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PROPOSED

BEST DEMONSTRATED AND AVAILABLE TECHNOLOGY (BDAT)

BACKGROUND DOCUMENT FOR

F024

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1.0 INTRODUCTION

In accordance with the amendments to the Resource Conservation and Recovery Act (RCRA) enacted in the Hazardous and Solid Waste Amendments (HSWA) of November 8, 1984, the Environmental Protection Agency (EPA) is proposing to establish best demonstrated available technology (BDAT) treatment standards for the listed waste identified in 40 CFR 261.31 as F024, certain wastes from the production of chlorinated aliphatic hydrocarbons. Compliance with these BDAT treatment standards is a prerequisite for placement of the waste in units designated as land disposal units according to 40 CFR Part 268. The BDAT treatment standards will be effective as of June 8, 1989.

This background document provides the Agency's rationale and technical support for selecting the proposed constituents to be regulated in F024 and for developing proposed treatment standards for these constituents. The document also provides waste characterization information that serves as a basis for determining whether variances from a treatment standard may be warranted for a particular F024 waste that has characteristics such that the particular waste is more difficult to treat than the wastes that were analyzed in developing treatment standards for F024.

The Agency's legal authority and promulgated methodology for establishing treatment standards and the petition process necessary for requesting a variance from the treatment standards is summarized in EPA's Methodology for Developing BDAT Treatment Standards.

This background document presents waste-specific information on the number and locations of facilities affected by the land disposal restrictions for F024; the processes generating the waste; waste characterization data; the technologies used to treat the waste (or similar wastes, if any); and treatment performance data on which the proposed treatment standards are based. This document also explains EPA's determination of BDAT, selection of constituents to be regulated, and calculation of proposed treatment standards.

Under 40 CFR 261.31, wastes identified as F024 are listed as follows:

> F024 - Wastes, including but not limited to, distillation residues, heavy ends, tars, and reactor clean-out wastes from the production of chlorinated aliphatic hydrocarbons, having carbon content from one to five, utilizing free radical catalyzed processes. (This listing does not include light ends, spent filters and filter aids, spent dessicants, wastewater, wastewater treatment sludges, spent catalysts, and wastes listed in 40 CFR 261.32.)

The Agency estimates that there are 29 facilities that generate F024.

The Agency is proposing to regulate 10 organic constituents, 2 metal constituents, and 5 dioxins and furans in both F024 nonwastewater and F024 wastewater. Due to the wide variation in the types of F024 generated by industry, a large number of constituents were selected for proposed regulation to ensure that the different hazardous constituents which may be present in F024 are controlled. For the purpose of determining the applicability of the proposed treatment standards, wastewaters are wastes containing less than 1%

(weight basis) total suspended solids* and less than 1% (weight basis) total organic carbon (TOC). Wastes not meeting this definition are classified as nonwastewaters.

The proposed BDAT treatment standards for organic constituents in both nonwastewater and wastewater forms of F024 are based on treatment performance data from rotary kiln incineration of F024.

The proposed BDAT treatment standards for two metal constituents in F024 nonwastewater, chromium and nickel, are based on a transfer of treatment performance data from stabilization of ash from the incineration of K048 and K051. The Agency is currently performing BDAT testing using stabilization to treat F024 incinerator ash. Depending on the results of this testing and the levels of treatment performance achieved, the Agency may establish a treatment standard for lead in F024 nonwastewater and may modify the nonwastewater standards for chromium and nickel. The proposed BDAT treatment standards for metal constituents in F024 wastewater are based on a transfer of treatment

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*The term "total suspended solids" (TSS) clarifies EPA's previously used terminology of "total solids" and "filterable solids." Specifically, total suspended solids is measured by Method 209C (total suspended solids dried at 103-105°C) in Standard Methods for the Examination of Water and Wastewater, American Public Health Association, American Water Works Association, and Water Pollution Control Federation, Sixteenth Edition (Reference 36).

performance data from treatment of K062 mixed with metal-bearing characteristic wastes by chemical precipitation followed by vacuum filtration.

The proposed BDAT treatment standards for dioxin and furan constituents in both nonwastewater and wastewater forms of F024 are set at the analytical limit of detection that can be routinely achieved for these constituents, consistent with the dioxins rule promulgated by the Agency on November 8, 1986 (51 Federal Register, 40572, 40638).

The following tables list the specific proposed BDAT treatment standards for F024. The treatment standards reflect the total concentration of each organic, dioxin and furan constituent being proposed for regulation in F024 nonwastewater and the total concentration of each organic, metal, dioxin and furan constituent being proposed for regulation in F024 wastewater. The treatment standards for metal constituents in nonwastewater are based on analysis of leachate obtained by use of the Toxicity Characteristic Leaching Procedure (TCLP) found in Appendix I of 40 CFR Part 268. The units for total constituent concentration are in mg/kg (parts per million on a weight-by-weight basis) for nonwastewater and in mg/l (parts per million on a weight-by-volume basis) for wastewater. The units for leachate analysis are in mg/l (parts per million on a weight-by-volume basis). If the concentrations of the proposed regulated constituents in F024, as generated, are lower than or equal to the proposed treatment standards, then treatment of F024 is not required prior to land disposal.

PROPOSED BDAT TREATMENT STANDARDS FOR F024
NONWASTEWATER

Maximum for Any Single Grab Sample

BDAT List Constituent		Total Composition (mg/kg)
10.	2-Chloro-1,3-butadiene	0.014
16.	3-Chloropropene	0.014
22.	1,1-Dichloroethane	0.014
23.	1,2-Dichloroethane	0.014
26.	1,2-Dichloropropane	0.014
27.	trans-1,3-Dichloropropene	0.014
28.	cis-1,3-Dichloropropene	0.014
70.	Bis(2-ethylhexyl)phthalate	1.8
104.	Di-n-octyl phthalate	1.8
113.	Hexachloroethane	1.8
207.	Hexachlorodibenzo-p-dioxins	0.001
208.	Hexachlorodibenzofurans	0.001
209.	Pentachlorodibenzo-p-dioxins	0.001
210.	Pentachlorodibenzofurans	0.001
212.	Tetrachlorodibenzofurans	0.001
		TCLP Leachate Concentration (mg/l)
159.	Chromium (total)	1.7
163.	Nickel	0.048

PROPOSED BDAT TREATMENT STANDARDS FOR F024
WASTEWATER

Maximum for Any Single Grab Sample

BDAT List Constituent		Total Composition (mg/l)
10.	2-Chloro-1,3-butadiene	0.28
16.	3-Chloropropene	0.28
22.	1,1-Dichloroethane	0.014
23.	1,2-Dichloroethane	0.014
26.	1,2-Dichloropropane	0.014
27.	trans-1,3-Dichloropropene	0.014
28.	cis-1,3-Dichloropropene	0.014
70.	Bis(2-ethylhexyl)phthalate	0.036
104.	Di-n-octyl phthalate	0.036
113.	Hexachloroethane	0.036
207.	Hexachlorodibenzo-p-dioxins	0.001
208.	Hexachlorodibenzofurans	0.001
209.	Pentachlorodibenzo-p-dioxins	0.001
210.	Pentachlorodibenzofurans	0.001
212.	Tetrachlorodibenzofurans	0.001
159.	Chromium (total)	0.35
163.	Nickel	0.47

2.0 INDUSTRY AFFECTED AND WASTE CHARACTERIZATION

The purpose of this section is to describe the industry affected by the proposed land disposal restrictions for F024 and to present available characterization data for this waste.

Under 40 CFR 261.31 (hazardous wastes from non-specific sources), wastes identified as F024 are listed as follows:

> Wastes, including but not limited to, distillation residues, heavy ends, tars, and reactor clean-out wastes from the production of chlorinated aliphatic hydrocarbons, having carbon content from one to five, utilizing free radical catalyzed processes. (This listing does not include light ends, spent filters and filter aids, spent dessicants, wastewater, wastewater treatment sludges, spent catalysts, and wastes listed in 40 CFR 261.32.)

2.1 Industry Affected and Process Description

By definition in 40 CFR 261.31, F024 is waste specifically generated from the production of C_1-C_5 aliphatic hydrocarbons by free radical catalyzed processes. The Agency estimates that there are 29 domestic facilities that may generate F024. Table 2-1 lists the number of facilities by state, while Table 2-2 lists the number of facilities by EPA region. These facilities were identified using both the 1987 Stanford Research Institute Directory of Chemical Producers for major C_1-C_5 chlorinated aliphatic hydrocarbons as well as plant reports prepared for EPA's Characterization and Assessment Division.

The chemicals used in chlorinated aliphatic hydrocarbon manufacture are chlorocarbon or hydrocarbon feedstocks and chlorine sources (Cl_2 or HCl). The majority of chlorinated aliphatic hydrocarbon manufacturing is based on five general chemical processes. They are:

(1) free radical initiated addition, substitution, and pyrolysis reactions,

(2) Lewis acid catalyzed addition and substitution reactions,

(3) oxychlorination,

(4) base catalyzed dehydrochlorination, and

(5) zinc chloride catalyzed chlorination of alcohols.

Several of these processes may be integrated within a facility to convert the feedstock into a variety of desirable products. F024 may be generated when free radical catalyzed processes are either utilized solely or combined with other reaction processes. A generalized process diagram of the production of C_1-C_5 chlorinated aliphatic hydrocarbons is presented in Figure 2-1.

As shown in Figure 2-1, an organic feedstock is fed, along with a chlorine source, into a series of chlorination reactors. Desired chemical conversions are catalyzed in the reactor by heat, a combination of heat and ultraviolet radiation, or chemicals (such as $FeCl_3$, $CuCl_2$, $ZnCl_2$, or NaOH); at least one such conversion must be catalyzed by free radicals for a generated waste to be considered F024. These reactions may be conducted in either the gas or the liquid phase. F024 is generated by these processes as reactor residues, tars, and periodic clean-out wastes.

Table 2-1

FACILITIES PRODUCING F024 BY STATE

State (EPA Region)	Number of Facilities
Alabama (IV)	1
California (IX)	1
Illinois (V)	1
Kansas (VII)	1
Kentucky (IV)	2
Louisiana (VI)	10
Maryland (III)	1
Michigan (V)	1
South Carolina (IV)	1
Tennessee (IV)	1
Texas (VI)	7
West Virginia (III)	2
Total:	29

Table 2-2

FACILITIES PRODUCING F024 BY EPA REGION

EPA Region	Number of Facilities
I	0
II	0
III	3
IV	5
V	2
VI	17
VII	1
VIII	0
IX	1
X	0
Total:	29

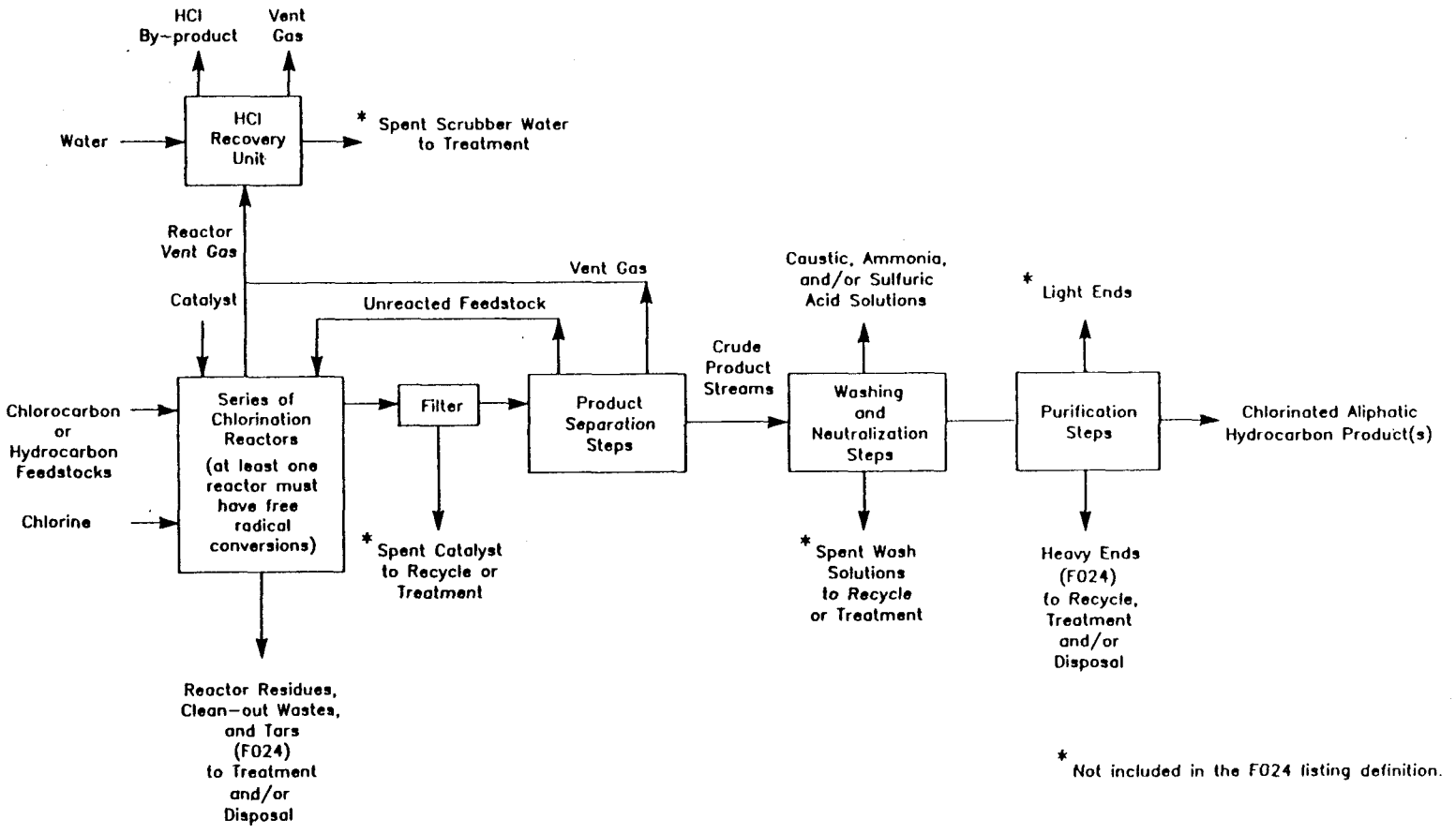

Figure 2-1. Generic Flow Diagram for Processes Generating F024 Wastes

The reaction product is then sent to a filtration unit where spent catalysts, if any, are removed for recycle or treatment. Spent catalysts are not included in the F024 listing definition.

The remaining product undergoes a separation step where it is quenched or cooled with water and/or distilled. This separates the unreacted feedstock from the crude product and helps prevent product decomposition. The unreacted feedstock is then recycled back to the reactors. Hydrochloric acid is usually a major co-product from the reactor and is typically recovered from the vent gases generated by both the reactor and the quenching/cooling step.

The crude product streams are generally put through a series of washing, neutralization, and drying steps, which aid in separating the organic phase (the product) from the aqueous phase. The spent wash solutions generated in these steps, along with the wastewater generated by HCl recovery, are then recycled or treated. A treated wastewater and various wastewater treatment sludges result. This wastewater and the wastewater treatment sludges are not included in the F024 listing definition.

Finally, the product stream goes through a series of purification and separation steps using fractional distillation and filtration techniques. The distillation residues or heavy ends resulting from these steps are included in the F024 listing definition.

2.2 Waste Characterization

Table 2-3 presents a summary of the available characterization data for F024. Data are presented for all BDAT List constituents that were detected in one or more F024 samples. The summary in Table 2-3 was compiled from data submitted by industry and data collected by EPA for a wide range of F024 waste matrices. These data include wastes generated from various C_1-C_5 manufacturing processes and include a wide range of physical forms, i.e., liquids, solids, and sludges. Specific data for 11 of the 16 facilities represented in this table have been claimed RCRA Confidential Business Information and can be found in the confidential portion of the rulemaking record for F024.

As can be seen in Table 2-3, the variability among different types of F024 is quite large. The wastes contains up to 95% organic constituents (BDAT List organics and non-BDAT List organics), less than 1% BDAT List metals and up to 10% each, oil and grease, moisture, and ash. The wide variations in both the detection limits and the analytical results are caused by the differences in the F024 waste matrices.

2.3 Determination of Waste Treatability Group

EPA bases its treatability group decisions primarily on whether wastes were generated by the same or by similar industries from similar processes. EPA believes that such groupings can be made because of the high

likelihood that the waste characteristics which affect treatment performance will be similar of these different wastes and therefore, similar levels of treatment performance can be achieved. Based on the similarities among the processes generating F024, the various types of F024 were combined in one waste treatability group.

Table 2-3

SUMMARY OF AVAILABLE CHARACTERIZATION DATA FOR F024

BDAT List Constituent	Concentration in F024 (ppm) (a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	Range (ppm)
222. Acetone	NR	NR	NR	<200	<20,000	<200	<10	4.6	21,000	<20,000	<0.05	<500	<0.05-21,000
4. Benzene	33-1,900	NR	20	<100	<10,000	<100	<5	<1	<1,000	<10,000	<0.025	<250	<0.025-1,900
5. Bromodichloromethane	7,260	NR	NR	<100	<10,000	<100	<5	<1	<1,000	<10,000	<0.025	<250	<0.025-7,260
7. Carbon tetrachloride	ND-50,400	100-1,000	NR	<100	<10,000	<100	<5	9.0	<1,000	<10,000	<0.025	<250	<0.025-50,400
9. Chlorobenzene	1.7-3,200	NR	NR	<100	<10,000	174	<5	<1	<1,000	<10,000	<0.025	<250	<0.025-3,200
10. 2-Chloro-1,3-butadiene	NR	NR	NR	5,462	<200,000	<2,000	<100	<20	139,721	<200,000	<0.5	<5,000	<0.5-139,721
14. Chloroform	ND-136	100-1,000	NR	<100	<10,000	<100	<5	<1	<1,000	<10,000	<0.025	<250	<0.025-1,000
16. 3-Chloropropene	ND	ND	ND	<2,000	<200,000	<2,000	<100	<20	<20,000	285,486	<0.5	<5,000	<0.5-285,486
20. trans-1,4-Dichloro-2-butene	NR	NR	NR	4,691	<200,000	<2,000	<100	<20	2,112	<200,000	<0.5	<5,000	<0.5-4,691
22. 1,1-Dichloroethane	1.7-440,000	NR	NR	<100	<10,000	<100	<5	<1	<1,000	<10,000	<0.025	<250	<0.025-440,000
23. 1,2-Dichloroethane	ND-950,000	10,000-500,000	NR	<100	<10,000	2,708	<5	<1	<1,000	<10,000	<0.025	11,000	<0.025-950,000
26. 1,2-Dichloropropane	54-191	NR	NR	<100	177,024	<100	<5	<1	<1,000	230,000	<0.025	<250	<0.025-230,000
27. trans-1,3-Dichloropropene	540	NR	NR	<100	260,036	<100	<5	<1	<1,000	290,000	<0.025	<250	<0.025-290,000

ND - Not detected; detection limit not available.
NR - Not reported.
(a) CBI EPA Listing Reports (References 3-8, 10, 12-14)
(b) Response to 3007 Questionnaire from plant L (Reference 9)
(c) Listing Background Document for F024, p. 34 (Reference 11)
(d) Collected by EPA at plant A (Reference 27)
(e) Collected by EPA at plant B (Reference 28)
(f) Collected by EPA at plant C (Reference 29)
(g) Collected by EPA at plant D (Reference 30)
(h) Collected by EPA at plant E (Reference 31)
(i) Plant A (Reference 32)
(j) Plant B (Reference 32)
(k) Plant C (Reference 32)
(l) Plant D (Reference 32)

Table 2-3 (Continued)

