of highly variable composition. The facility from which the effluent guidelines data shown in Table 4-7 were derived used a treatment system that first removed the metals and then biologically oxidized dissolved cyanides.

6. SELECTION OF REGULATED CONSTITUENTS

6.1 Selection of Regulated Constituents for Nonwastewaters

The constituents of concern in nonwastewater forms of K002 and K003 are lead and chromium. In Section 2.2, data on composition of these waste streams indicate that lead and chromium are the only BDAT list constituents present at significant levels. Additional data, also in Section 2.2, show that chromium is the only BDAT list constituent present at treatable levels in nonwastewater forms of K004 and K006.

Data available from the original listing documents for the wastes K005, K007, and K008, which are not currently generated, indicate that chromium and cyanide are the constituents of concern in K005. Cyanide is the only constituent of concern in K007, and chromium is the sole constituent of concern in K008.

As was discussed earlier in Sections 2.2 and 2.3, many plants produce more than one of the inorganic pigments and use or have used common wastewater treatment systems for management of wastewaters from these production operations. As a result, many of the nonwastewater forms of the wastes K002, K003, K004, K005, K006 (from anhydrous chrome oxide green production), K007, and K008 would be mixtures of these wastes. For this reason, the Agency is proposing that the constituents of concern for these wastes are chromium and lead. The Agency is not proposing cyanides as a regulated constituent for K005 and K007 nonwastewaters at this time. Complex iron cyanides, which are present in these wastes, are more difficult to treat than simple oxides, and further study of this issue is needed. The Agency is reserving the right to modify treatment standards to include cyanide treatments for K005 and K007 at a future date.

For K006 generated from the production of hydrated chrome oxide green, only chromium is proposed as the constituent of concern. The sole production facility for this pigment has only produced this one pigment in its history of operation and does not mix this production waste with the wastes from the manufacture of other pigments. Therefore, for this nonwastewater, chromium is the only constituent of concern.

6.2 Selection of Regulated Constituents for Wastewaters

In Sections 2 and 3 of this background document, the nature of the wastewater forms of K002, K003, K004, K005, K006, K007, and K008 were discussed. These wastewaters arise basically from two sources: leachates from landfills containing these wastes, and wastewaters arising from the treatment of one or more of these wastes as generated nonwastewaters. These wastewaters have the potential, as a result, to contain all of the constituents of concern present in the nonwastewater forms of K002, K003, K004, K005, K006, K007, and K008. For this reason, the Agency is regulating lead and chromium in these wastewaters, as it did for the nonwastewaters. In addition, the Agency is regulating cyanide in K005 and K007 wastewater because it is being regulated as part of the effluent limitations guidelines for the chrome pigments subcategory of the inorganic chemicals industry (USEPA 1982)

7. CALCULATION OF BDAT TREATMENT STANDARDS

The Agency is establishing a treatment standard based on chemical treatment and subsequent stabilization in the nonwastewater forms of K002, K003, K004, K005, K006 (from anhydrous chrome oxide green production), K007, and K008. EPA is transferring standards from the listed waste K062 nonwastewaters, which contain similar concentrations of lead and chromium. The specific treatment technologies involved are chromate reduction and lime and/or sulfide precipitation. The Agency is presently not promulgating treatment standards for complex cyanides in K005 and K007 nonwastewaters because problems in the treatment of complex iron cyanides need further study. The Agency reserves the right to modify the treatment standards for K005 and K007 nonwastewaters in the future to include cyanide treatment standards. The BDAT treatment standards for K002, K003, K004, K005, K006 (from anhydrous chrome oxide green), K007, and K008 nonwastewaters are as in Table 7-1.

In the case of K006 generated from the production of hydrated chrome oxide green pigment, the Agency is proposing a standard based on stabilization and transferred from the use of this technology with the listed waste F006. This waste will contain boron compounds which could render it more difficult to stabilize. However, data supplied by the facility (see Table 4-3) indicate that such a standard can be met. The BDAT treatment standards for K006 from production of hydrated chrome oxide green are shown in Table 7-2.