SUMMARY OF AVAILABLE CHARACTERIZATION DATA FOR F024

BDAT List Constituent	Concentration in F024 (ppm) (a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	Range (ppm)
28. cis-1,3-Dichloropropene	570	NR	NR	<100	139,760	<100	<5	<1	<1,000	160,000	<0.025	<250	<0.025-160,000
226. Ethyl benzene	1.1-230	NR	NR	<100	<10,000	<100	<5	<1	<1,000	<10,000	<0.025	<250	<0.025-230
34. Methyl ethyl ketone	ND	ND	ND	<100	<10,000	<100	<5	<1	2,200	<20,000	<0.05	<500	<0.05-2,200
38. Methylene chloride	5-1,900	NR	ND	<100	<10,000	<100	<5	<1	<1,000	<10,000	ND	<250	<1-1,900
40. 1,1,1,2-Tetrachloroethane	58,000	NR	ND	<100	<10,000	<100	<5	<1	<1,000	<10,000	<0.025	<250	<0.025-58,000
41. 1,1,2,2-Tetrachloroethane	16,000	ND	ND	<100	<10,000	<100	<5	<1	<1,000	<10,000	<0.025	<250	<0.025-16,000
42. Tetrachloroethene	1.5-47,200	1,000-10,000	ND	<100	<10,000	<100	<5	<1	<1,000	<10,000	0.330	<250	<1-47,200
43. Toluene	31-34,000	NR	ND	<100	<10,000	<100	<5	<1	<1,000	<10,000	<0.025	<250	<0.025-34,000
45. 1,1,1-Trichloroethane	1.1-620	NR	ND	<100	<10,000	<100	<5	<1	<1,000	<10,000	<0.025	<250	<0.025-620
46. 1,1,2-Trichloroethane	260-92,000	NR	ND	<100	<10,000	891	<5	<1	<1,000	<10,000	<0.025	860	<0.025-92,000
47. Trichloroethene	ND-81,800	1,000-10,000	ND	<100	<10,000	<100	<5	<1	<1,000	<10,000	<0.025	<250	<0.025-81,800
49. 1,2,3-Trichloropropane	ND	ND	ND	<100	<10,000	<100	<5	<1	<1,000	9,712	<0.025	<250	<0.025-9,712
50. Vinyl chloride	ND	100-1,000	NR	<200	<20,000	<200	<10	<2	<2,000	<20,000	<0.05	<500	<0.05-1,000
59. Benz(a)anthracene	ND	ND	ND	<200	<50	<24	<340	<900	<172	<189	0.888	ND	<24-0.888

ND - Not detected; detection limit not available.
NR - Not reported.
(a) CBI EPA Listing Reports (References 3-8, 10, 12-14)
(b) Response to 3007 Questionnaire from plant L (Reference 9)
(c) Listing Background Document for F024, p. 34 (Reference 11)
(d) Collected by EPA at plant A (Reference 27)
(e) Collected by EPA at plant B (Reference 28)
(f) Collected by EPA at plant C (Reference 29)
(g) Collected by EPA at plant D (Reference 30)
(h) Collected by EPA at plant E (Reference 31)
(i) Plant A (Reference 32)
(j) Plant B (Reference 32)
(k) Plant C (Reference 32)
(l) Plant D (Reference 32)

Table 2-3 (Continued)

SUMMARY OF AVAILABLE CHARACTERIZATION DATA FOR F024

BDAT List Constituent	Concentration in F024 (ppm) (a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	Range (ppm)
62. Benzo(a)pyrene	ND	ND	ND	<200	<50	<24	<340	<900	<172	<189	0.600	<0.351	<0.351-0.600
63. Benzo(b)fluoranthene	ND	ND	ND	<200	<50	<24	<340	<900	<172	<189	0.716	ND	<24-0.716
64. Benzo(ghi)perylene	ND	ND	ND	<200	<50	<24	<340	<900	<172	<189	0.421	<0.351	<0.351-0.421
65. Benzo(k)fluoranthene	ND	ND	ND	<200	<50	<24	<340	<900	<172	<189	0.874	ND	<24-0.874
68. Bis(2-chloroethyl)ether	ND-9,800	NR	NR	<200	<50	64	<340	<900	<172	<189	<0.351	32.4	<0.351-9,800
70. Bis(2-ethylhexyl)phthalate	7.9-480	NR	NR	<200	<50	<24	5.9	<900	<172	<189	7.63	ND	<24-480
77. 2-Chloronaphthalene	ND-260	NR	NR	<200	<50	<24	<340	<900	<172	<189	<0.351	ND	<0.351-260
80. Chrysene	ND	ND	ND	<200	<50	<24	<340	<900	<172	<189	1.06	0.407	<24-1.06
86. 1,3-Dichlorobenzene	ND-1,300	NR	NR	<200	<50	<24	<340	<900	<172	<189	<0.351	<0.351	<0.351-1,300
87. 1,2-Dichlorobenzene	ND-24,000	NR	NR	<200	<50	<24	<340	<900	<172	<189	<0.351	<0.351	<0.351-24,000
88. 1,4-Dichlorobenzene	ND-8,000	NR	NR	<200	<50	<24	<340	<900	<172	<189	<0.351	2.08	<0.351-8,000

ND - Not detected; detection limit not available.
NR - Not reported.
(a) CBI EPA Listing Reports (References 3-8, 10, 12-14)
(b) Response to 3007 Questionnaire from plant L (Reference 9)
(c) Listing Background Document for F024, p. 34 (Reference 11)
(d) Collected by EPA at plant A (Reference 27)
(e) Collected by EPA at plant B (Reference 28)
(f) Collected by EPA at plant C (Reference 29)
(g) Collected by EPA at plant D (Reference 30)
(h) Collected by EPA at plant E (Reference 31)
(i) Plant A (Reference 32)
(j) Plant B (Reference 32)
(k) Plant C (Reference 32)
(l) Plant D (Reference 32)

Table 2-3 (Continued)

SUMMARY OF AVAILABLE CHARACTERIZATION DATA FOR F024

BDAT List Constituent	Concentration in F024 (ppm) (a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	Range (ppm)
92. Diethyl phthalate	1.2-120	NR	NR	<200	<50	<24	<340	<900	<172	<189	ND	<0.351	<0.351-120
104. Di-n-octyl phthalate	34	NR	NR	<200	<50	<24	5.5	<900	<172	<189	ND	<0.351	<0.351-34
110. Hexachloro-benzene	ND-3,198	NR	NR	<200	<50	<24	4.7	18,018	<172	<189	2.06	0.628	<24-18,018
111. Hexachloro-butadiene	ND-4,074	100-1,000	NR	<200	<50	<24	<340	16,470	<172	<189	<172	<0.351	<0.351-16,470
112. Hexachloro-cyclopentadiene	1.3	NR	NR	<200	<50	<24	<340	<900	<172	<189	<0.351	<0.351	<0.351-1.3
113. Hexachloroethane	ND-460,000	1,000-10,000	NR	<200	<50	<24	<340	<900	<172	<189	0.442	<0.351	<0.351-460,000
116. Indeno(1,2,3-cd) pyrene	ND	ND	ND	<200	<50	<24	<340	<900	<172	<189	0.411	<0.351	<0.351-0.411
121. Naphthalene	3.4-330	NR	NR	<200	<50	<24	<340	<900	<172	<189	ND	ND	<24-330
126. Nitrobenzene	1.4	NR	NR	<200	<50	<24	<340	<900	<172	<189	<0.351	<0.351	<0.351-1.4
136. Pentachloro-benzene	500	NR	NR	ND	ND	ND	0.53	1,290	<860	<945	<1.76	<1.76	<1.76-1,290
137. Pentachloroethane	ND-26,000	100-1,000	NR	ND	ND	ND	ND	ND	<172	<189	<0.351	<0.351	<0.351-26,000
141. Phenanthrene	ND	ND	ND	<200	<50	<24	<340	<900	<172	<189	1.27	0.892	<24-1.27
150. 1,2,4-Trichloro-benzene	160-1,400	NR	NR	<200	<50	<24	<340	<900	<172	<189	<0.351	ND	<0.351-1,400
154. Antimony	NR	NR	NR	<1.8	<1.8	<2.1	2.2	<2.1	<2.9	<2.9	<2.9	<2.9	<1.8-2.2
155. Arsenic	NR	NR	NR	<0.86	<0.86	7.8	<1.0	<1.0	<1.0	<1.0	<1.0	2	<0.86-7.8

ND - Not detected; detection limit not available.
NR - Not reported.
(a) CBI EPA Listing Reports (References 3-8, 10, 12-14)
(b) Response to 3007 Questionnaire from plant L (Reference 9)
(c) Listing Background Document for F024, p. 34 (Reference 11)
(d) Collected by EPA at plant A (Reference 27)
(e) Collected by EPA at plant B (Reference 28)
(f) Collected by EPA at plant C (Reference 29)
(g) Collected by EPA at plant D (Reference 30)
(h) Collected by EPA at plant E (Reference 31)
(i) Plant A (Reference 32)
(j) Plant B (Reference 32)
(k) Plant C (Reference 32)
(l) Plant D (Reference 32)

Table 2-3 (Continued)

SUMMARY OF AVAILABLE CHARACTERIZATION DATA FOR F024

BDAT List Constituent	Concentration in F024 (ppm) (a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	Range (ppm)
156. Barium	NR	NR	NR	0.3	0.22	26	1.4	0.26	0.27	0.30	34	6.8	0.22-34
158. Cadmium	NR	NR	NR	<0.26	<0.26	<0.3	<0.3	<0.3	<0.4	<0.4	3.1	<0.4	<0.26-3.1
159. Chromium (total)	NR	NR	NR	<0.43	<0.46	88	3.5	2.8	<0.4	<0.4	285	57	<0.4-285
160. Copper	108-110	NR	NR	4.9	2.2	638	406	1	<0.4	<0.4	45	800	<0.4-800
161. Lead	<50-5	NR	NR	1.36	<0.43	3.6	2.5	<1.0	<0.5	<0.5	9.0	3.8	<0.43-9.0
162. Mercury	NR	NR	NR	0.24	<0.1	0.13	<0.1	<0.1	<0.1	<0.1	0.19	<0.1	<0.1-0.24
163. Nickel	240	NR	NR	<2.2	<2.2	256	71	8	<0.9	<0.9	318	636	<0.9-636
167. Vanadium	NR	NR	NR	<0.17	<0.17	10	<0.2	<0.2	<0.3	<0.3	1	1.3	<0.17-10
168. Zinc	7.9-90	NR	NR	0.74	1.9	104	15	0.82	1.6	0.73	443	92	0.73-443
169. Cyanide	NR	NR	NR	<0.50	<0.51	4.57	<0.52	NR	<0.43	<0.44	<0.49	2.92	<0.43-4.57
170. Fluoride	NR	NR	NR	NR	NR	NR	NR	NR	<0.99	<1.00	1.08	10.5	<0.99-10.5
171. Sulfide	NR	NR	NR	153	349	<6.4	<5.1	NR	9.1	7.8	<4.8	<4.6	<4.6-349
	Concentration in F024 (ppb)												Range (ppb)
207. Hexachloro-dibenzo-p-dioxins	NR	NR	NR	NR	NR	NR	NR	NR	<0.0014	<0.0005	10.4	2.2	<0.005-10.4
208. Hexachlorodibenzo-furans	NR	NR	NR	NR	NR	NR	NR	NR	<0.0007	<0.0003	3.1	50.5	<0.0003-50.5
209. Pentachlorodibenzo-p-dioxins	NR	NR	NR	NR	NR	NR	NR	NR	<0.0014	<0.0005	2.3	0.31	<0.0005-2.3
210. Pentachlorodibenzo-furans	NR	NR	NR	NR	NR	NR	NR	NR	<0.0005	<0.0002	1.6	28.7	<0.0002-28.7
212. Tetrachlorodibenzo-furans	NR	NR	NR	NR	NR	NR	NR	NR	<0.0002	<0.0002	0.63	12	<0.0002-12

NR - Not reported.

(a) CBI EPA Listing Reports (References 3-8, 10, 12-14)
(b) Response to 3007 Questionnaire from plant L (Reference 9)
(c) Listing Background Document for F024, p. 34 (Reference 11)
(d) Collected by EPA at plant A (Reference 27)
(e) Collected by EPA at plant B (Reference 28)
(f) Collected by EPA at plant C (Reference 29)
(g) Collected by EPA at plant D (Reference 30)
(h) Collected by EPA at plant E (Reference 31)
(i) Plant A (Reference 32)
(j) Plant B (Reference 32)
(k) Plant C (Reference 32)
(l) Plant D (Reference 32)

3.0 APPLICABLE AND DEMONSTRATED TREATMENT TECHNOLOGIES

This section identifies the treatment technologies that are applicable to F024 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 theoretically be usable to treat the waste in question or to treat a waste that is similar in terms of 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.) To be demonstrated, the technology must be employed in full-scale operation for treatment of the waste in question or a similar waste. Technologies available only at pilot- and bench-scale operations are not considered in identifying demonstrated technologies.

3.1 Applicable Treatment Technologies

Since F024 contains high concentrations of organic compounds (as shown in Section 2.0), applicable treatment technologies include those that recover, destroy, or reduce the total amount of various organic compounds in the waste. The Agency has identified the following treatment technologies as applicable for F024: incineration (fluidized bed, rotary kiln, and liquid injection) followed by stabilization of incinerator ash and chemical precipitation followed by sludge filtration of scrubber water; solvent extraction

followed by incineration or recycle of the extract and stabilization and/or chemical precipitation followed by sludge filtration of the raffinate; and total recycle or reuse. These treatment technologies were identified based on current literature sources, field testing, and current waste treatment practices.

Incineration is a destruction technology in which energy, in the form of heat, is transferred to the waste to destabilize chemical bonds and eventually destroy hazardous constituents. In general, two residuals are generated by incineration processes: ash and scrubber water. Incinerator ash may require stabilization to reduce the leachability of metals in the waste. Scrubber water may require treatment using chemical precipitation followed by sludge filtration to remove dissolved metals from the wastewater.

Solvent extraction is a separation technology in which organics are removed from the waste due to greater constituent solubility in the solvent phase than in the waste phase. This technology results in the formation of two treatment residuals: the treated waste residual and the extract. The treated waste residual may be further treated by stabilization and/or chemical precipitation followed by sludge filtration. The extract may be recycled or treated further by incineration.

Total recycle or reuse processes are processes that do not generate a residual. The applicability of these processes is dependent on the type of

F024 generated. For example, heavy ends or distillation bottoms are recycled in other production processes at some facilities; however, reactor cleanout wastes are generally not suitable for recycle or reuse.

The Agency recognizes that wastewater forms of F024 may also be generated from the treatment of this waste. Since wastewater forms of F024 may contain hazardous organic constituents at treatable levels, applicable technologies include those that destroy or reduce the total amount of various organic compounds in the waste. Therefore, the Agency has identified the following treatment technologies as potentially applicable for treatment of wastewater forms of F024 with treatable organic constituent concentrations: biological treatment and carbon adsorption.

3.2 Demonstrated Treatment Technologies

The demonstrated technologies that the Agency has identified for treatment of F024 nonwastewater other than ash are total recycle or reuse, stabilization, and incineration (including rotary kiln, liquid injection, and fluidized bed incineration). The Agency is not aware of any facilities that treat, on a full-scale operational basis, F024 or wastes judged to be similar using solvent extraction; therefore, EPA believes that solvent extraction is not currently demonstrated for F024.

The Agency has identified chemical precipitation followed by sludge filtration as demonstrated for treatment of metals in F024 wastewater. Although the Agency is not aware of any facilities that treat wastewater forms

of F024, chemical precipitation followed by sludge filtration is demonstrated for wastewaters judged to be similar to scrubber water generated from the incineration of F024. Therefore, this technology is also demonstrated for F024 wastewater.

Total Recycle or Reuse. EPA is aware of four plants that recycle or reuse F024 on a full-scale basis in manufacturing processes. Specific information regarding the recycle or reuse of these wastes has been claimed confidential business information by the facilities.

Incineration. Incineration provides for destruction of the organics in the waste. Incineration generally results in the formation of two treatment residuals: ash and scrubber water. Rotary kiln incineration is demonstrated on a full-scale operational basis for treatment of F024 at five facilities. Liquid injection incineration is demonstrated on a full-scale operational basis for treatment of F024 at four facilities. In addition, fluidized bed incineration is demonstrated on a full-scale basis for treatment of F024 at one facility.

The treatment process that the Agency tested was a rotary kiln incinerator with a secondary combustor and combustion gas scrubber system.

Stabilization. Stabilization reduces the leachability of metals in the waste. This technology results in the formation of a chemically- or physically-stabilized treatment residual. The Agency evaluated the

performance of a pilot-scale stabilization process on incinerator ash similar to rotary kiln incinerator ash from treatment of F024 as shown in Section 4.0 of this document.

Chemical Precipitation followed by Sludge Filtration. Chemical precipitation removes dissolved metals from the wastewater by forming an insoluble metal precipitate sludge. Sludge filtration separates the precipitated sludge from the wastewater. The Agency tested chemical precipitation followed by sludge filtration for a waste mixture similar to F024 at one facility, as shown in Section 4.0 of this document.

4.0 TREATMENT PERFORMANCE DATA BASE

This section presents the data available to EPA on the performance of demonstrated technologies in treating the listed waste F024. These data are used elsewhere in this document for determining which technologies represent proposed BDAT (Section 5.0), for selecting constituents being proposed for regulation (Section 6.0), and for developing proposed treatment standards (Section 7.0). In addition to using full-scale treatment performance data, eligible data may include that developed at research facilities or obtained at less than full-scale operations, provided that the technology is demonstrated in full-scale operation for a similar waste or wastes as described in Section 3.0.

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

Where data are not available on the treatment of the specific waste of concern, the Agency may elect to transfer performance data on the treatment of a similar waste or wastes, using a demonstrated technology. To transfer data from another waste treatability group, EPA must find that the waste covered by this background document is no more difficult to treat (based on

the waste characteristics that affect performance of the demonstrated treatment technology) than the treated wastes from which treatment performance data are being transferred.

Treatment performance data were not available for BDAT List metals in F024 nonwastewater and wastewater. Treatment performance data from stabilization of ash from the incineration of K048 and K051 were transferred to F024 nonwastewater. Treatment performance data from lime and sulfide precipitation followed by vacuum filtration of K062 mixed with metal-bearing characteristic wastes were transferred to F024 wastewater.

Table 4-1 presents the BDAT List constituents that were detected in the untreated waste streams during the rotary kiln incineration of F024 from plants A, B, C, and D, as well as a biological sludge and an organic liquid that were burned with the F024. Table 4-2 presents the BDAT List constituents detected in the kiln ash residual and Table 4-3 presents the BDAT List constituents detected in the scrubber water residual. Table 4-4 presents design and operating data for the rotary kiln and the secondary combustor. Table 4-5 presents treatment performance data and operating data for stabilization of ash from fluidized bed incineration of K048 and K051. Table 4-6 presents treatment performance data for lime and sulfide precipitation followed by vacuum filtration of K062 mixed with other metal-bearing characteristic wastes. Testing procedures used to analyze the BDAT List constituents are identified in the analytical quality assurance/quality control discussion in Appendix A of this background document.

Table 4-1

WASTE CHARACTERIZATION DATA COLLECTED BY EPA FOR F024 FROM PLANTS* A, B, C, AND D AND OTHER WASTES TREATED BY ROTARY KILN INCINERATION

BDAT List Constituent		Concentration in Untreated Wastes** Fed to the Rotary Kiln			Concentration in Untreated Wastes** Fed to the Secondary Combustor		
		Plant C (ppm)	Plant D (ppm)	Sludge (ppm)	Plant A (ppm)	Plant B (ppm)	Organic Liquid (ppm)
222.	Acetone	<0.05	<500	<500	21,000	<20,000	<2,000
10.	2-Chloro-1,3-butadiene	<0.5	<5,000	<5,000	139,721	<200,000	<20,000
14.	Chloroform	<0.025	<250	<250	<1,000	<10,000	<1,000
16.	3-Chloropropene	<0.5	<5,000	<5,000	<20,000	285,486	<20,000
20.	trans-1,4-Dichloro-2-butene	<0.5	<5,000	<5,000	2,112	<200,000	<20,000
23.	1,2-Dichloroethane	<0.25	11,000	<250	<1,000	<10,000	26,068
26.	1,2-Dichloropropane	<0.025	<250	<250	<1,000	230,000	<1,000
27.	trans-1,3-Dichloropropene	<0.025	<250	<250	<1,000	290,000	<1,000
28.	cis-1,3-Dichloropropene	<0.025	<250	<250	<1,000	160,000	<1,000
34.	Methyl ethyl ketone	<0.05	<250	<500	2,200	<20,000	<2,000
38.	Methylene chloride	<0.025	<250	<250	<1,000	<10,000	1,884
42.	Tetrachloroethene	0.3	<250	<500	<1,000	<10,000	1,838
43.	Toluene	<0.025	<250	<250	<1,000	<10,000	25,930
45.	1,1,1-Trichloroethane	<0.025	<250	<250	<1,000	<10,000	1,214
46.	1,1,2-Trichloroethane	<0.025	860	<250	<1,000	<10,000	<1,000
49.	1,2,3-Trichloropropane	<0.025	<250	<2,500	<1,000	9,712	<1,000
59.	Benz(a)anthracene	0.89	<0.351	<134	<172	<189	<196
62.	Benzo(a)pyrene	0.6	<0.351	<134	<172	<189	<196
63.	Benzo(b)fluoranthene	0.72	<0.351	<134	<172	<189	<196
64.	Benzo(ghi)perylene	0.42	<0.351	<134	<172	<189	<196

Note: The variation in detection limits for the same constituent was caused by the variation in the waste matrices.

*Plant codes are listed in Appendix B.

**F024 from Plants A and B were liquids; F024 from Plants C and D were sludges.

Table 4-1 (Continued)

WASTE CHARACTERIZATION DATA COLLECTED BY EPA FOR F024 FROM PLANTS* A, B, C, AND D AND OTHER WASTES TREATED BY ROTARY KILN INCINERATION

BDAT List Constituent	Concentration in Untreated Wastes** Fed to the Rotary Kiln			Concentration in Untreated Wastes** Fed to the Secondary Combustor		
	Plant C (ppm)	Plant D (ppm)	Sludge (ppm)	Plant A (ppm)	Plant B (ppm)	Organic Liquid (ppm)
65. Benzo(k)fluoranthene	0.87	<0.351	<134	<172	<189	<196
68. Bis(2-chloroethyl)ether	<0.351	32.4	<134	<172	<189	<196
70. Bis(2-ethylhexyl)phthalate	7.6	0.58	<134	<172	<189	<196
80. Chrysene	1.1	0.41	<134	<172	<189	<196
87. 1,3-Dichlorobenzene	<0.351	<0.351	<134	<172	<189	302
88. 1,4-Dichlorobenzene	<0.351	2.08	<134	<172	<189	<196
89. 3,3'-Dichlorobenzidine	<1.76	<1.76	<266	<860	<945	915
92. Diethyl phthalate	0.05	<0.351	15.45	<172	<189	<196
110. Hexachlorobenzene	2.1	0.63	<134	<172	<189	<196
113. Hexachloroethane	0.44	<0.351	<134	<172	<189	<196
116. Indeno(1,2,3-cd)pyrene	0.41	<0.351	<134	<172	<189	<196
121. Naphthalene	<0.351	<0.351	1,500	<172	<189	<196
141. Phenanthrene	1.27	0.90	<134	<172	<189	<196
142. Phenol	<0.351	<0.351	<134	<172	<189	1,842
150. 1,2,4-Trichlorobenzene	<0.351	<0.351	<134	<172	<189	279
155. Arsenic	<1.0	2.0	<1.0	<1.0	<1.0	NA
156. Barium	34	6.8	35	0.27	0.30	NA
158. Cadmium	3.1	<0.4	3.1	<0.4	<0.4	NA
159. Chromium (total)	285	57	294	<0.4	<0.4	NA
160. Copper	45	800	46	<0.4	<0.4	NA

NA - Not analyzed.

Note: The variation in detection limits for the same constituent was caused by the variation in the waste matrices.

*Plant codes are listed in Appendix B.

**F024 from Plants A and B were liquids; F024 from Plants C and D were sludges.

Table 4-1 (Continued)

WASTE CHARACTERIZATION DATA COLLECTED BY EPA FOR F024 FROM PLANTS* A, B, C, AND D AND OTHER WASTES TREATED BY ROTARY KILN INCINERATION

BDAT List Constituent	Concentration in Untreated Wastes** Fed to the Rotary Kiln			Concentration in Untreated Wastes** Fed to the Secondary Combustor		
	Plant C (ppm)	Plant D (ppm)	Sludge (ppm)	Plant A (ppm)	Plant B (ppm)	Organic Liquid (ppm)
161. Lead	9.0	3.8	10	<0.5	<0.5	NA
162. Mercury	0.19	<0.1	0.28	<0.1	<0.1	NA
163. Nickel	318	636	333	<0.9	<0.9	NA
165. Silver	<0.4	<0.4	0.56	<0.4	<0.4	NA
167. Vanadium	1.0	1.3	1.4	<0.3	<0.3	NA
168. Zinc	443	92	455	1.6	0.73	NA
169. Cyanide	<0.49	2.92	NA	<0.43	<0.44	NA
170. Fluoride	1.08	10.5	NA	<0.99	<1.00	NA
171. Sulfide	<4.8	<4.6	NA	9.1	7.8	NA
207. Hexachlorodibenzo-p-dioxins	0.01	0.002	NA	$<1.4\times10^{-6}$	$<5.3\times10^{-7}$	NA
208. Hexachlorodibenzofurans	0.003	0.05	NA	$<7.1\times10^{-7}$	$<2.7\times10^{-7}$	NA
209. Pentachlorodibenzo-p-dioxins	0.002	0.0003	NA	$<1.4\times10^{-6}$	$<5.0\times10^{-7}$	NA
210. Pentachlorodibenzofurans	0.002	0.03	NA	$<5.1\times10^{-7}$	$<2.0\times10^{-7}$	NA
212. Tetrachlorodibenzofurans	0.001	0.01	NA	$<1.6\times10^{-7}$	$<1.6\times10^{-7}$	NA

NA - Not analyzed.
Note: The variation in detection limits for the same constituent was caused by the variation in the waste matrices.
*Plant codes are listed in Appendix B.
**F024 from Plants A and B were liquids; F024 from Plants C and D were sludges.

Table 4-2

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FROM
ROTARY KILN INCINERATION OF F024 FROM PLANTS A, B, C, AND D

KILN ASH RESIDUAL

BDAT List Constituent		Concentration in Kiln Ash - Total Composition (mg/kg) Sample Set #1	Sample Set #2	Sample Set #3	Sample Set #4	Sample Set #5	Sample Set #6	Range (mg/kg)
21.	Dichlorodi-fluoromethane*	0.71	1.40	1.50	1.60	1.70	1.40	0.71-1.70
92.	Diethyl phthalate**	0.67	0.67	0.67	0.60	0.45	1.14	0.45-1.14
170.	Fluoride	NA	NA	2.11	NA	NA	NA	2.11
		Concentration in Kiln Ash - TCLP (mg/l)						Range (mg/l)
154.	Antimony	0.062	<0.029	<0.029	<0.029	0.042	0.030	<0.029-0.062
155.	Arsenic	0.079	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01-0.079
156.	Barium	1.64	1.67	1.94	1.78	1.64	1.56	1.56-1.94
157.	Beryllium	<0.001	0.002	0.001	0.002	0.002	0.001	<0.001-0.002
158.	Cadmium	<0.004	0.037	0.033	0.028	0.016	0.027	<0.004-0.037
159.	Chromium (total)	<0.004	0.28	0.29	0.31	0.32	0.13	<0.004-0.32
160.	Copper	0.026	6.48	5.37	4.57	4.54	4.80	0.026-6.48
161.	Lead	<0.032	1.2	29.3	22.0	21.6	1.25	<0.032-29.3
162.	Mercury	0.0002	<0.0002	<0.0002	0.0003	<0.0002	<0.0002	<0.0002-0.0003
163.	Nickel	0.24	3.08	3.68	4.45	4.78	5.32	0.24-5.32
167.	Vanadium	0.005	0.004	<0.003	0.008	<0.003	0.005	<0.003-0.008
168.	Zinc	0.060	1.84	1.90	1.61	1.56	2.78	<0.060-2.78

NA - Not analyzed.
*This constituent was also detected in the laboratory blank at 0.27 mg/kg.
**This constituent was also detected in the laboratory blank at 0.51 mg/kg.

Table 4-3

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FROM
ROTARY KILN INCINERATION OF F024 FROM PLANTS A, B, C, AND D

SCRUBBER WATER RESIDUAL

BDAT List Constituent		Concentration in Scrubber Water - Total Composition (mg/l)					
		Sample Set #1	Sample Set #2	Sample Set #3	Sample Set #4	Sample Set #5	Sample Set #6
6.	Bromomethane	<0.01	<0.01	<0.01	<0.01	<0.01	0.032
12.	Chloroethane	<0.01	<0.01	<0.01	<0.01	<0.01	0.031
15.	Chloromethane	<0.01	<0.01	<0.01	<0.01	<0.01	0.020
21.	Dichlorodifluoromethane	<0.01	<0.01	0.29*	0.36*	0.40*	0.44*
50.	Vinyl chloride	<0.01	<0.01	<0.01	<0.01	<0.01	0.026
92.	Diethyl phthalate	<0.0116	<0.0121	<0.0108	<0.0104	0.057	<0.0107
154.	Antimony	11.3	12.3	9.27	10.8	7.94	8.72
155.	Arsenic	0.48	<0.2	0.58	0.51	<0.1	<0.5
156.	Barium	33.5	18.3	24.7	38.4	27.0	26.8
158.	Cadmium	6.62	6.47	6.95	6.63	2.90	4.81
159.	Chromium (total)	27.6	32.1	15.1	33.1	24.4	24.8
160.	Copper	175	190	107	209	144	158
161.	Lead	361	401	433	358	386	371
162.	Mercury	0.31	0.20	0.45	0.29	0.42	0.34
163.	Nickel	13.7	16.5	14.2	17.3	14.2	13.4
164.	Selenium	3.08	1.09	<2.5	<2.5	<5.0	<0.5
165.	Silver	10.9	10.7	10.1	9.45	7.12	5.38
167.	Vanadium	1.05	1.72	0.37	1.84	1.52	0.97
168.	Zinc	160	162	174	179	128	137
170.	Fluoride	NA	NA	153	NA	NA	NA
207.	Hexachlorodibenzo-p-dioxins	NA	NA	$<7.2\times10^{-6}$	NA	NA	NA
208.	Hexachlorodibenzofurans	NA	NA	0.0003	NA	NA	NA
209.	Pentachlorodibenzo-p-dioxins	NA	NA	$<5.6\times10^{-6}$	NA	NA	NA
210.	Pentachlorodibenzofurans	NA	NA	0.0001	NA	NA	NA
212.	Tetrachlorodibenzofurans	NA	NA	9.6×10^{-6}	NA	NA	NA

NA - Not analyzed.
*This constituent was also detected in the laboratory blank at 0.23 mg/l.

Table 4-4

DESIGN AND OPERATING DATA FOR THE ROTARY KILN AND SECONDARY COMBUSTOR FOR SAMPLE SETS 1 THROUGH 6

Parameter (units)	Design Value	Operating Value					
		Sample Set #1 (11:20 am)* (11:45 am)*	Sample Set #2 (12:15 pm)* (12:45 pm)*	Sample Set #3 (1:15 pm)* (1:45 pm)*	Sample Set #4 (2:15 pm)* (2:45 pm)*	Sample Set #5 (3:15 pm)* (3:45 pm)*	Sample Set #6 (4:15 pm)* (4:45 pm)*
Kiln Outlet Temperature (^{o}F)	1,000-1,700	1,391 1,255	1,393 1,405	1,360 1,604	1,425 1,413	1,452 1,450	1,207 1,551
Rotary Kiln Solid Waste[a] Feed Rate (lbs/minute)	NS	32 32	32 32	32 32	32 32	32 32	32 32
Kiln Rotational Speed[b] (RPM)	0.2-0.6	0.45 0.45	0.45 0.45	0.45 0.45	0.25 0.45	0.23 0.27	0.27 0.1
BTU Loading - Rotary Kiln (MMBTU/hour)	11	16 17	17 16	16 16	16 16	16 16	16 15
Secondary Combustor Temperature (^{o}F)	1,800-2,200	2,025 2,021	2,056 2,142	2,132 1,990	2,093 2,119	2,123 2,126	2,006 1,877
Secondary Combustor Liquid Waste[c] Feed Rate (lbs/minute)	NS	18.2 27.7	29.2 27.7	29.4 32.3	25.9 25.6	29.6 25.4	13.4 1.2
BTU Loading-Secondary Combustor (MMBTU/hour)	19	10 14	15 14	15 17	14 13	15 15	11 7

[a] This represents F024 from plants C and D and the sludge that were treated by the rotary kiln incineration system.

[b] The kiln rotational speed was decreased during the run to allow for a longer residence time of the kiln solids and to lower the temperature of the waste heat boiler.

[c] This represents F024 from plants A and B and the organic liquid that were treated by the rotary kiln incineration system.

NS - Not specified.

* This time corresponds to the time of data collection.

Note: Kiln solids residence time is estimated to be 30-60 minutes. Secondary combustor residence time is approximately 3 seconds. Both estimates are based on discussions with plant personnel.

Table 4-5

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K048 AND K051
PLANT Y - STABILIZATION OF INCINERATOR ASH

Detected BDAT List Metal Constituent	Untreated Waste Concentration in TCLP Extract of K048 and K051 Incinerator Ash	Treated Waste Concentration in TCLP Extract of Stabilized Fluidized Bed Incinerator Ash Lime and Fly Ash Binder Run 1 mg/L (ppm)	Run 2 mg/L (ppm)	Run 3 mg/L (ppm)
154. Antimony	0.06-0.09	<0.163	<0.163	<0.163
155. Arsenic	0.008-0.025	<0.004	<0.004	0.006
156. Barium	0.17-0.25	0.558	0.524	0.599
158. Cadmium	<0.003	<0.003	<0.003	<0.003
159. Chromium (total)	2.1-2.6	1.13	1.21	1.08
160. Copper	0.02	<0.003	<0.003	0.006
161. Lead	<0.05	<0.006	<0.006	<0.006
162. Mercury	0.0002-0.0003	NA	NA	NA
163. Nickel	0.02-0.03	<0.018	<0.018	<0.018
167. Vanadium	2.5-3.6	0.148	0.149	0.156
168. Zinc	0.055-0.11	0.02	0.022	0.052

Design and Operating Parameters	Stabilization Process Lime and Fly Ash Binder Run 1	Run 2	Run 3
Binder to Ash Ratio	NP	NP	NP
Lime to Ash Ratio	0.2	0.2	0.2
Fly Ash to Ash Ratio	0.2	0.2	0.2
Water to Ash Ratio	0.5	0.5	0.5
Ambient Temperature (°C)	19	19	19
Mixture pH	12.0	12.1	12.1
Cure Time (days)	28	28	28
Unconfined Compressive Strength	565.8	512.6	578.8

NA - Not analyzed.
NP - Not applicable.

Source: Waterways Onsite Engineering Report (Reference 21).

Table 4-6

TREATMENT PERFORMANCE DATA COLLECTED BY EPA FOR K062
PLANT Z - LIME AND SULFIDE PRECIPITATION FOLLOWED BY VACUUM FILTRATION*

	Detected BDAT List Metal Constituent	Sample Set #8		Sample Set #11		Sample Set #12	
		Untreated K062 Concentration (ppm)	Treated K062 Wastewater Concentration (ppm)	Untreated K062 Concentration (ppm)	Treated K062 Wastewater Concentration (ppm)	Untreated K062 Concentration (ppm)	Treated K062 Wastewater Concentration (ppm)
154.	Antimony	<10	<1	<10	<1	<10	<1.00
155.	Arsenic	<1	<0.1	<1	<0.1	<1	<0.10
156.	Barium	<10	<1	<10	<1	12	<1.00
157.	Beryllium	<2	<0.2	<2	<0.2	<2	<0.20
158.	Cadmium	<5	<0.5	<5	<0.5	23	<5
221.	Chromium (hexavalent)	0.13	<0.01	0.08	0.106	0.30	<0.01
159.	Chromium (total)	831	0.15	395	0.12	617	0.18
160.	Copper	217	0.16	191	0.14	137	0.24
161.	Lead	212	<0.01	<10	<0.01	136	<0.01
162.	Mercury	<1	<0.1	<1	<0.1	<1	<0.10
163.	Nickel	669	0.36	712	0.33	382	0.39
164.	Selenium	<10	<1	<10	<1	<10	<1.00
165.	Silver	<2	<0.2	<2	<0.2	<2	<0.20
166.	Thallium	<10	<1	<10	<1	<10	<1.00
168.	Zinc	151	0.130	5	0.070	135	0.100

*Only three of the 12 data sets analyzed at Plant Z represented treatment by this treatment train. The other data sets included pretreatment technologies such as chromium reduction and treatment for cyanide. These data are not included since these pretreatment technologies are not applicable to F024.

Source: Envirite Onsite Engineering Report (Reference 33).

5.0 IDENTIFICATION OF BEST DEMONSTRATED AND AVAILABLE TECHNOLOGY (BDAT)

This section presents the Agency's rationale behind the proposed determination of the best demonstrated and available technology (BDAT) for F024. BDAT for F024 has been determined to be rotary kiln incineration followed by stabilization of the incinerator ash and chemical precipitation followed by filtration of the scrubber water. However, the Agency believes that well-designed and well-operated liquid injection and fluidized bed incineration systems can meet the BDAT treatment standards established for F024.

To determine BDAT, the Agency examines all available treatment performance data on technologies that are identified as demonstrated to determine whether one or more of the technologies performs significantly better than the others. All treatment performance data used for determination of the best technology must first be corrected for accuracy, as discussed in EPA's Methodology for Developing BDAT Treatment Standards. (The data are corrected for accuracy in order to account for the ability of an analytical technique to recover a particular constituent from the waste in a particular test.) The "best" performing treatment technology is evaluated to determine whether the resulting treatment is substantial, as determined by the analysis of variance (ANOVA) test. (The ANOVA test is discussed in EPA's Methodology for Developing BDAT Treatment Standards.) The technology that performs "best" must be specified for all streams associated with the management of the listed waste.

The technology that is found to perform best on a particular waste is then evaluated to determine whether it is "available." To be available, the technology must (1) be commercially available and (2) provide "substantial" treatment of the waste, as determined through evaluation of treatment performance data corrected for accuracy. In determining whether treatment is substantial, EPA may consider data on a treatment technology's performance on a waste similar to the waste in question, provided that the similar waste is at least as difficult to treat. If it is determined that the best technology is not available, then the next best technology is evaluated, and so on.

5.1 Review of Performance Data

The available treatment performance data presented in Section 4.0 were reviewed and assessed to determine whether they represent operation of a well-designed and well-operated system, whether sufficient quality assurance/quality control measures were employed to ensure the accuracy of the data, and whether the appropriate measures of performance were used to assess the performance of the treatment technology.

The treatment performance data and the design and operating data collected during the test on the rotary kiln incineration of F024 at plant X, stabilization of K048 and K051 incinerator ash at plant Y, and lime and sulfide precipitation followed by vacuum filtration of K062 mixed with other metal-bearing characteristic wastes at plant Z were reviewed for the points described above. The appropriate measures of performance (total constituent

concentration for incineration and lime and sulfide precipitation followed by vacuum filtration, and TCLP for stabilization) were used to assess the treatment systems. Additionally, the Agency had no reason to believe that the treatment systems were not well-designed and well-operated or that insufficient analytical quality assurance/quality control measures were employed. (Design and operating data and quality assurance/quality control information are presented in References 32, 21, and 33 for samples collected at plants X, Y, and Z, respectively.) Therefore, these data were considered in the determination of BDAT for F024.

F024 treatment performance data are not available for liquid injection and fluidized bed incineration. Therefore, in the absence of treatment performance data for this waste, liquid injection and fluidized bed incineration were not selected as BDAT for F024. However, the Agency believes that well-designed and well-operated liquid injection and fluidized bed incineration systems can meet the BDAT treatment standards established for F024.

5.2 Accuracy Correction of Treatment Performance Data

As part of the review of treatment performance data for rotary kiln incineration, the data were adjusted to take into account any analytical interferences associated with the chemical make-up of the samples. Generally, performance data were corrected for accuracy as follows: (1) a matrix spike recovery was determined, as explained below, for each BDAT List constituent detected in the untreated or treated waste; (2) an accuracy correction factor

was determined for each of the above constituents by dividing 100 by the matrix spike recovery (expressed as a percentage) for that constituent; and (3) the reported concentration of each BDAT List constituent detected in the untreated or treated waste was corrected by multiplying the concentration by the corresponding accuracy correction factor.