For the wastewater forms of K002, K003, K004, K005, K006, K007, and K008, the Agency is transferring the treatment standards directly from the Effluent Guidelines Limitations for the chrome pigments subcategory of the Inorganic Chemical Industry (USEPA 1982), because wastewater forms of these wastes should closely resemble the wastewaters generated by the inorganic pigments industry. The treatment standards for K002, K003, K004, K006, and K008 wastewaters are listed in Table 7-3. Table 7-4 shows the treatment standards for K005 and K007 wastewaters.

Table 7-1 BDAT Treatment Standards for K002, K003, K004, K005, K006 (Anhydrous Chrome Oxide Green Subcategory), K007, and K008 Nonwastewaters

Constituent	TCLP concentration (mg/l)
Chromium (total)	0.094
Lead (total)	0.37

Table 7-2. BDAT Treatment Standards for K006 (Generated from the Production of Chrome Oxide Green) Nonwastewaters

Constituent	TCLP concentration (mg/l)
Chromium (total)	3.2

Table 7-3. Treatment Standards for K002, K003, K004, K006 (for Production of Both Anhydrous and Hydrated Chrome Oxide Green) and K008 Wastewaters

Constituent	Wastewater concentration (mg/l)	
	30-day average	24-hour maximum
Lead (total)	1.2	2.9
Chromium (total)	1.4	3.4

Table 7-4. Treatment Standards for K005 and K007 Wastewaters

Regulated Constituent	Total concentration (mg/l)	
	30-day average	24-hour maximum
Chromium (total)	1.2	2.9
Lead (total)	0.31	0.74

8. REFERENCES

APHA, AWWA, and WPCF. 1985. American Public Health Association, American Water Works Association, and Water Pollution Control Federation. Standard methods for the examination of water and wastewater. 16th ed. Washington, D.C.: American Public Health Association.

Engelhard Corporation. 1989. Letter submission of data to USEPA, Englehard Corporation, Menlo Park, New Jersey.

Pfizer Materials Science Products. 1989. Letter submission of data to USEPA, Pfizer Materials Science Products. Easton, Pennsylvania.

USEPA. 1980a. U.S. Environmental Protection Agency, Office of Solid Waste. Background document for the Resource Conservation and Recovery Act, Subtitle C--identification and listing of hazardous waste. Washington, D.C.: U.S. Environmental Protection Agency.

USEPA. 1980b. U.S. Environmental Protection Agency, Industrial Environmental Research Laboratory. Multi-media assessment of the inorganic chemicals industry, Volume II. Cincinnati, Ohio: U.S. Environmental Protection Agency.

USEPA. 1982. Development Document for Effluent Limitations Guidelines (BATEA), New Source Performance Standards and Pretreatment Standards for the Inorganic Chemicals Manufacturing Point Source Category, Washington, D.C.: U.S. Environmental Protection Agency.

USEPA. 1987. U.S. Environmental Protection Agency, Office of Solid Waste. Onsite engineering report of stabilization of wastewater treatment sludge from the production of inorganic pigments. Washington, D.C.: U.S. Environmental Protection Agency.

USEPA. 1988a. U.S. Environmental Protection Agency, Office of Solid Waste. Best demonstrated available technology (BDAT) background document for F006. Washington, D.C.: U.S. Environmental Protection Agency.

USEPA. 1988b. U.S. Environmental Protection Agency, Office of Solid Waste. Generic quality assurance project plan for the Land Disposal Restrictions Program ("BDAT"). Washington, D.C.: U.S. Environmental Protection Agency.

USEPA. 1988c. U.S. Environmental Protection Agency, Office of Solid Waste. Methodology for developing BDAT treatment standards. Washington, D.C.: U.S. Environmental Protection Agency.

USEPA. 1988d. U.S. Environmental Protection Agency, Office of Solid Waste. Treatment technology background document. Washington, D.C.: U.S. Environmental Protection Agency.

USEPA. 1988e. U.S. Environmental Protection Agency, Office of Solid Waste. Best Demonstrated Available Technology (BDAT) background document for K046. Washington, D.C.: U.S. Environmental Protection Agency.

USEPA. 1988f. U.S. Environmental Protection Agency, Office of Solid Waste. Best Demonstrated Available Technology (BDAT) background document for K062. Washington, D.C.: U.S. Environmental Protection Agency.

USEPA. 1989. U.S. Environmental Protection Agency, Office of Solid Waste. Best Demonstrated Available Technology (BDAT) background document for F007. Washington, D.C.: U.S. Environmental Protection Agency.