Matrix spike recoveries are developed by analyzing a sample of a treated waste for a constituent and then re-analyzing the sample after the addition of a known amount of the same constituent (i.e., spike) to the sample. The matrix spike recovery represents the total amount of constituent recovered after spiking minus the initial concentration of the constituent in the sample, and the result divided by the known amount of constituent added.

5.2.1 Nonwastewater

Matrix spike recoveries used in adjustment of the treatment performance data for the kiln ash residue are presented in Table A-8 of Appendix A of this background document. Duplicate matrix spikes were performed for some BDAT List constituents in kiln ash. If duplicate matrix spikes were performed for a constituent, the matrix spike recovery used for that constituent was the lower of the two values from the first matrix spike and the duplicate spike.

Where a matrix spike was not performed for a constituent, the matrix spike recovery for the constituent was derived from the average matrix spike recoveries of the appropriate group of constituents (for example, volatile

organics) for which recovery data were available. In these cases, the matrix spike recoveries for all volatile organics, semivolatile organics, or dioxins/furans from the first matrix spike were averaged. Similarly, an average matrix spike recovery was calculated for the duplicate matrix spike recoveries. The lower of the two average matrix spike recoveries of the volatile, semivolatile, or dioxin/furan group was used for any volatile, semivolatile, or dioxin/furan constituent for which no matrix spike was performed.

The accuracy correction factors for nonwastewater (rotary kiln ash) data calculated using this method are presented in Table A-10 of Appendix A of this document. The corrected concentrations for each BDAT List constituent in the rotary kiln ash, that was detected in either the untreated F024 or rotary kiln ash, are presented in Table 5-1. Note that constituent concentrations in the kiln ash residue were not adjusted to values below the detection limit for that constituent. If accuracy correction resulted in a value less than the detection limit, the accuracy-corrected concentration was set equal to the detection limit.

5.2.2 Wastewater

Matrix spike recoveries used to calculate accuracy correction factors for adjustment of the treatment performance data are presented in Table A-9 of Appendix A. As shown in Table A-9, if duplicate matrix spikes were performed for a constituent, the matrix spike recovery used for that constituent was the lower of the two values from the first matrix spike and the duplicate spike.

Table 5-1

BDAT LIST CONSTITUENT
CONCENTRATIONS IN KILN ASH RESIDUE CORRECTED FOR ACCURACY*

BDAT List Constituent	Sample Set:	Corrected Total Concentration in the F024 Rotary Kiln Incinerator Ash (ppm) 1	2	3	4	5	6
Volatiles							
222. Acetone		0.010	0.010	0.010	0.010	0.010	0.010
10. 2-Chloro-1,3-butadiene		0.100	0.100	0.100	0.100	0.100	0.100
16. 3-Chloropropene		0.100	0.100	0.100	0.100	0.100	0.100
20. trans-1,4-Dichloro-2-butene		0.100	0.100	0.100	0.100	0.100	0.100
21. Dichlorodifluoromethane		0.710	1.400	1.500	1.600	1.700	1.400
23. 1,2-Dichloroethane		0.005	0.005	0.005	0.005	0.005	0.005
26. 1,2-Dichloropropane		0.005	0.005	0.005	0.005	0.005	0.005
27. trans-1,3-Dichloropropene		0.005	0.005	0.005	0.005	0.005	0.005
28. cis-1,3-Dichloropropene		0.005	0.005	0.005	0.005	0.005	0.005
34. Methyl ethyl ketone		0.010	0.010	0.010	0.010	0.010	0.010
42. Tetrachloroethene		0.005	0.005	0.005	0.005	0.005	0.005
46. 1,1,2-Trichloroethane		0.005	0.005	0.005	0.005	0.005	0.005
49. 1,2,3-Trichloropropane		0.005	0.005	0.005	0.005	0.005	0.005
Semivolatiles							
59. Benz(a)anthracene		0.632	0.632	0.666	0.632	0.632	0.632
62. Benzo(a)pyrene		0.632	0.632	0.666	0.632	0.632	0.632
63. Benzo(b)fluoranthene		0.632	0.632	0.666	0.632	0.632	0.632
64. Benzo(ghi)perylene		0.632	0.632	0.666	0.632	0.632	0.632
65. Benzo(k)fluoranthene		0.632	0.632	0.666	0.632	0.632	0.632
68. Bis(2-chloroethyl)ether		0.632	0.632	0.666	0.632	0.632	0.632
70. Bis(2-ethylhexyl)phthalate		0.632	0.632	0.666	0.632	0.632	0.632
80. Chrysene		0.632	0.632	0.666	0.632	0.632	0.632
88. 1,4-Dichlorobenzene		0.462	0.462	0.488	0.462	0.462	0.462
92. Diethyl phthalate		1.264	1.264	1.280	1.145	0.854	2.164
110. Hexachlorobenzene		0.632	0.632	0.666	0.632	0.632	0.632
113. Hexachloroethane		0.632	0.632	0.666	0.632	0.632	0.632

*This table presents data for the BDAT List constituents detected in either the untreated F024 from plants A, B, C, and D or the rotary kiln ash. Calculations are shown in Appendix A.

Table 5-1 (Continued)

BDAT LIST CONSTITUENT
CONCENTRATIONS IN KILN ASH RESIDUE CORRECTED FOR ACCURACY*

BDAT List Constituent	Sample Set:	Corrected Total Concentration in the F024 Rotary Kiln Incinerator Ash (ppm) 1	2	3	4	5	6
Semivolatiles (Cont.)							
116. Indeno(1,2,3-cd)pyrene		0.632	0.632	0.666	0.632	0.632	0.632
141. Phenanthrene		0.632	0.632	0.666	0.632	0.632	0.632
Inorganics							
170. Fluoride		NA	NA	2.11	NA	NA	NA
Dioxins and furans							
207. Hexachlorodibenzo-p-dioxins		NA	NA	0.0001	NA	NA	NA
208. Hexachlorodibenzofurans		NA	NA	0.00004	NA	NA	NA
209. Pentachlorodibenzo-p-dioxins		NA	NA	0.0001	NA	NA	NA
210. Pentachlorodibenzofurans		NA	NA	0.00003	NA	NA	NA
212. Tetrachlorodibenzofurans		NA	NA	0.00003	NA	NA	NA

Metals	Sample Set:	Corrected TCLP Concentration in the Stabilized K048 and K051 Incinerator Ash (ppm) 1	2	3
154. Antimony		0.22	0.22	0.22
155. Arsenic		0.004	0.004	0.004
156. Barium		0.58	0.54	0.62
158. Cadmium		0.004	0.004	0.004
159. Chromium (total)		1.47	1.58	1.41
160. Copper		0.004	0.004	0.008
161. Lead		0.008	0.008	0.008
163. Nickel		0.026	0.026	0.026
167. Vanadium		0.16	0.16	0.17
168. Zinc		0.029	0.032	0.076

*This table presents data for the BDAT List constituents detected in either the untreated F024 from plants A, B, C, and D or the rotary kiln ash. Calculations are shown in Appendix A.

NA - Not analyzed.

Where a matrix spike was not performed for a constituent, the matrix spike recovery for the constituent was derived from the average matrix spike recoveries of the appropriate group of constituents (for example, volatile organics) for which recovery data were available. In these cases, the matrix spike recoveries for all volatile organics, semivolatile organics, or dioxins/furans from the first matrix spike were averaged. Similarly, an average matrix spike recovery was calculated for the duplicate matrix spike recoveries. The lower of the two average matrix spike recoveries of the volatile, semivolatile, or dioxin/furan group was used for any volatile, semivolatile, or dioxin/furan constituent for which no matrix spike was performed.

The accuracy correction factors for wastewater (scrubber water) data calculated using this method are presented in Table A-10 of Appendix A of this document. The corrected concentration for each BDAT List constituent in the scrubber water, that was detected in either the untreated F024 or scrubber water, are presented in Table 5-2. Note that constituent concentrations in the scrubber water residual were not adjusted to values below the detection limit for that constituent. If accuracy correction resulted in a value less than the detection limit, the accuracy-corrected value was set equal to the detection limit.

5.3 Statistical Comparison of Treatment Performance Data

In cases where the Agency has treatment performance data from more than one technology, EPA uses the statistical method known as analysis of

Table 5-2

BDAT LIST CONSTITUENT
CONCENTRATIONS IN SCRUBBER WATER CORRECTED FOR ACCURACY*

BDAT List Constituent	Sample Set:	Corrected Total Concentration in the F024 Combustion Gas Scrubber Water (ppm) 1	2	3	4	5	6
Volatiles							
222. Acetone		0.010	0.010	0.010	0.010	0.010	0.010
6. Bromomethane		0.010	0.010	0.010	0.010	0.010	0.032
10. 2-Chloro-1,3-butadiene		0.101	0.101	0.101	0.101	0.101	0.101
12. Chloroethane		0.010	0.010	0.010	0.010	0.010	0.031
15. Chloromethane		0.010	0.010	0.010	0.010	0.010	0.020
16. 3-Chloropropene		0.101	0.101	0.101	0.101	0.101	0.101
20. trans-1,4-Dichloro-2-butene		0.101	0.101	0.101	0.101	0.101	0.101
21. Dichlorodifluoromethane		0.010	0.010	0.292	0.363	0.403	0.444
23. 1,2-Dichloroethane		0.005	0.005	0.005	0.005	0.005	0.005
26. 1,2-Dichloropropane		0.005	0.005	0.005	0.005	0.005	0.005
27. trans-1,3-Dichloropropene		0.005	0.005	0.005	0.005	0.005	0.005
28. cis-1,3-Dichloropropene		0.005	0.005	0.005	0.005	0.005	0.005
34. Methyl ethyl ketone		0.010	0.010	0.010	0.010	0.010	0.010
42. Tetrachloroethene		0.005	0.005	0.005	0.005	0.005	0.005
46. 1,1,2-Trichloroethane		0.005	0.005	0.005	0.005	0.005	0.005
49. 1,2,3-Trichloropropane		0.005	0.005	0.005	0.005	0.005	0.005
Semivolatiles							
59. Benz(a)anthracene		0.014	0.014	0.013	0.012	0.013	0.013
62. Benzo(a)pyrene		0.014	0.014	0.013	0.012	0.013	0.013
63. Benzo(b)fluoranthene		0.014	0.014	0.013	0.012	0.013	0.013
64. Benzo(ghi)perylene		0.014	0.014	0.013	0.012	0.013	0.013
65. Benzo(k)fluoranthene		0.014	0.014	0.013	0.012	0.013	0.013
68. Bis(2-chloroethyl)ether		0.014	0.014	0.013	0.012	0.013	0.013
70. Bis(2-ethylhexyl)phthalate		0.014	0.014	0.013	0.012	0.013	0.013
80. Chrysene		0.014	0.014	0.013	0.012	0.013	0.013

*This table presents data for the BDAT List constituents detected in either the untreated F024 from plants A, B, C, and D or the scrubber water. Calculations are shown in Appendix A.

NA - Not analyzed.

Table 5-2 (Continued)

BDAT LIST CONSTITUENT
CONCENTRATIONS IN SCRUBBER WATER CORRECTED FOR ACCURACY*

BDAT List Constituent	Sample Set:	Corrected Total Concentration in the F024 Combustion Gas Scrubber Water (ppm) 1	2	3	4	5	6
Semivolatiles (Continued)							
88. 1,4-Dichlorobenzene		0.021	0.021	0.019	0.017	0.019	0.019
92. Diethyl phthalate		0.014	0.014	0.013	0.012	0.066	0.013
110. Hexachlorobenzene		0.014	0.014	0.013	0.012	0.013	0.013
113. Hexachloroethane		0.014	0.014	0.013	0.012	0.013	0.013
116. Indeno(1,2,3-cd)pyrene		0.014	0.014	0.013	0.012	0.013	0.013
141. Phenanthrene		0.014	0.014	0.013	0.012	0.013	0.013
Inorganics							
170. Fluoride		NA	NA	153	NA	NA	NA
Dioxins and furans							
207. Hexachlorodibenzo-p-dioxins		NA	NA	0.00001	NA	NA	NA
208. Hexachlorodibenzofurans		NA	NA	0.0003	NA	NA	NA
209. Pentachlorodibenzo-p-dioxins		NA	NA	0.00001	NA	NA	NA
210. Pentachlorodibenzofurans		NA	NA	0.0001	NA	NA	NA
212. Tetrachlorodibenzofurans		NA	NA	0.00001	NA	NA	NA

Metals	Sample Set:	Corrected Total Concentration in the Treated K062 Wastewater (ppm) 1	2	3
159. Chromium (total)		0.221	0.176	0.265
162. Lead		0.013	0.013	0.013
163. Nickel		0.387	0.355	0.419

*This table presents data for the BDAT List constituents detected in either the untreated F024 from plants A, B, C, and D or the scrubber water. Calculations are shown in Appendix A.

NA - Not analyzed.

variance, ANOVA (discussed in EPA's Methodology for Developing BDAT Treatment Standards), to determine if one technology performs significantly better than the rest. For F024, the Agency has treatment performance data for only one treatment system and, therefore, an ANOVA comparison is not appropriate.

5.4 Available Treatment Technologies

The demonstrated technologies for treatment of F024, rotary kiln incineration, stabilization, and chemical precipitation followed by sludge filtration, are considered to be commercially available. Furthermore, the Agency has determined that these technologies will provide substantial treatment of F024. Therefore, these technologies are available for treatment of F024.

Methods of total recycle or reuse are not considered to be commercially available for F024 as they are proprietary or patented processes and cannot be purchased or licensed from the proprietor. In addition, a process used successfully by one facility may not work for another, due to the wide variations in the waste. Therefore, total recycle or reuse cannot be further considered for BDAT purposes, as it is not an available treatment technology.

5.5 Proposed BDAT for F024

As discussed above, rotary kiln incineration followed by stabilization of the incinerator ash and chemical precipitation followed by filtration

of the scrubber water have been determined to be demonstrated and available. Since the Agency does not have treatment performance data for any other technologies treating F024 or similar wastes, this treatment train is "best". Therefore, the best demonstrated and available technology (BDAT) for F024 has been determined to be rotary kiln incineration followed by stabilization of the incinerator ash and chemical precipitation followed by filtration of the scrubber water. However, the Agency believes that well-designed and well-operated liquid injection and fluidized bed incineration systems can meet the BDAT treatment standards established for organic constituents in F024.

6.0 SELECTION OF REGULATED CONSTITUENTS

The Agency has developed a list of hazardous constituents (the BDAT Constituent List, presented in EPA's Methodology for Developing BDAT Treatment Standards) 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, organophosphorus insecticides, PCBs, and dioxins and furans. This section presents the rationale for the selection of constituents being proposed for regulation from the BDAT List of constituents in wastewater and nonwastewater forms of F024.

Generally, constituents selected for proposed regulation must satisfy the following criteria:

1) They must be on the BDAT List of regulated constituents. (Presence on the BDAT List implies the existence of approved methods for analyzing the constituent in treated waste matrices.)

2) They must be present in, or be suspected of being present in, the untreated waste. For example, in some cases, analytical difficulties (such as masking) may prevent a constituent from being identified in the untreated waste, but its identification in a treatment residual may lead the Agency to conclude that it is present in the untreated waste.

3) Where treatment performance data are transferred, the constituents selected for proposed regulation must be easier to treat than the constituent(s) from which performance data are transferred. Waste characteristics affecting the performance (WCAPs) of treatment vary according to the technology of concern. For instance, for incineration, the WCAPs include bond dissociation energy, thermal conductivity, and boiling point.

From a group of constituents that are eligible for regulation because they meet the above criteria, EPA may select a subset of constituents that represents the broader group. For example, from a group of constituents that react similarly to treatment, the Agency might select only those that are the most difficult to treat as constituents to regulate, to facilitate implementation of the compliance and enforcement program.

The Agency initially considered all constituents on the BDAT List for proposed regulation. Summarized in Table 6-1, at the end of this section, are available F024 characterization data for all BDAT List constituents. For constituents known to be present in the untreated F024, the range of detected concentrations is shown in the table. Constituents that were not detected in the untreated waste but were detected in the treated waste are identified by "*." Constituents for which the Agency does not have analytical characterization data are identified by "NA" (not analyzed).

The Agency is not proposing to regulate all of the BDAT List constituents considered for regulation. A BDAT List constituent was deleted from further consideration for proposed regulation if (1) the constituent was not detected in the untreated and/or treated wastes, (2) the constituent was not analyzed for in the untreated waste, or (3) other reasons, as discussed in Section 6.1. Constituents that were selected for proposed regulation are discussed in Section 6.2.

6.1 BDAT List Constituents Deleted from Consideration for Regulation

A BDAT List constituent that was detected in untreated F024 was deleted from consideration for regulation if (1) available treatment performance data for the constituent did not show effective treatment by BDAT, (2) the constituent was not present at treatable concentrations in the waste, or (3) other reasons, as described below. BDAT List constituents that remained, following the deletions described in this subsection, were further considered for regulation. These constituents are listed in Table 6-2 for nonwastewater and Table 6-3 for wastewater. All tables are included at the end of this section.

Sulfide was not further considered for regulation in F024 wastewater and nonwastewater because the technology determined to be BDAT for F024 (rotary kiln incineration followed by stabilization of nonwastewater and chemical precipitation followed by filtration of wastewater) does not provide effective treatment for this BDAT List constituent. Moreover, the Agency is unaware of any demonstrated technology for treatment of sulfide in F024 or similar wastes.

Similarly, barium, cadmium, lead, mercury, and silver were deleted from further consideration for regulation in F024 nonwastewater because the Agency's data on BDAT for stabilization of nonwastewater (fluidized bed incinerator ash) did not show effective treatment for these BDAT List constituents.

In addition, barium was deleted from further consideration for regulation in wastewater because it is not effectively treated by BDAT for wastewater (chemical precipitation followed by filtration).

Arsenic was deleted from further consideration for regulation in nonwastewater because it was not present in the untreated waste at treatable concentrations.

Similarly, benz(a)anthracene, benzo(b)fluoranthene, benzo(ghi)-perylene, benzo(k)fluoranthene, chrysene, and indeno (1,2,3-cd) pyrene were deleted from further consideration for regulation in F024 because they were not present in the untreated waste at treatable concentrations.

Copper, vanadium, and zinc were considered for regulation in F024 wastewater and nonwastewater but were not selected as proposed regulated constituents. Although the metal compounds, copper cyanide, vanadium pentoxide, and zinc cyanide are listed on Appendix VIII of 40 CFR Part 261, the individual metals, copper, vanadium, and zinc, are not listed. In this Second Thirds rulemaking, the Agency is only proposing to regulate copper, vanadium, and/or zinc when they cannot be controlled by regulation of other metal constituents. For F024, copper, vanadium, and zinc are believed to be controlled by the regulation of total chromium and nickel and are therefore not being proposed for regulation.

6.2 BDAT List Constituents Selected for Regulation

The selection of constituents proposed for regulation in nonwastewater and wastewater is discussed in Sections 6.2.1 and 6.2.2, respectively.

6.2.1 Nonwastewater

Constituents proposed for regulation in F024 nonwastewater were selected from those BDAT List constituents detected in the untreated waste, unless they were deleted from consideration as discussed in Section 6.1.

Table 6-4 presents each constituent selected for proposed regulation in F024 after consideration of (1) the constituent concentration in the untreated waste, (2) whether the constituent is adequately controlled by regulation of another constituent, and (3) the relative difficulty associated with achieving effective treatment of the constituent by BDAT for nonwastewater (rotary kiln incineration followed by stabilization).

The Agency's determination of adequate control for organic constituents was based on an evaluation of the characteristics of the constituents that would affect the performance of rotary kiln incineration relative to the kiln ash residual, specifically, the boiling points of the constituents. In general, a constituent is believed to be controlled by regulation of another constituent that has a higher boiling point. Boiling points for the BDAT List

organic constituents further considered for regulation, as shown in Table 6-2, are listed in Appendix C.

The BDAT List organic constituents selected for proposed regulation, based on the above discussion, are 2-chloro-1,3-butadiene, 3-chloropropene, 1,1-dichloroethane, 1,2-dichloroethane, 1,2-dichloropropane, trans-1,3-dichloropropene, cis-1,3-dichloropropene, bis(2-ethylhexyl)phthalate, di-n-octyl phthalate, and hexachloroethane.

The constituents controlled by regulating other constituents are discussed below.

The remaining 35 BDAT List organic constituents that were further considered for proposed regulation in F024 nonwastewater due to their presence in the untreated waste (see Table 6-2) are not being proposed for regulation. These 35 constituents were found at lower concentrations in the untreated waste than the organic constituents selected for proposed regulation. Hence, they were deleted from consideration for proposed regulation because they are believed to be adequately controlled by incineration of other organic constituents that have been selected for proposed regulation in F024. Deletion of constituents from consideration for proposed regulation in F024 was based on a comparison of the boiling points of those remaining 35 organic constituents with the boiling points of those constituents selected for proposed regulation. The control of constituents deleted from consideration for proposed regulation by constituents selected for proposed regulation is presented in Table 6-5.

Cyanide was detected in untreated F024 but was not selected for proposed regulation because this constituent was found at low concentrations in the untreated waste and is believed to be adequately controlled by treatment standards proposed for the BDAT List organic constituents.

Two metals, total chromium and nickel, were selected for proposed regulation in F024 nonwastewater.

Five dioxins and furans, hexachlorodibenzo-p-dioxins, hexachlorodibenzofurans, pentachlorodibenzo-p-dioxins, pentachlorodibenzofurans, and tetrachlorodibenzofurans, were selected for proposed regulation in F024 nonwastewater based on the difficulty in treating these constituents, reflected by their high boiling points along with their inherent toxicity.

Dichlorodifluoromethane, diethyl phthalate, antimony, and beryllium were not detected in untreated F024 but were detected in the rotary kiln ash residual. These constituents were not selected for proposed regulation in F024 nonwastewater. Dichlorodifluoromethane and diethyl phthalate are not being proposed for regulation because they were detected in the laboratory blank at 0.27 ppm and 0.51 ppm, respectively, and are believed to be laboratory contaminants. The Agency believes antimony and beryllium concentrations detected in the kiln ash are attributable to their presence in the sludge and organic liquid wastes incinerated with F024. These constituents were not typically found in untreated F024 (see Table 2-3). Therefore, these constituents were not selected for proposed regulation in F024 nonwastewater.

6.2.2 Wastewater

Constituents proposed for regulation in F024 wastewater were chosen using the same constituent selection method used for nonwastewater; that is, constituents proposed for regulation in wastewater were selected from the BDAT List constituents that were detected in the untreated waste, unless they were deleted from consideration as discussed in Section 6.1.

Table 6-6 presents each constituent selected for proposed regulation in F024 after consideration of (1) the constituent concentration in the untreated waste, (2) whether the constituent is adequately controlled by regulation of another constituent, and (3) the relative difficulty associated with achieving effective treatment of the constituent by BDAT for wastewater (rotary kiln incineration followed by chemical precipitation and filtration).

The Agency's determination of adequate control for organic constituents was based on an evaluation of the characteristics of the constituents that would affect performance of incineration relative to the scrubber water residual, specifically, the estimated bond dissociation energies for the constituents. In general, a constituent is believed to be controlled by regulation of another constituent that has a higher bond dissociation energy. Estimated bond dissociation energies for the BDAT List organic constituents further considered for regulation, as shown in Table 6-3, are listed in Appendix C.

The BDAT List organic constituents selected for proposed regulation based on the above discussion are 2-chloro-1,3-butadiene, 3-chloropropene, 1,1-dichloroethane, 1,2-dichloroethane, 1,2-dichloropropane, trans-1,3-dichloropropene, cis-1,3-dichloropropene, bis(2-ethylhexyl)phthalate, di-n-octyl phthalate, and hexachloroethane.

The constituents controlled by regulating other constituents are discussed below.

The remaining 38 BDAT List organic constituents that were further considered for proposed regulation in F024 wastewater due to their presence in the untreated waste (see Table 6-3) are not being proposed for regulation. These 38 constituents were found at lower concentrations in the untreated waste than the organic constituents selected for proposed regulation and were deleted from consideration for proposed regulation because they are believed to be adequately controlled by incineration of the organic constituents proposed for regulation in F024. Deletion of constituents from consideration for proposed regulation in F024 was based on a comparison of the bond dissociation energies (BDEs) of those remaining 38 organic constituents with the BDEs of those constituents selected for proposed regulation. The control of constituents deleted from consideration for proposed regulation by constituents selected for proposed regulation is presented in Table 6-7.

Cyanide was detected in untreated F024 but was not selected for proposed regulation because this constituent was found at low concentrations

in the untreated waste and is believed to be adequately controlled by treatment standards proposed for the BDAT List organic constituents.

Two metals, total chromium and nickel, were selected for proposed regulation in F024 wastewater. All other BDAT List metal constituents initially considered for regulation were not selected because these constituents were found at low concentrations in the untreated waste and are believed to be adequately controlled by treatment standards proposed for total chromium and nickel. Control of metal constituents is provided by the use of chemical precipitation followed by sludge filtration. By removing the metals present at the highest concentrations in the untreated waste, adequate treatment will be provided for other metals present at lower treatable concentrations.

Five dioxins and furans, hexachlorodibenzo-p-dioxins, hexachlorodibenzofurans, pentachlorodibenzo-p-dioxins, pentachlorodibenzofurans, and tetrachlorodibenzofurans, were selected for proposed regulation in F024 wastewater based on the detected presence of these BDAT List constituents in the scrubber water residual, along with their inherent toxicity.

Bromomethane, chloroethane, chloromethane, dichlorodifluoromethane, diethyl phthalate, antimony, and selenium were not detected in untreated F024 but were detected in the scrubber water residual from rotary kiln incineration. These constituents were not selected for proposed regulation in F024 wastewater. Dichlorodifluoromethane is not being proposed for regulation because it was detected in the laboratory blank at 0.23 ppm and is believed

to be a laboratory contaminant. Diethyl phthalate is not being proposed for regulation because it was detected in only one scrubber water sample at a low concentration (0.057 ppm). In addition, diethyl phthalate, (BDE 3,145 kcal/mole) is controlled by regulation of bis (2-ethylhexyl) phthalate (BDE 6,464 kcal/mole) and di-n-octyl phthalate (BDE 6,565 kcal/mole). The Agency believes the concentrations of the five remaining constituents detected in the scrubber water, bromomethane, chloroethane, chloromethane, antimony, and selenium, are attributable to their presence in the sludge and organic liquid wastes incinerated with F024. These constituents were not typically found in F024 (see Table 2-3). Therefore, these constituents were not selected for proposed regulation in F024 wastewater.

Table 6-1

STATUS OF BDAT LIST CONSTITUENTS
IN UNTREATED F024

BDAT List Constituent		Detection Status	Concentration in Untreated F024 (mg/kg)
Volatiles			
222.	Acetone	X	<0.05-21,000
1.	Acetonitrile		<0.5
2.	Acrolein		<0.5
3.	Acrylonitrile		<0.5
4.	Benzene	X	<0.025-1,900
5.	Bromodichloromethane	X	<0.025-7,260
6.	Bromomethane		<0.05*
223.	n-Butyl alcohol		NA
7.	Carbon tetrachloride	X	<0.025-50,400
8.	Carbon disulfide		<0.025
9.	Chlorobenzene	X	<0.025-3,200
10.	2-Chloro-1,3-butadiene	X	<0.5-139,721
11.	Chlorodibromomethane		<0.025
12.	Chloroethane		<0.05*
13.	2-Chloroethyl vinyl ether		NA
14.	Chloroform	X	<0.025-1,000
15.	Chloromethane		<0.05*
16.	3-Chloropropene	X	<0.5-285,486
17.	1,2-Dibromo-3-chloropropane		<0.05
18.	1,2-Dibromoethane		<0.025
19.	Dibromomethane		<0.025
20.	trans-1,4-Dichloro-2-butene	X	<0.5-4,691
21.	Dichlorodifluoromethane		<0.05*
22.	1,1-Dichloroethane	X	<0.025-440,000
23.	1,2-Dichloroethane	X	<0.025-950,000
24.	1,1-Dichloroethylene		<0.025
25.	trans-1,2-Dichloroethene		NA
26.	1,2-Dichloropropane	X	<0.025-230,000
27.	trans-1,3-Dichloropropene	X	<0.025-290,000
28.	cis-1,3-Dichloropropene	X	<0.025-160,000

NA - Not analyzed.
* - Not detected in the untreated waste, but detected in the treatment residual.
X - Indicates that a constituent was quantified above its detection limit in one or more untreated F024 samples.

Table 6-1 (Continued)

STATUS OF BDAT LIST CONSTITUENTS
IN UNTREATED F024

BDAT List Constituent		Detection Status	Concentration in Untreated F024 (mg/kg)
Volatiles (Continued)			
29.	1,4-Dioxane		<1
224.	2-Ethoxyethanol		NA
225.	Ethyl acetate		NA
226.	Ethyl benzene	X	<0.025-230
30.	Ethyl cyanide		<20
227.	Ethyl ether		NA
31.	Ethyl methacrylate		<0.5
214.	Ethylene oxide		<2
32.	Iodomethane		<0.25
33.	Isobutyl alcohol		<1
228.	Methanol		NA
34.	Methyl ethyl ketone	X	<0.05-2,200
229.	Methyl isobutyl ketone		<0.05
35.	Methyl methacrylate		<0.5
37.	Methacrylonitrile		<0.5
38.	Methylene chloride	X	<1-1,900
230.	2-Nitropropane		NA
39.	Pyridine		<2
40.	1,1,1,2-Tetrachloroethane	X	<0.025-58,000
41.	1,1,2,2-Tetrachloroethane	X	<0.025-16,000
42.	Tetrachloroethene	X	<1-47,200
43.	Toluene	X	<0.025-34,000
44.	Tribromomethane		<0.025
45.	1,1,1-Trichloroethane	X	<0.025-620
46.	1,1,2-Trichloroethane	X	<0.025-92,000
47.	Trichloroethene	X	<0.025-81,800
48.	Trichloromonofluoromethane		<1
49.	1,2,3-Trichloropropane	X	<0.025-9,712
231.	1,1,2-Trichloro-1,2,2-trifluoroethane		NA
50.	Vinyl chloride	X	<0.05-1,000

NA - Not analyzed.
X - Indicates that a constituent was quantified above its detection limit in one or more untreated F024 samples.

Table 6-1 (Continued)

STATUS OF BDAT LIST CONSTITUENTS
IN UNTREATED F024

BDAT List Constituent		Detection Status	Concentration in Untreated F024 (mg/kg)
Volatiles (Continued)			
215.	1,2-Xylene		<0.025
216.	1,3-Xylene		<0.025
217.	1,4-Xylene		<0.025
Semivolatiles			
51.	Acenaphthalene		<0.351
52.	Acenaphthene		<0.351
53.	Acetophenone		<1.76
54.	2-Acetylaminofluorene		<0.702
55.	4-Aminobiphenyl		<0.702
56.	Aniline		<0.351
57.	Anthracene		<172
58.	Aramite		<1.76
59.	Benz(a)anthracene	X	<24-0.888
218.	Benzal chloride		NA
60.	Benzenethiol		<0.702
62.	Benzo(a)pyrene	X	<0.351-0.60
63.	Benzo(b)fluoranthene	X	<24-0.716
64.	Benzo(ghi)perylene	X	<0.351-0.421
65.	Benzo(k)fluoranthene	X	<24-0.874
66.	p-Benzoquinone		<0.351
67.	Bis(2-chloroethoxy)methane		<0.351
68.	Bis(2-chloroethyl)ether	X	<0.351-9,800
69.	Bis(2-chloroisopropyl)ether		<0.351
70.	Bis(2-ethylhexyl)phthalate	X	<24-480
71.	4-Bromophenyl phenyl ether		<0.351
72.	Butyl benzyl phthalate		<0.351
73.	2-sec-Butyl-4,6-dinitrophenol		<1.76
74.	p-Chloroaniline		<0.351
75.	Chlorobenzilate		<0.702

NA - Not analyzed.
X - Indicates that a constituent was quantified above its detection limit in one or more untreated F024 samples.

Table 6-1 (Continued)

STATUS OF BDAT LIST CONSTITUENTS
IN UNTREATED F024

BDAT List Constituent		Detection Status	Concentration in Untreated F024 (mg/kg)
Semivolatiles (Continued)			
76.	p-Chloro-m-cresol		<0.351
77.	2-Chloronaphthalene	X	<0.351-260
78.	2-Chlorophenol		<0.351
79.	3-Chloropropionitrile		<0.702
80.	Chrysene	X	<24-1.06
81.	ortho-Cresol		<0.351
82.	para-Cresol		<0.351
232.	Cyclohexanone		NA
83.	Dibenz(a,h)anthracene		<0.351
84.	Dibenzo(a,e)pyrene		NA
85.	Dibenzo(a,i)pyrene		NA
86.	m-Dichlorobenzene	X	<0.351-1,300
87.	o-Dichlorobenzene	X	<0.351-24,000
88.	p-Dichlorobenzene	X	<0.351-8,000
89.	3,3'-Dichlorobenzidine		<1.76
90.	2,4-Dichlorophenol		<0.351
91.	2,6-Dichlorophenol		<0.702
92.	Diethyl phthalate	X	<0.351-120
93.	3,3'-Dimethoxybenzidine		<0.702
94.	p-Dimethylaminoazobenzene		<0.702
95.	3,3'-Dimethylbenzidine		<0.702
96.	2,4-Dimethylphenol		<0.351
97.	Dimethyl phthalate		<0.351
98.	Di-n-butyl phthalate		<0.351
99.	1,4-Dinitrobenzene		<0.351
100.	4,6-Dinitro-o-cresol		<1.76
101.	2,4-Dinitrophenol		<1.76
102.	2,4-Dinitrotoluene		<0.351
103.	2,6-Dinitrotoluene		<0.351
104.	Di-n-octyl phthalate	X	<0.351-34

NA - Not analyzed.
X - Indicates that a constituent was quantified above its detection limit in one or more untreated F024 samples.

Table 6-1 (Continued)

STATUS OF BDAT LIST CONSTITUENTS
IN UNTREATED F024

BDAT List Constituent		Detection Status	Concentration in Untreated F024 (mg/kg)
Semivolatiles (Continued)			
105.	Di-n-propylnitrosamine		<0.351
106.	Diphenylamine		<0.702
219.	Diphenylnitrosamine		NA
107.	1,2-Diphenylhydrazine		<1.76
108.	Fluoranthene		<0.351
109.	Fluorene		<0.351
110.	Hexachlorobenzene	X	<24-18,018
111.	Hexachlorobutadiene	X	<0.351-16,470
112.	Hexachlorocyclopentadiene	X	<0.351-1.3
113.	Hexachloroethane	X	<0.351-460,000
114.	Hexachlorophene		NA
115.	Hexachloropropene		<0.702
116.	Indeno(1,2,3-cd)pyrene	X	<0.351-0.411
117.	Isosafrole		<0.702
118.	Methapyrilene		<0.702
119.	3-Methylcholanthrene		<0.702
120.	4,4'-Methylenebis(2-chloroaniline)		<0.702
36.	Methyl methanesulfonate		NA
121.	Naphthalene	X	<24-330
122.	1,4-Naphthoquinone		<0.702
123.	1-Naphthylamine		<1.76
124.	2-Naphthylamine		<1.76
125.	p-Nitroaniline		<1.76
126.	Nitrobenzene	X	<0.351-1.4
127.	4-Nitrophenol		<1.76
128.	n-Nitrosodi-n-butylamine		<0.702
129.	n-Nitrosodiethylamine		<0.351
130.	n-Nitrosodimethylamine		<0.351
131.	n-Nitrosomethylethylamine		<0.351
132.	n-Nitrosomorpholine		<0.702

NA - Not analyzed.
X - Indicates that a constituent was quantified above its detection limit in one or more untreated F024 samples.

Table 6-1 (Continued)

STATUS OF BDAT LIST CONSTITUENTS
IN UNTREATED F024

BDAT List Constituent	Detection Status	Concentration in Untreated F024 (mg/kg)
Semivolatiles (Continued)		
133. n-Nitrosopiperidine		<0.351
134. n-Nitrosopyrrolidine		<1.76
135. 5-Nitro-o-toluidine		<1.76
136. Pentachlorobenzene	X	<1.76-1,290
137. Pentachloroethane	X	<0.351-26,000
138. Pentachloronitrobenzene		<3.51
139. Pentachlorophenol		<1.76
140. Phenacetin		<0.702
141. Phenanthrene	X	<24-1.27
142. Phenol		<0.351
220. Phthalic anhydride		<0.351
143. 2-Picoline		NA
144. Pronamide		<0.351
145. Pyrene		<0.702
146. Resorcinol		<0.351
147. Safrole		<0.351
148. 1,2,4,5-Tetrachlorobenzene		<1.76
149. 2,3,4,6-Tetrachlorophenol		<0.702
150. 1,2,4-Trichlorobenzene	X	<0.351-1,400
151. 2,4,5-Trichlorophenol		<1.76
152. 2,4,6-Trichlorophenol		<0.351
153. Tris(2,3-dibromopropyl)phosphate		<1.76
Metals		
154. Antimony	X	<1.8-2.2
155. Arsenic	X	<0.86-7.8
156. Barium	X	0.22-34
157. Beryllium		<0.1*
158. Cadmium	X	<0.26-3.1

NA - Not analyzed.
* - Not detected in the untreated waste, but detected in the treatment residual.
X - Indicates that a constituent was quantified above its detection limit in one or more untreated F024 samples.

Table 6-1 (Continued)

STATUS OF BDAT LIST CONSTITUENTS
IN UNTREATED F024

BDAT List Constituent	Detection Status	Concentration in Untreated F024 (mg/kg)
Metals (Continued)		
159. Chromium (total)	X	<0.4-285
221. Chromium (hexavalent)		<10
160. Copper	X	<0.4-800
161. Lead	X	<0.43-9.0
162. Mercury	X	<0.1-0.24
163. Nickel	X	<0.9-636
164. Selenium		<0.5*
165. Silver		<0.4
166. Thallium		<10
167. Vanadium	X	<0.17-10
168. Zinc	X	0.73-443
Inorganics		
169. Cyanide	X	<0.43-4.57
170. Fluoride	X	<0.99-10.5
171. Sulfide	X	<4.6-349
Organochlorine pesticides		NA
Phenoxyacetic acid herbicides		NA
Organophosphorous insecticides		NA
PCBs		
200. Aroclor 1016		<10
201. Aroclor 1221		<10
202. Aroclor 1232		<10
203. Aroclor 1242		<10
204. Aroclor 1248		<10
205. Aroclor 1254		<10
206. Aroclor 1260		<10

NOTE: The BDAT List pesticides were not expected to be seen in the F024 samples or treatment residuals and were not analyzed for.
NA - Not analyzed.

X - Indicates that a constituent was quantified above its detection limit in one or more untreated F024 samples.

Table 6-1 (Continued)

STATUS OF BDAT LIST CONSTITUENTS
IN UNTREATED F024

BDAT List Constituent	Detection Status	Concentration in Untreated F024 (mg/kg)
Dioxins and furans		(ug/kg)
207. Hexachlorodibenzo-p-dioxins	X	<0.0005-10
208. Hexachlorodibenzofurans	X	<0.0007-50
209. Pentachlorodibenzo-p-dioxins	X	<0.0005-2
210. Pentachlorodibenzofurans	X	<0.0005-30
211. Tetrachlorodibenzo-p-dioxins		<0.03
212. Tetrachlorodibenzofurans		<0.0002-10
213. 2,3,7,8-Tetrachlorodibenzo-p-dioxin	X	<0.03

X - Indicates that a constituent was quantified above its detection limit in one or more untreated F024 samples.

Table 6-2

BDAT LIST CONSTITUENTS CONSIDERED FOR REGULATION*
IN F024 NONWASTEWATER AFTER INITIAL SCREENING

222.	Acetone
4.	Benzene
5.	Bromodichloromethane
7.	Carbon tetrachloride
9.	Chlorobenzene
10.	2-Chloro-1,3-butadiene
14.	Chloroform
16.	3-Chloropropene
20.	trans-1,4-Dichloro-2-butene
21.	Dichlorodifluoromethane
22.	1,1-Dichloroethane
23.	1,2-Dichloroethane
26.	1,2-Dichloropropane
27.	trans-1,3-Dichloropropene
28.	cis-1,3-Dichloropropene
226.	Ethyl benzene
34.	Methyl ethyl ketone
38.	Methylene chloride
40.	1,1,1,2-Tetrachloroethane
41.	1,1,2,2-Tetrachloroethane
42.	Tetrachloroethene
43.	Toluene
45.	1,1,1-Trichloroethane
46.	1,1,2-Trichloroethane
47.	Trichloroethene
49.	1,2,3-Trichloropropane
50.	Vinyl chloride
68.	Bis(2-chloroethyl)ether
70.	Bis(2-ethylhexyl)phthalate
77.	2-Chloronaphthalene
86.	1,3-Dichlorobenzene
87.	1,2-Dichlorobenzene
88.	1,4-Dichlorobenzene
92.	Diethyl phthalate

*All constituents on this list were detected in F024 and were either selected for proposed regulation (as shown in Table 6-4) or are believed to be controlled by regulation of another consitituent.

Table 6-2 (Continued)

BDAT LIST CONSTITUENTS CONSIDERED FOR REGULATION*
IN F024 NONWASTEWATER, AFTER INITIAL SCREENING

104.	Di-n-octyl phthalate
110.	Hexachlorobenzene
111.	Hexachlorobutadiene
112.	Hexachlorocyclopentadiene
113.	Hexachloroethane
121.	Naphthalene
126.	Nitrobenzene
136.	Pentachlorobenzene
137.	Pentachloroethane
141.	Phenanthrene
150.	1,2,4-Trichlorobenzene
154.	Antimony
157.	Beryllium
159.	Chromium (total)
163.	Nickel
169.	Cyanide
207.	Hexachlorodibenzo-p-dioxins
208.	Hexachlorodibenzofurans
209.	Pentachlorodibenzo-p-dioxins
210.	Pentachlorodibenzofurans
212.	Tetrachlorodibenzofurans

*All constituents on this list were detected in F024 and were either selected for proposed regulation (as shown in Table 6-4) or are believed to be controlled by regulation of another consitituent.

Table 6-3

BDAT LIST CONSTITUENTS CONSIDERED FOR REGULATION*
IN F024 WASTEWATER AFTER INITIAL SCREENING

222.	Acetone
4.	Benzene
5.	Bromodichloromethane
6.	Bromomethane
7.	Carbon tetrachloride
9.	Chlorobenzene
10.	2-Chloro-1,3-butadiene
12.	Chloroethane
14.	Chloroform
15.	Chloromethane
16.	3-Chloropropene
20.	trans-1,4-Dichloro-2-butene
21.	Dichlorodifluoromethane
22.	1,1-Dichloroethane
23.	1,2-Dichloroethane
26.	1,2-Dichloropropane
27.	trans-1,3-Dichloropropene
28.	cis-1,3-Dichloropropene
226.	Ethyl benzene
34.	Methyl ethyl ketone
38.	Methylene chloride
40.	1,1,1,2-Tetrachloroethane
41.	1,1,2,2-Tetrachloroethane
42.	Tetrachloroethene
43.	Toluene
45.	1,1,1-Trichloroethane
46.	1,1,2-Trichloroethane
47.	Trichloroethene
49.	1,2,3-Trichloropropane
50.	Vinyl chloride
68.	Bis(2-chloroethyl)ether
70.	Bis(2-ethylhexyl)phthalate
77.	2-Chloronaphthalene

*All constituents on this list were detected in F024 and were either selected for proposed regulation (as shown in Table 6-5) or are believed to be controlled by regulation of another constituent.

Table 6-3 (Continued)

BDAT LIST CONSTITUENTS CONSIDERED FOR REGULATION*
IN F024 WASTEWATER AFTER INITIAL SCREENING

86.	1,3-Dichlorobenzene
87.	1,2-Dichlorobenzene
88.	1,4-Dichlorobenzene
92.	Diethyl phthalate
104.	Di-n-octyl phthalate
110.	Hexachlorobenzene
111.	Hexachlorobutadiene
112.	Hexachlorocyclopentadiene
113.	Hexachloroethane
121.	Naphthalene
126.	Nitrobenzene
136.	Pentachlorobenzene
137.	Pentachloroethane
141.	Phenanthrene
150.	1,2,4-Trichlorobenzene
154.	Antimony
155.	Arsenic
158.	Cadmium
159.	Chromium (total)
161.	Lead
162.	Mercury
163.	Nickel
164.	Selenium
165.	Silver
169.	Cyanide
207.	Hexachlorodibenzo-p-dioxins
208.	Hexachlorodibenzofurans
209.	Pentachlorodibenzo-p-dioxins
210.	Pentachlorodibenzofurans
212.	Tetrachlorodibenzofurans

*All constituents on this list were detected in F024 and were either selected for proposed regulation (as shown in Table 6-5) or are believed to be controlled by regulation of another constituent.

Table 6-4

BDAT LIST CONSTITUENTS SELECTED FOR PROPOSED REGULATION
IN F024 NONWASTEWATER

10.	2-Chloro-1,3-butadiene
16.	3-Chloropropene
22.	1,1-Dichloroethane
23.	1,2-Dichloroethane
26.	1,2-Dichloropropane
27.	trans-1,3-Dichloropropene
28.	cis-1,3-Dichloropropene
70.	Bis(2-ethylhexyl)phthalate
104.	Di-n-octyl phthalate
113.	Hexachloroethane
159.	Chromium (total)
163.	Nickel
207.	Hexachlorodibenzo-p-dioxins
208.	Hexachlorodibenzofurans
209.	Pentachlorodibenzo-p-dioxins
210.	Pentachlorodibenzofurans
212.	Tetrachlorodibenzofurans

Table 6-5

CONTROL OF CONSTITUENTS DELETED FROM FURTHER CONSIDERATION FOR PROPOSED REGULATION
BY CONSTITUENTS SELECTED FOR PROPOSED REGULATION IN F024 NONWASTEWATER

	BDAT List Constituent Deleted from Further Consideration for Proposed Regulation (Boiling Point)	BDAT List Constituent Proposed for Regulation (Boiling Point)														
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
50.	Vinyl chloride (-13.37°C)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
38.	Methylene chloride (39.75°C)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
222.	Acetone (56.5°C)		X	X	X	X	X	X	X	X	X	X	X	X	X	X
14.	Chloroform (61-62°C)				X	X	X	X	X	X	X	X	X	X	X	X
45.	1,1,1-Trichloroethane (74-74.1°C)				X	X	X	X	X	X	X	X	X	X	X	X
7.	Carbon tetrachloride (76.7-77°C)				X	X	X	X	X	X	X	X	X	X	X	X
34.	Methyl ethyl ketone (79.6°C)				X	X	X	X	X	X	X	X	X	X	X	X
4.	Benzene (80°C)				X	X	X	X	X	X	X	X	X	X	X	X
47.	Trichloroethene (86.7-87°C)					X	X	X	X	X	X	X	X	X	X	X
5.	Bromodichloromethane (90°C)					X	X	X	X	X	X	X	X	X	X	X
43.	Toluene (110.6°C)							X	X	X	X	X	X	X	X	X
46.	1,1,2-Trichloroethane (113-114°C)								X	X	X	X	X	X	X	X
42.	Tetrachloroethene (121°C)								X	X	X	X	X	X	X	X
9.	Chlorobenzene (131-132°C)								X	X	X	X	X	X	X	X
226.	Ethyl benzene (136.3°C)								X	X	X	X	X	X	X	X
40.	1,1,1,2-Tetrachloroethane (146.5°C)								X	X	X	X	X	X	X	X
41.	1,1,2,2-Tetrachloroethane (146.5-147°C)								X	X	X	X	X	X	X	X
20.	trans-1,4-Dichloro-2-butene (155.5°C)								X	X	X	X	X	X	X	X
49.	1,2,3-Trichloropropane (156.8°C)								X	X	X	X	X	X	X	X
137.	Pentachloroethane (161-162°C)								X	X	X	X	X	X	X	X
86.	1,3-Dichlorobenzene (173°C)								X	X	X	X	X	X	X	X
88.	1,4-Dichlorobenzene (174-174.1°C)								X	X	X	X	X	X	X	X
68.	Bis(2-chloroethyl)ether (178°C)								X	X	X	X	X	X	X	X
87.	1,2-Dichlorobenzene (180.5-181°C)								X	X	X	X	X	X	X	X

KEY:

A - 16. 3-Chloropropene (44-45°C)
B - 22. 1,1-Dichloroethane (57-57.3°C)
C - 10. 2-Chloro-1,3-butadiene (59.4°C)
D - 23. 1,2-Dichloroethane (83-84°C)
E - 26. 1,2-Dichloropropane (96.4°C)
F - 28. cis-1,3-Dichloropropene (108°C)
G - 27. trans-1,3-Dichloropropene (112°C)
H - 113. Hexachloroethane (186.8-187°C)
I - 70. Bis(2-ethylhexyl)phthalate (385°C)
J - 104. Di-n-octyl phthalate (385°C)
K - 207. Hexachlorodibenzo-p-dioxins (400-500°C)
L - 208. Hexachlorodibenzofurans (400-500°C)
M - 209. Pentachlorodibenzo-p-dioxins (400-500°C)
N - 210. Pentachlorodibenzofurans (400-500°C)
O - 212. Tetrachlorodibenzofurans (400-500°C)

X - Indicates EPA's belief that the constituent deleted from further consideration for proposed regulation will be adequately controlled by regulation of the indicated constituent proposed for regulation.

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Table 6-5 (Continued)

CONTROL OF CONSTITUENTS DELETED FROM FURTHER CONSIDERATION FOR PROPOSED REGULATION
BY CONSTITUENTS SELECTED FOR PROPOSED REGULATION IN F024 NONWASTEWATER

	BDAT List Constituent Deleted from Further Consideration for Proposed Regulation (Boiling Point)	BDAT List Constituent Proposed for Regulation (Boiling Point)														
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
126.	Nitrobenzene (210-211°C)									X	X	X	X	X	X	X
111.	Hexachlorobutadiene (210-220°C)									X	X	X	X	X	X	X
150.	1,2,4-Trichlorobenzene (213°C)									X	X	X	X	X	X	X
121.	Naphthalene (217.9-218°C)									X	X	X	X	X	X	X
112.	Hexachlorocyclopentadiene (234°C)									X	X	X	X	X	X	X
77.	2-Chloronaphthalene (256°C)									X	X	X	X	X	X	X
136.	Pentachlorobenzene (275-277°C)									X	X	X	X	X	X	X
92.	Diethyl phthalate (298°C)									X	X	X	X	X	X	X
110.	Hexachlorobenzene (323-326°C)									X	X	X	X	X	X	X
141.	Phenanthrene (340°C)									X	X	X	X	X	X	X

KEY:

A - 16. 3-Chloropropene (44-45°C)
B - 22. 1,1-Dichloroethane (57-57.3°C)
C - 10. 2-Chloro-1,3-butadiene (59.4°C)
D - 23. 1,2-Dichloroethane (83-84°C)
E - 26. 1,2-Dichloropropane (96.4°C)
F - 28. cis-1,3-Dichloropropene (108°C)
G - 27. trans-1,3-Dichloropropene (112°C)
H - 113. Hexachloroethane (186.8-187°C)

I - 70. Bis(2-ethylhexyl)phthalate (385°C)
J - 104. Di-n-octyl phthalate (385°C)
K - 207. Hexachlorodibenzo-p-dioxins (400-500°C)
L - 208. Hexachlorodibenzofurans (400-500°C)
M - 209. Pentachlorodibenzo-p-dioxins (400-500°C)
N - 210. Pentachlorodibenzofurans (400-500°C)
O - 212. Tetrachlorodibenzofurans (400-500°C)

X - Indicates EPA's belief that the constituent deleted from further consideration for proposed regulation will be adequately controlled by regulation of the indicated constituent proposed for regulation.

Table 6-6

BDAT LIST CONSTITUENTS SELECTED FOR PROPOSED REGULATION
IN F024 WASTEWATER

10.	2-Chloro-1,3-butadiene
16.	3-Chloropropene
22.	1,1-Dichloroethane
23.	1,2-Dichloroethane
26.	1,2-Dichloropropane
27.	trans-1,3-Dichloropropene
28.	cis-1,3-Dichloropropene
70.	Bis(2-ethylhexyl)phthalate
104.	Di-n-octyl phthalate
113.	Hexachloroethane
159.	Chromium (total)
163.	Nickel
207.	Hexachlorodibenzo-p-dioxins
208.	Hexachlorodibenzofurans
209.	Pentachlorodibenzo-p-dioxins
210.	Pentachlorodibenzofurans
212.	Tetrachlorodibenzofurans

Table 6-7

CONTROL OF CONSTITUENTS DELETED FROM FURTHER CONSIDERATION FOR PROPOSED REGULATION
BY CONSTITUENTS SELECTED FOR PROPOSED REGULATION IN F024 WASTEWATER

	BDAT List Constituent Deleted from Further Consideration for Proposed Regulation (BDE)	BDAT List Constituent Proposed for Regulation (Bond Dissociation Energy)														
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
7.	Carbon tetrachloride (320 kcal/mole)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
5.	Bromodichloromethane (330 kcal/mole)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
14.	Chloroform (340 kcal/mole)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
38.	Methylene chloride (360 kcal/mole)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
42.	Tetrachloroethene (465 kcal/mole)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
47.	Trichloroethene (485 kcal/mole)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
50.	Vinyl chloride (525 kcal/mole)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
137.	Pentachloroethane (585 kcal/mole)		X	X	X	X	X	X	X	X	X	X	X	X	X	X
40.	1,1,1,2-Tetrachloroethane (605 kcal/mole)		X	X	X	X	X	X	X	X	X	X	X	X	X	X
41.	1,1,2,2-Tetrachloroethane (605 kcal/mole)		X	X	X	X	X	X	X	X	X	X	X	X	X	X
45.	1,1,1-Trichloroethane (625 kcal/mole)		X	X	X	X	X	X	X	X	X	X	X	X	X	X
46.	1,1,2-Trichloroethane (625 kcal/mole)		X	X	X	X	X	X	X	X	X	X	X	X	X	X
111.	Hexachlorobutadiene (855 kcal/mole)							X	X	X	X	X	X	X	X	X
49.	1,2,3-Trichloropropane (910 kcal/mole)							X	X	X	X	X	X	X	X	X
222.	Acetone (945 kcal/mole)								X	X	X	X	X	X	X	X
112.	Hexachlorocyclopentadiene (1,025 kcal/mole)												X	X	X	X
20.	trans-1,4-Dichloro-2-butene (1,075 kcal/mole)												X	X	X	X
34.	Methyl ethyl ketone (1,230 kcal/mole)												X	X	X	X
68.	Bis(2-chloroethyl)ether (1,290 kcal/mole)												X	X	X	X
86.	1,3-Dichlorobenzene (1,295 kcal/mole)												X	X	X	X

KEY:

A - 113. Hexachloroethane (565 kcal/mole)
B - 22. 1,1-Dichloroethane (645 kcal/mole)
C - 23. 1,2-Dichloroethane (645 kcal/mole)
D - 27. trans-1,3-Dichloropropene (790 kcal/mole)
E - 28. cis-1,3-Dichloropropene (790 kcal/mole)
F - 16. 3-Chloropropene (810 kcal/mole)
G - 26. 1,2-Dichloropropane (930 kcal/mole)
H - 10. 2-Chloro-1,3-butadiene (955 kcal/mole)
I - 208. Hexachlorodibenzofurans (960 kcal/mole)
J - 210. Pentachlorodibenzofurans (980 kcal/mole)
K - 212. Tetrachlorodibenzofurans (1,000 kcal/mole)
L - 207. Hexachlorodibenzo-p-dioxins (2,470 kcal/mole)
M - 209. Pentachlorodibenzo-p-dioxins (2,490 kcal/mole)
N - 70. Bis(2-ethylhexyl)phthalate (6,465 kcal/mole)
O - 104. Di-n-octyl phthalate (6,565 kcal/mole)

X - Indicates EPA's belief that the constituent deleted from further consideration for proposed regulation will be adequately controlled by regulation of the indicated constituent proposed for regulation.

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Table 6-7 (Continued)

CONTROL OF CONSTITUENTS DELETED FROM FURTHER CONSIDERATION FOR PROPOSED REGULATION
BY CONSTITUENTS SELECTED FOR PROPOSED REGULATION IN F024 WASTEWATER

	BDAT List Constituent Deleted from Further Consideration for Proposed Regulation (BDE)	BDAT List Constituent Proposed for Regulation (Bond Dissociation Energy)														
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
87.	1,2-Dichlorobenzene (1,295 kcal/mole)												X	X	X	X
88.	1,4-Dichlorobenzene (1,295 kcal/mole)												X	X	X	X
110.	Hexachlorobenzene (1,305 kcal/mole)												X	X	X	X
136.	Pentachlorobenzene (1,310 kcal/mole)												X	X	X	X
150.	1,2,4-Trichlorobenzene (1,320 kcal/mole)												X	X	X	X
9.	Chlorobenzene (1,330 kcal/mole)												X	X	X	X
4.	Benzene (1,340 kcal/mole)												X	X	X	X
126.	Nitrobenzene (1,435 kcal/mole)												X	X	X	X
43.	Toluene (1,620 kcal/mole)												X	X	X	X
226.	Ethyl benzene (1,905 kcal/mole)														X	X
77.	2-Chloronaphthalene (2,115 kcal/mole)												X	X	X	X
121.	Naphthalene (2,120 kcal/mole)												X	X	X	X
141.	Phenanthrene (2,900 kcal/mole)														X	X
92.	Diethyl phthalate (3,145 kcal/mole)														X	X

KEY:

A - 113. Hexachloroethane (565 kcal/mole)
B - 22. 1,1-Dichloroethane (645 kcal/mole)
C - 23. 1,2-Dichloroethane (645 kcal/mole)
D - 27. trans-1,3-Dichloropropene (790 kcal/mole)
E - 28. cis-1,3-Dichloropropene (790 kcal/mole)
F - 16. 3-Chloropropene (810 kcal/mole)
G - 26. 1,2-Dichloropropane (930 kcal/mole)
H - 10. 2-Chloro-1,3-butadiene (955 kcal/mole)
I - 208. Hexachlorodibenzofurans (960 kcal/mole)
J - 210. Pentachlorodibenzofurans (980 kcal/mole)
K - 212. Tetrachlorodibenzofurans (1,000 kcal/mole)
L - 207. Hexachlorodibenzo-p-dioxins (2,470 kcal/mole)
M - 209. Pentachlorodibenzo-p-dioxins (2,490 kcal/mole)
N - 70. Bis(2-ethylhexyl)phthalate (6,465 kcal/mole)
O - 104. Di-n-octyl phthalate (6,565 kcal/mole)

X - Indicates EPA's belief that the constituent deleted from further consideration for proposed regulation will be adequately controlled by regulation of the indicated constituent proposed for regulation.

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7.0 DEVELOPMENT OF BDAT TREATMENT STANDARDS

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

BDAT treatment standards are determined for each constituent by multiplying the arithmetic mean of accuracy-adjusted constituent concentrations detected in treated waste by a "variability factor" specific to each constituent in a treatment performance data set. Accuracy adjustment of treatment performance data was discussed in Section 5.0 in relation to defining "substantial treatment." Variability factors correct for normal variations in the performance of a particular technology over time and are designed to reflect the 99th percentile level of performance that the technology achieves in commercial operation. (For more information on the principles of calculating variability factors, see EPA's Methodology for Developing BDAT Treatment Standards.)

Where EPA has identified BDAT for a particular waste, but because of data limitations or for some other compelling reason cannot define specific concentration-based treatment standards for that waste, the Agency can require the use of that treatment technology as a treatment standard. Similarly, where there are no known generators of a waste, or where EPA believes that the

waste can be totally recycled or reused as a raw material, the Agency may specify a "no land disposal" standard, which effectively amounts to establishing a treatment performance standard at zero for all waste constituents.

In Section 5.0 of this document, the best demonstrated and available technology for treatment of F024 was chosen based on available treatment performance data. In Section 6.0, the constituents proposed for regulation were selected in order to ensure effective treatment of the waste. The purpose of Section 7.0 is to calculate proposed treatment standards for each of these constituents using the available treatment performance data from the BDAT treatment technologies. Included in this section is a step-by-step discussion of the calculation of proposed treatment standards for the nonwastewater and wastewater forms of F024.

Rotary kiln incineration followed by stabilization of incinerator ash and chemical precipitation followed by filtration of scrubber water was determined to be BDAT for F024 (see Section 5.0). Rotary kiln incineration generally results in the generation of two treatment residuals: ash (a nonwastewater form of F024) and combustion gas scrubber water (a wastewater form of F024). The best measure of performance for a destruction technology, such as rotary kiln incineration, is the total amount of constituent remaining after treatment. Therefore, proposed BDAT treatment standards for organic constituents were calculated based on total constituent concentration data. Proposed BDAT treatment standards for metal constituents were based on treatment performance data transferred from K048 and K051 for nonwastewater

residuals and K062 mixed with other metal-bearing characteristic wastes for wastewater residuals. Proposed BDAT treatment standards for dioxin and furan constituents are set at the analytical limit of detection that can be routinely achieved for these constituents, consistent with the dioxins rule promulgated by the Agency on November 8, 1986 (51 Federal Register, 40572, 40638).

7.1 Calculation of Treatment Standards for Nonwastewater Forms of F024

BDAT List Organics

The proposed treatment standards for nonwastewater forms of F024 were calculated using treatment performance data from rotary kiln incineration of F024. Table 7-1 presents the concentrations of organic constituents in the treatment residual (ash) resulting from rotary kiln incineration of F024. Concentrations are presented for constituents that were used to develop proposed treatment standards for constituents in F024 nonwastewater, as discussed further in this subsection. The concentration data presented in Table 7-1 have been corrected for accuracy to account for analytical recovery as described in Section 5.0.

The proposed nonwastewater treatment standards were calculated for organic constituents being proposed for regulation in F024 as shown in Table 7-2. The following three steps were used to calculate the proposed treatment standards:

Table 7-1

CORRECTED CONCENTRATION DATA FOR ORGANICS AND
METALS IN ROTARY KILN INCINERATOR ASH FROM TREATMENT OF F024

BDAT List Constituent	Sample Set:	Corrected Concentration* in the Treated Waste					
		Total Composition (mg/kg)					
		1	2	3	4	5	6
Volatiles							
23. 1,2-Dichloroethane		0.005	0.005	0.005	0.005	0.005	0.005
46. 1,1,2-Trichloroethane		0.005	0.005	0.005	0.005	0.005	0.005
Semivolatiles							
70. Bis(2-ethylhexyl) phthalate		0.632	0.632	0.666	0.632	0.632	0.632
113. Hexachloroethane		0.632	0.632	0.666	0.632	0.632	0.632
		TCLP (mg/l)					
Metals**							
159. Chromium (total)		1.47	1.58	1.41			
163. Nickel		0.026	0.026	0.026			

*Constituent concentrations have been adjusted for accuracy to account for analytical recoveries ("corrected"), as discussed in Section 5.0.

**These data are from the stabilization of K048 and K051 incinerator ash.

Table 7-2

CALCULATION OF PROPOSED NONWASTEWATER TREATMENT STANDARDS FOR F024

Regulated Constituent	F024 Constituent From Which Treatment Performance Data Were Transferred	Arithmetic Average of Corrected Treatment Values (ppm)	Variability Factor (VF)	Proposed Treatment Standard* (Average x VF) (ppm)
Organics (Total Composition)				
10. 2-Chloro-1,3-butadiene**	1,2-Dichloroethane	0.005	2.8	0.014
16. 3-Chloropropene**	1,2-Dichloroethane	0.005	2.8	0.014
22. 1,1-Dichloroethane	1,2-Dichloroethane	0.005	2.8	0.014
23. 1,2-Dichloroethane	NA	0.005	2.8	0.014
26. 1,2-Dichloropropane**	1,1,2-Trichloroethane	0.005	2.8	0.014
27. trans-1,3-Dichloropropene**	1,1,2-Trichloroethane	0.005	2.8	0.014
28. cis-1,3-Dichloropropene**	1,1,2-Trichloroethane	0.005	2.8	0.014
70. Bis(2-ethylhexyl)phthalate	NA	0.63	2.8	1.8
104. Di-n-octyl phthalate	Bis(2-ethylhexyl)phthalate	0.63	2.8	1.8
113. Hexachloroethane	NA	0.63	2.8	1.8

Regulated Constituent	K048/K051 Constituent From Which Treatment Performance Data Were Transferred	Arithmetic Average of Corrected Treatment Values (ppm)	Variability Factor (VF)	Proposed Treatment Standard* (Average x VF) (ppm)
Metals (TCLP)				
159. Chromium (total)	Chromium (total)	1.48	1.14	1.7
163. Nickel	Nickel	0.027	1.79	0.048

*The values shown on this table for treatment standards have been rounded off to show significant figures only.

**This constituent was found in a liquid form of F024, which was incinerated in a secondary combustor and so, did not contribute to a kiln ash residual.

NA - Not applicable.

Note: The treatment standard being proposed for BDAT List dioxins and furans in F024 is 1 ppb. This represents the analytical limit of detection that can be routinely achieved for these constituents by laboratories in the United States, consistent with the dioxins rule promulgated by the Agency on November 8, 1986 (51 Federal Register, 40572, 40638).

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(1) The arithmetic average of the accuracy-corrected concentrations for each regulated constituent in the untreated waste was calculated using the data presented in Table 7-1;

(2) Using these same data, a variability factor (discussed in EPA's Methodology for Developing BDAT Treatment Standards) was calculated that represents the variability inherent in the performance of the treatment system, collection of treated samples, and analysis of samples. Where concentrations in the treated waste were reported as less than or equal to the detection limit for all the data points in the data set, variability is still expected since the actual concentrations could range from 0 to the detection limit. In these cases, the Agency assumed a lognormal distribution of data points between the detection limit and a value 1/10 of the detection limit and calculated a variability factor of 2.8; and

(3) The treatment standard for each constituent being proposed for regulation was calculated by multiplying the arithmetic average of the accuracy-corrected concentrations (from (1) above) by the variability factor (from (2) above).

As explained in Section 6.0, constituents being proposed for regulation were selected based on all available F024 characterization data. However, performance data were not available from treatment of F024 for some organic constituents that were proposed for regulation because not all constituents proposed for regulation were detected in the F024 that was treated by rotary kiln incineration and sampled by EPA. Where treatment performance data were not available for an organic constituent proposed for regulation, treatment performance data were transferred to the organic constituent from another organic constituent that was detected in the untreated F024 sampled by EPA, based on the boiling points of the constituents. (Boiling point is a waste characteristic that affects the performance of rotary kiln incineration, and is discussed in EPA's Treatment Technology Background Document. Appendix C of this document presents information on this waste characteristic. The constituent with the same or the closest

higher boiling point for which the Agency had treatment performance data from rotary kiln incineration of F024 was selected for transfer of treatment performance data to the constituent for which there was no treatment performance data. Cases where such a transfer of data occurred are summarized below and appear in Table 7-2, which shows the calculations of the proposed treatment standards for F024.

Five of the constituents listed below, 2-chloro-1,3-butadiene, 3-chloropropene, 1,2-dichloropropane, trans-1,3-dichloropropene, and cis-1,3-dichloropropene, were detected in a liquid form of untreated F024. Liquid wastes were incinerated in a secondary combustor, and as such, did not contribute to a kiln ash residual. Thus, treatment standards for these constituents had to be calculated based on treatment performance data transferred from constituents that were detected in a solid form of untreated F024, since solid wastes were incinerated in the rotary kiln and contributed to the kiln ash residual. These five constituents are being proposed for regulation in F024 nonwastewater, despite only being found in liquid forms of untreated F024, because of the wide variation in the types of F024 generated by industry. It is likely that each of these constituents is present in a solid form of F024 for which the Agency does not have data. Therefore, establishing nonwastewater treatment performance standards for these constituents ensures that they will be controlled for all types of F024 generated.

10. 2-Chloro-1,3-butadiene. The proposed treatment standard for 2-chloro-1,3-butadiene (bp 59.4°C) is based on data transferred from treatment of 1,2-dichloroethane (bp 83-84°C). The Agency expects that 2-chloro-1,3-

butadiene can be treated to concentrations as low or lower than 1,2-dichloroethane.

16. 3-Chloropropene. The proposed treatment standard for 3-chloropropene (bp 44-45°C) is based on data transferred from treatment of 1,2-dichloroethane (bp 83-84°C). The Agency expects that 3-chloropropene can be treated to concentrations as low or lower than 1,2-dichloroethane.

22. 1,1-Dichloroethane. 1,1-Dichloroethane was not found in the F024 that was treated by rotary kiln incineration and sampled by EPA. The proposed treatment standard for 1,1-dichloroethane (bp 57-57.3°C) is based on data transferred from treatment of 1,2-dichloroethane (bp 83-84°C). The Agency expects that 1,1-dichloroethane can be treated to concentrations as low or lower than 1,2-dichloroethane.

26. 1,2-Dichloropropane. The proposed treatment standard for 1,2-dichloropropane (bp 96.4°C) is based on data transferred from treatment of 1,1,2-trichloroethane (bp 113-114°C). The Agency expects that 1,2-dichloropropane can be treated to concentrations as low or lower than 1,1,2-trichloroethane.

27. trans-1,3-Dichloropropene. The proposed treatment standard for trans-1,3-dichloropropene (bp 112°C) is based on data transferred from treatment of 1,1,2-trichloroethane (bp 113-114°C). The Agency expects that trans-1,3-dichloropropene can be treated to concentrations as low or lower than 1,1,2-trichloroethane.

28. cis-1,3-Dichloropropene. The proposed treatment standard for cis-1,3-dichloropropene (bp 108°C) is based on data transferred from treatment of 1,1,2-trichloroethane (bp 113-114°C). The Agency expects that cis-1,3-dichloropropene can be treated to concentrations as low or lower than 1,1,2-trichloroethane.

104. Di-n-octyl phthalate. Di-n-octyl phthalate was not found in the F024 that was treated by rotary kiln incineration and sampled by EPA. The proposed treatment standard for di-n-octyl phthalate (bp 385°C) is based on data transferred from treatment of bis (2-ethylhexyl) phthalate (bp 385°C). The Agency expects that di-n-octyl phthalate can be treated to concentrations as low or lower than bis (2-ethylhexyl) phthalate.

BDAT List Metals

The Agency has no treatment performance data for metals in F024 nonwastewater. Proposed treatment standards for metal constituents in F024 were based on treatment performance data transferred from the stabilization of K048 and K051 incinerator ash. The Agency believes that K048 and K051 nonwastewater residuals are sufficiently similar to F024 nonwastewater residuals such that treatment performance data can be transferred. Treatment performance data for each metal constituent being proposed for regulation in F024 nonwastewater were transferred from K048 and K051 to F024.

Included in Table 7-1 are the concentrations of metal constituents in the stabilized kiln ash residual resulting from rotary kiln incineration of

K048 and K051. These concentration data have been corrected for accuracy to account for analytical recovery, as described in Section 5.0.

The proposed nonwastewater treatment standards were calculated for metal constituents being proposed for regulation in F024 as shown in Table 7-2. These calculations are consistent with the methodology previously described in this section for BDAT List organic constituents.

The Agency is currently performing BDAT testing using stabilization to treat F024 incinerator ash. Depending on the results of this testing and the levels of treatment performance achieved, the Agency may establish a treatment standard for lead in F024 nonwastewater and may modify the nonwastewater standards for chromium and nickel.

BDAT List Dioxins and Furans

The treatment standard being proposed for dioxins and furans in F024 nonwastewater is 1 ppb. This standard represents the analytical limit of detection that can be routinely achieved by laboratories in the United States, consistent with the dioxins rule promulgated on November 8, 1986 (51 Federal Register, 40572, 40638).

7.2 Calculation of Treatment Standards for Wastewater Forms of F024

BDAT List Organics

The proposed treatment standards for wastewater forms of F024 were calculated using treatment performance data from rotary kiln incineration of F024. Table 7-3 presents the concentrations of organic constituents in the treatment residual (scrubber water) resulting from rotary kiln incineration of F024. Concentrations are presented for constituents that were used to develop proposed treatment standards for constituents in F024 wastewater, as discussed further in this subsection. The concentration data presented in Table 7-3 have been corrected for accuracy to account for analytical recovery as described in Section 5.0.

The proposed wastewater treatment standards were calculated for organic constituents being proposed for regulation in F024 as shown in Table 7-4. The following three steps were used to calculate the proposed treatment standards:

(1) The arithmetic average of the accuracy-corrected concentrations for each regulated constituent in the untreated waste was calculated using the data presented in Table 7-3;

(2) Using these same data, a variability factor (discussed in Appendix A of this document) was calculated that represents the variability inherent in the performance of the treatment system, collection of treated samples, and analysis of samples. Where concentrations in the treated waste were reported as less than or equal to the detection limit for all the data points in the data set, variability is still expected since the actual concentrations could range from 0 to the detection limit. In these cases, the Agency assumed a lognormal distribution of

Table 7-3

CORRECTED CONCENTRATION DATA FOR ORGANICS AND METALS IN COMBUSTION GAS SCRUBBER WATER FROM TREATMENT OF F024

BDAT List Constituent	Sample Set:	Corrected Concentration* in the Treated Waste — Total Composition (mg/l) 1	2	3	4	5	6
Volatiles							
10.	2-Chloro-1-3-butadiene	0.101	0.101	0.101	0.101	0.101	0.101
16.	3-Chloropropene	0.101	0.101	0.101	0.101	0.101	0.101
23.	1,2-Dichloroethane	0.005	0.005	0.005	0.005	0.005	0.005
26.	1,2-Dichloropropane	0.005	0.005	0.005	0.005	0.005	0.005
27.	trans-1,3-Dichloropropene	0.005	0.005	0.005	0.005	0.005	0.005
28.	cis-1,3-Dichloropropene	0.005	0.005	0.005	0.005	0.005	0.005
Semivolatiles							
70.	Bis(2-ethylhexyl) phthalate	0.014	0.014	0.013	0.012	0.013	0.013
113.	Hexachloroethane	0.014	0.014	0.013	0.012	0.013	0.013
Metals**							
159.	Chromium (total)	0.22	0.18	0.26			
163.	Nickel	0.39	0.36	0.42			

*Constituent concentrations have been adjusted for accuracy to account for analytical recoveries ("corrected"), as discussed in Section 5.0.

**These data are from the lime and sulfide precipitation followed by vacuum filtration treatment of K062 mixed with other metal-bearing characteristic wastes.

Table 7-4

CALCULATION OF PROPOSED WASTEWATER TREATMENT STANDARDS FOR F024

Regulated Constituent	F024 Constituent From Which Treatment Performance Data Were Transferred	Arithmetic Average of Corrected Treatment Values (ppm)	Variability Factor (VF)	Proposed Treatment Standard* (Average x VF) (ppm)
Organics (Total Composition)				
10. 2-Chloro-1,3-butadiene	NA	0.101	2.8	0.28
16. 3-Chloropropene	NA	0.101	2.8	0.28
22. 1,1-Dichloroethane	1,2-Dichloroethane	0.005	2.8	0.014
23. 1,2-Dichloroethane	NA	0.005	2.8	0.014
26. 1,2-Dichloropropane	NA	0.005	2.8	0.014
27. trans-1,3-Dichloropropene	NA	0.005	2.8	0.014
28. cis-1,3-Dichloropropene	NA	0.005	2.8	0.014
70. Bis(2-ethylhexyl)phthalate	NA	0.013	2.8	0.036
104. Di-n-octyl phthalate	Bis(2-ethylhexyl)phthalate	0.013	2.8	0.036
113. Hexachloroethane	NA	0.013	2.8	0.036

Regulated Constituent	K062 Constituent From Which Treatment Performance Data Were Transferred	Arithmetic Average of Corrected Treatment Values (ppm)	Variability Factor (VF)	Proposed Treatment Standard* (Average x VF) (ppm)
Metals (Total Composition)				
159. Chromium (total)	Chromium (total)	0.221	1.58	0.35
163. Nickel	Nickel	0.387	1.21	0.47

*The values shown on this table for treatment standards have been rounded off to show significant figures only.

NA - Not applicable.

Note: The treatment standard being proposed for BDAT List dioxins and furans in F024 is 1 ppb. This represents the analytical limit of detection that can be routinely achieved for these constituents by laboratories in the United States, consistent with the dioxins rule promulgated by the Agency on November 8, 1986 (51 Federal Register, 40572, 40638).

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data points between the detection limit and a value 1/10 of the detection limit and calculated a variability factor of 2.8; and

(3) The treatment standard for each constituent being proposed for regulation was calculated by multiplying the arithmetic average of the accuracy-corrected concentrations (from (1) above) by the variability factor (from (2) above).

As discussed in Section 6.0, constituents being proposed for regulation were selected based on all available F024 characterization data. However, performance data were not available from treatment of F024 for some organic constituents that were proposed for regulation, because not all constituents proposed for regulation were detected in the F024 that was treated by rotary kiln incineration and sampled by EPA. Where treatment performance data were not available for an organic constituent proposed for regulation, treatment performance data were transferred to the organic constituent from another organic constituent that was detected in the untreated F024 sampled by EPA, based on the bond dissociation energy of the constituents. (Bond dissociation energy (BDE) is a waste characteristic that affects the performance of rotary kiln incineration, and is discussed in EPA's Treatment Technology Background Document. Appendix C of this document presents information on this waste characteristic. The constituent with the same or the closest bond dissociation energy for which the Agency had treatment data from rotary kiln incineration of F024 was selected for transfer of treatment performance data to the constituent for which there was no treatment performance data. Cases where such a transfer of data occurred are summarized below and appear in Table 7-4, which shows the calculations of the proposed treatment standards for F024.

22. 1,1-Dichloroethane. 1,1-Dichloroethane was not found in the F024 that was treated by rotary kiln incineration and sampled by EPA. The proposed treatment standard for 1,1-dichloroethane (BDE 645 kcal/mole) is based on data transferred from treatment of 1,2-dichloroethane (BDE 645 kcal/mole). The Agency expects that 1,1-dichloroethane can be treated to concentrations as low or lower than 1,2-dichloroethane.

104. Di-n-octyl phthalate. Di-n-octyl phthalate was not found in the F024 that was treated by rotary kiln incineration and sampled by EPA. The proposed treatment standard for di-n-octyl phthalate (BDE 6,565 kcal/mole) is based on data transferred from treatment of bis(2-ethylhexyl) phthalate (BDE 6,465 kcal/mole). The 100 kcal/mole difference between these BDEs is believed to be within the accuracy of the BDE calculation; therefore, the Agency expects that di-n-octyl phthalate can be treated to concentrations as low or lower than bis(2-ethylhexyl) phthalate.

BDAT List Metals

The Agency has no treatment performance data for metals in F024 wastewater. Proposed treatment standards for metal constituents in F024 were based on treatment performance data transferred from the lime and sulfide precipitation followed by vacuum filtration of K062 mixed with other metal-bearing characteristic wastes. The Agency believes that wastewater residuals of K062 mixed with other metal-bearing characteristic wastes are sufficiently

similar to F024 wastewater residuals such that treatment performance data can be transferred. Treatment performance data for each metal constituent being proposed for regulation in F024 wastewater were transferred from K062 mixed with other metal-bearing characteristic wastes to F024.

Included in Table 7-3 are the concentrations of metal constituents in the wastewater residual following the lime and sulfide precipitation and vacuum filtration of K062 mixed with other metal-bearing characteristic wastes. These concentration data have been corrected for accuracy to account for analytical recovery, as described in Section 5.0.

The proposed wastewater treatment standards were calculated for metal constituents being proposed for regulation in F024 as shown in Table 7-4. These calculations are consistent with the methodology previously described in this section for BDAT List organic constituents.

BDAT List Dioxins and Furans

The treatment standard being proposed for dioxins and furans in F024 wastewater is 1 ppb. This standard represents the analytical limit of detection that can be routinely achieved by laboratories in the United States, consistent with the dioxins rule promulgated on November 8, 1986 (51 Federal Register, 40572, 40638).

8.0 REFERENCES

1. U.S. Environmental Protection Agency. Methodology for Developing BDAT Treatment Standards. January, 1989.

2. SRI International. 1987 Directory of Chemical Producers-United States of America, SRI International, Menlo Park, California. 1987.

3. U.S. EPA. Final Plant Report - LCP Chemicals, West Virginia, Inc., Moundsville, West Virginia. October 4, 1982.

4. U.S. EPA. Analytical Data Report - Dow Chemical USA, Texas Division. January 11, 1988.

5. U.S. EPA. Analytical Data Report - PPG Industries, Inc., Lake Charles, Louisiana. April 20, 1988.

6. U.S. EPA. Analytical Data Report - Formosa Plastics, Baton Rouge, Louisiana. April 20, 1988.

7. U.S. EPA. Analytical Data Report - Borden Chemical, Geismar, Louisiana. April 20, 1988.

8. U.S. EPA. Final Plant Report - Vulcan Materials Company, Geismar, Louisiana. November 19, 1981.

9. PPG Industries, Inc. PPG's response to RCRA Section 3007 Questionnaire. February 18, 1983.

10. U.S. EPA. Final Plant Report - Dow Chemical USA, Louisiana Division, Plaquemine, Louisiana. September 10, 1982.

11. U.S. EPA. Draft Listing Background Document for C1-C5 Chlorinated Aliphatic Hydrocarbon Production Utilizing Free Radical Catalyzed Processes. February 10, 1984.

12. U.S. EPA. Final Plant Report - FMC Corporation, Baltimore, Maryland. September 10, 1982.

13. U.S. EPA. Final Plant Report - Denka Chemical Corporation, Houston, Texas. May 27, 1982.

14. U.S. EPA. Final Plant Report - DuPont Chemical Company, LaPlace, Louisiana. April 10, 1982.

15. U.S. EPA. Treatment Technology Background Document. January, 1989.

16. U.S. EPA. Test Methods for Evaluating Solid Waste, SW-846 Third Edition, Office of Solid Waste and Emergency Response, Washington, D.C., November 1986.

17. U.S. EPA. Sampling and Analysis Plan for F024 Incineration Test at ENSCO in El Dorado, Arkansas. November 1988.

18. Windholz, Martha, editor. 1983. The Merck Index, 10th edition. Rahway, NJ: Merck and Company.

19. Weast, R.C., editor. 1984. CRC Handbook of Chemistry and Physics, 65th edition. Boca Raton, FL: CRC Press, Inc.

20. Verschueren, Karel. 1983. Handbook of Environmental Data on Organic Chemicals, 2nd edition. NY: Van Nostrand Reinhold Company, Inc.

21. U.S. EPA. Onsite Engineering Report of Stabilization of K048 and K051 Fluidized Bed Incineration Ash at Waterways Experiment Station, Vicksburg, Mississippi for Amoco Oil Company. February 19, 1988.

22. Hawley, Gessner G. 1971. The Condensed Chemical Dictionary, 8th edition. NY: Van Nostrand Reinhold Company, Inc.

23. Sanderson, R.T., Chemical Bonds and Bond Energy, Arizona State University, Academic Press, New York and London, 1971.

24. Dean, J.A. (ed.), Lange's Handbook of Chemistry, 12th ed., McGraw-Hill, 1979, pp. 8-11.

25. Weast, R.C., editor. 1980. CRC Handbook of Chemistry and Physics, 61st edition. Boca Raton, FL: CRC Press, Inc.

26. Rordorf, Berchtold F. 1986. Thermal Properties of Dioxins, Furans, and Related Compounds. Chemosphere. 15:1325-1332.

27. U.S. EPA. Draft F024 Characterization Report for DuPont Chemical Company, LaPlace, Louisiana. October 24, 1988.

28. U.S. EPA. Draft F024 Characterization Report for Shell Chemical Company, Norco, Louisiana. October 24, 1988.

29. U.S. EPA. Draft F024 Characterization Report for Vista Chemical Company, Lake Charles, Louisiana. October 21, 1988.

30. U.S. EPA. Draft F024 Characterization Report for Vulcan Chemical Company, Wichita, Kansas. October 24, 1988.

31. U.S. EPA. Draft F024 Characterization Report for Velsicol Chemical Company, Memphis, Tennessee. October 24, 1988.

32. U.S. EPA. Draft Onsite Engineering Report of Treatment Technology Performance and Operation for ENSCO, El Dorado, Arkansas. December, 1988.

33. U.S. EPA. Onsite Engineering Report of Treatment Technology Performance and Operation for Envirite Corporation, York, Pennsylvania. December 19, 1986.

34. U.S. EPA. Best Demonstrated Available Technology (BDAT) Background Document for K048, K049, K050, K051, K052. August 8, 1988.

35. U.S. EPA. Draft Onsite Engineering Report for Horsehead Resource Development Company for K061. March, 1988.

36. American Public Health Association, American Water Works Association, and and Water Pollution Control Federation. Standard Methods for the Examination of Water and Watewater, Sixteenth Edition. 1985.

APPENDIX A

ANALYTICAL QA/QC

The analytical methods used for analysis of the constituents being proposed for regulation and identified in Section 6.0 are presented in Table A-1 of this Appendix. SW-846 Methods (EPA's Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, SW-846) are used in most cases for determining total constituent concentration.

In some instances, it was necessary to deviate from the SW-846 Methods. Deviations from SW-846 Methods required to analyze the sample matrix are listed in Table A-2. SW-846 allows for the use of alternative or equivalent procedures or equipment; these are noted in Tables A-3 through A-7.

The accuracy determination for a constituent is based on the matrix spike recovery values. Tables A-8 and A-9 present the matrix spike recovery data for BDAT List constituents in the kiln ash and scrubber water residuals, respectively.

The accuracy correction factors for BDAT List constituents detected in untreated F024 and in the kiln ash and scrubber water residuals are summarized in Table A-10. The accuracy correction factors were determined for each constituent by dividing 100 by the matrix spike recovery (expressed in percentage) for that constituent.

Table A-1

ANALYTICAL METHODS FOR CONSTITUENTS PROPOSED FOR REGULATION IN F024

Regulated Constituent	Constituent Concentration in Kiln Ash: Preparation Method	Constituent Concentration in Kiln Ash: Analytical Method	Reference	Constituent Concentration in Scrubber Water: Preparation Method	Constituent Concentration in Scrubber Water: Analytical Method	Reference
VOLATILES						
10. 2-Chloro-1,3-butadiene 16. 3-Chloropropene 22. 1,1-Dichloroethane 23. 1,2-Dichloroethane 26. 1,2-Dichloropropane 27. trans-1,3-Dichloropropene 28. cis-1,3-Dichloropropene	Purge and Trap (Method 5030)	Gas Chromatography/ Mass Spectrometry for Volatile Organics (Method 8240)	1	Purge and Trap (Method 5030)	Gas Chromatography/ Mass Spectrometry for Volatile Organics (Method 8240)	1
SEMIVOLATILES						
70. Bis(2-ethylhexyl)-phthalate 104. Di-n-octyl phthalate 113. Hexachloroethane		Column Technique (Method 8270)			Column Technique (Method 8270)	
METALS						
159. Chromium (total) 163. Nickel	Acid Digestion of Sediments, Sludges, and Soils (Method 3050)	Inductively Coupled Plasma Atomic Emission Spectroscopy (Method 6010)	1	Acid Digestion of Liquids (Method 3010/3020)	Inductively Coupled Plasma Atomic Emission Spectroscopy (Method 6010)	1

Reference:

1. U.S. EPA. Test Methods for Evaluating Solid Waste, SW-846 Third Edition, Office of Solid Waste and Emergency Response, Washington, D.C., November 1986.

Table A-1 (Continued)

ANALYTICAL METHODS FOR CONSTITUENTS PROPOSED FOR REGULATION IN F024

Regulated Constituent	Constituent Concentration in Kiln Ash			Constituent Concentration in Scrubber Water		
	Preparation Method	Analytical Method	Reference	Preparation Method	Analytical Method	Reference
DIOXINS/FURANS						
207. Hexachlorodibenzo-p-dioxins 208. Hexachlorodibenzofurans 209. Pentachlorodibenzo-p-dioxins 210. Pentachlorodibenzofurans 212. Tetrachlorodibenzofurans	NA	Analysis of Polychlorinated Dibenzo-p-dioxins and Polychlorinated Dibenzofurans (Method 8280)	1	NA	Analysis of Polychlorinated Dibenxo-p-dioxins and Polychlorinated Dibenzofurans (Method 8280)	1

NA - Not applicable.

Reference:

1. U.S. EPA. Test Methods for Evaluating Solid Waste, SW-846 Third Edition, Office of Solid Waste and Emergency Response, Washington, D.C., November 1986.

Table A-2

DEVIATIONS FROM SW-846

Analysis	Method	SW-846 Specifications	Deviation from SW-846	Rationale for Deviation
Acid digestion for metals analyzed	3010 3020	Digest 100 ml of sample in a conical beaker.	Initial sample volume of 50 ml was digested in Griffin straight-side beakers. All acids and peroxides were halved.	Sample volume and reagents were reduced in half; therefore, time required to reduce sample to near dryness was reduced. However, this procedure produced no impact on the precision and accuracy of the date.

Table A-3

SPECIFIC PROCEDURES USED IN EXTRACTION OF ORGANIC COMPOUNDS WHEN ALTERNATIVES TO SW-846 METHODS ARE ALLOWED BY APPROVAL OF EPA CHARACTERIZATION AND ASSESSMENT DIVISION

Analysis	SW-846 method	Sample aliquot	SW-846 specification	Specific procedures allowed by approval of EPA-CAD
Continuous liquid-liquid extraction	3520	1 liter	• The internal standards are prepared by dissolution in carbon disulfide and then dilution to such volume that the final solvent is 20% carbon disulfide and 80% methylene chloride.	• The preparation of the internal standards is changed to eliminate the use of carbon disulfide. The internal standards are prepared in methylene chloride only.
Soxhlet extraction	3540	1 gram	• The internal standards are prepared by dissolution in carbon disulfide and then dilution to such volume that the final solvent is 20% carbon disulfide and 80% methylene chloride.	• The preparation of the internal standards is changed to eliminate the use of carbon disulfide. The internal standards are prepared in methylene chloride only.

Table A-4

SPECIFIC PROCEDURES OR EQUIPMENT USED IN EXTRACTION OF ORGANIC COMPOUNDS WHEN ALTERNATIVES OR EQUIVALENTS ARE ALLOWED IN THE SW-846 METHODS

Analysis	SW-846 method	Sample aliquot	Alternatives or equivalents allowed by SW-846 methods	Specific procedures or equipment used
Purge-and-trap	5030	5 milliliters of liquid; 1 gram of solid	• The purge-and-trap device to be used is specified in Figure 1 of the method. The desorber to be used is described in Figures 2 and 3, and the packing materials are described in Section 4.10.2 of SW-846. The method allows equivalents of this equipment or materials to be used.	• The purge-and-trap equipment and the desorber used are as specified in SW-846. The purge-and-trap equipment is a Teckmar LSC-2 with standard purging chambers[1] (Supelco cat. 2-0293). The packing materials for the traps are 1/3 silica gel and 2/3 2,6-diphenylene.
			• The method specifies that the trap must be at least 25 cm long and have an inside diameter of at least 0.105 cm.	• The length of the trap is 30 cm and the diameter is 0.105 cm.
			• The surrogates recommended are toluene-d8, 4-bromofluorobenzene, and 1,2-dichloroethane-d4. The recommended concentration level is 50 µg/l.	• The surrogates are added as specified in SW-846.
Soxhlet extraction	3540	1 gram of solid	• The recommended surrogates and their concentrations are the same as for Method 3520.	• The surrogates used and their concentration levels are the same as for Method 3520.
			• Sample grinding may be required for sample not passing through a 1-mm standard sieve or a 1-mm opening.	• Sample grinding is not required.

Table A-4 (Continued)

SPECIFIC PROCEDURES OR EQUIPMENT USED IN EXTRACTION OF ORGANIC COMPOUNDS WHEN ALTERNATIVES OR EQUIVALENTS ARE ALLOWED IN THE SW-846 METHODS

Analysis	SW-846 method	Sample aliquot	Alternatives or equivalents allowed by SW-846 methods	Specific procedures or equipment used
Continuous liquid-liquid extraction	3520	1 liter of liquid	• Acid and base/neutral extracts are usually combined before analysis by GC/MS. Under some situations, however, they may be extracted and analyzed separately.	• Acid and base/neutral extracts are combined.
			• The base/neutral surrogates recommended are 2-fluorobiphenyl, nitrobenzene-d5, and terphenyl-d14. The acid surrogates recommended are 2-fluorophenol, 2,4,6-tribromophenol, and phenol-d6. Additional compounds may be used for surrogates. The recommended concentrations for low-medium concentration level samples are 100 ppm for acid surrogates and 200 ppm for base/neutral surrogates. Volume of surrogate may be adjusted.	• Surrogates are the same as those recommended by SW-846, with the exception that phenol-d5 is substituted for phenol-d6. The concentrations used are the concentrations recommended in SW-846.

Table A-5

SPECIFIC PROCEDURES OR EQUIPMENT USED FOR ANALYSIS OF ORGANIC COMPOUNDS WHEN ALTERNATIVES OR EQUIVALENTS ARE ALLOWED IN THE SW-846 METHODS

Analysis	SW-846 method	Sample preparation method	Alternatives or equivalents allowed in SW-846 for equipment or in procedure	Specific equipment or procedures used
Gas chromatography/ mass spectrometry for volatile organics	8240	5030	Recommended GC/MS operating conditions:	Actual GC/MS operating conditions:
			Electron energy: 70 ev (nominal)	Electron energy: 70 ev
			Mass range: 35-260 amu	Mass range: 35-260 amu
			Scan time: To give 5 scans/peak but not to exceed 7 sec/scan	Scan time: 2.5 sec/scan
			Initial column temperature: 45°C	Initial column temperature: 38°C
			Initial column holding time: 3 min	Initial column holding time: 2 min
			Column temperature program: 8°C/min	Column temperature program: 10°C/min
			Final column temperature: 200°C	Final column temperature: 225°C
			Final column holding time: 15 min	Final column holding time: 30 min or xylene elutes
			Injector temperature: 200-225°C	Injector temperature: 225°C
			Source temperature: According to manufacturer's specification	Source temperature: manufacturer's recommended value of 100°C
			Transfer line temperature: 250-300°C	Transfer line temperature: 275°C
			Carrier gas: Hydrogen at 50 cm/sec, or helium at 30 cm/sec	Carrier gas: Helium at 30 ml/min
			The column should be 6 ft x 0.1 in I.D. glass, packed with 1% SP-1000 on Carbopack B (60/80 mesh) or an equivalent.	The column used is an 8 ft x 0.1 in I.D. glass, packed with 1% SP-1000 on Carbopack B (60/80 mesh).
			Samples may be analyzed by purge-and-trap technique or by direct injection.	The samples are analyzed using the purge-and-trap technique.
				Additional information on actual system used: Equipment: Finnegan model 5100 GC/MS/DS system Data system: SUPERINCOS Autoquan Mode: Electron impact NBS library available Interface to MS: Jet separator

Table A-5 (Continued)

SPECIFIC PROCEDURES OR EQUIPMENT USED FOR ANALYSIS OF ORGANIC COMPOUNDS WHEN ALTERNATIVES OR EQUIVALENTS ARE ALLOWED IN THE SW-846 METHODS

Analysis	SW-846 method	Sample preparation method	Alternatives or equivalents allowed in SW-846 for equipment or in procedure		Specific equipment or procedures used	
			Recommended GC/MS operating conditions:		Actual GC/MS operating conditions:	
Gas chromatography/ mass spectrometry for semivolatile organics: capillary column technique	8270	3520-liquids 3540-solids	Mass range:	35-500 amu	Mass range:	35-500 amu
			Scan time:	1 sec/scan	Scan time:	1 sec/scan
			Initial column temperature:	40°C	Initial column temperature:	30°C
			Initial column holding time:	4 min	Initial column holding time:	4 min
			Column temperature program:	40-270°C at 10°C/min	Column temperature program:	8°C/min to 275° and 10°C/min until 305°C
			Final column temperature hold:	270°C (until benzo[g,h,i,]perylene has eluted)	Final column temperature hold:	305°C
			Injector temperature:	250-300°C	Injector temperature:	240-260°C
			Transfer line temperature:	250-300°C	Transfer line temperature:	300°C
			Source temperature:	According to manufacturer's specification	Source temperature:	Manufacturer's recommendation (nonheated)
			Injector:	Grob-type, splitless	Injector:	Grob-type, splitless
			Sample volume:	1-2 µl	Sample volume:	1 µl of sample extract
			Carrier gas:	Hydrogen at 50 cm/sec or helium at 30 cm/sec	Carrier gas:	Helium at 40 cm/sec
			The column should be 30 m by 0.25 mm I.D., 1-µm film thickness silicon-coated fused silica capillary column (J&W Scientific DB-5 or equivalent).		The column used is a 30 m x 0.32 mm I.D. RT_x-5 (5% phenyl methyl silicone) FSCC. Additional information on actual system used: Equipment: Finnegan model 5100 GC/MS/DS system Software Package SUPERINCOS Autoquan	

Table A-6

SPECIFIC PROCEDURES OR EQUIPMENT USED IN PREPARATION AND ANALYSIS
OF METALS WHEN ALTERNATIVES OR EQUIVALENTS ARE ALLOWED IN THE SW-846 METHODS

Analysis	SW-846 method	Equipment	Alternative or equivalent allowed by SW-846 methods	Specific procedures or equipment used
Inductively coupled plasma atomic emission spectroscopy	6010	Jarrell Ash 1140	• Operate equipment following instructions provided by instrument's manufacturer. • For operation with organic solvents, auxiliary argon gas inlet is recommended.	• Equipment is operated using procedures specified in the Jarrell Ash (JA) 1140 Operator's Manual. • Auxiliary argon gas is not required for sample matrix.

Table A-7

SPECIFIC PROCEDURES OR EQUIPMENT USED FOR ANALYSIS OF CYANIDE AND SULFIDE WHEN ALTERNATIVES OR EQUIVALENTS ARE ALLOWED IN THE SW-846 METHODS

Analysis	SW-846 method	Sample aliquot	Alternatives or equivalent allowed by SW-846 methods	Specific procedures used
Total and amenable cyanide	9012	500 ml	• Hydrogen sulfide treatment may be required.	• Hydrogen sulfide treatment is not required.
			• A Fisher-Mulligan absorber or equivalent should be used.	• A Wheaton Distilling Apparatus absorber is used.
Sulfide	9030	200 ml	• An aqueous starch solution or a soluble starch powder may be used.	• An aqueous starch solution is used.
			• The titrant used may be either sodium thiosulfate or phenylarsine oxide.	• The titrant used is sodium thiosulfate.
			• Sample pretreatment may be required.	• For pretreatment of an aqueous sample, zinc acetate is added to precipitate the sulfide, and the zinc sulfide precipitate is filtered and analyzed.

Table A-8

MATRIX SPIKE RECOVERIES FOR KILN ASH RESIDUE

Spike Constituent	Original Amount Found* (ppm)	Sample Result: Amount Spiked (ppm)	Sample Result: Amount Recovered (ppm)	Sample Result: Percent Recovery** (%)	Duplicate Sample Result: Amount Spiked (ppm)	Duplicate Sample Result: Amount Recovered (ppm)	Duplicate Sample Result: Percent Recovery** (%)
VOLATILES							
4. Benzene	DL	0.050	0.063	126	0.050	0.065	130
9. Chlorobenzene	DL	0.050	0.045	90	0.050	0.054	108
24. 1,1-Dichloroethene	DL	0.050	0.040	80	0.050	0.061	122
43. Toluene	DL	0.050	0.085	170	0.050	0.111	222
47. Trichloroethene	DL	0.050	0.089	178	0.050	0.108	216
AVERAGE RECOVERY FOR VOLATILES				128.8			159.6
SEMIVOLATILES (BASE/NEUTRAL FRACTION)							
52. Acenaphthene	DL	0.050	0.015	30	0.050	0.044	88
88. 1,4-Dichlorobenzene	DL	0.050	0.036	72	0.050	0.045	90
102. 2,4-Dinitrotoluene	DL	0.050	0.019	38	0.050	0.050	100
105. N-Nitroso-di-n-propylamine	DL	0.050	0.055	110	0.050	0.059	118
145. Pyrene	DL	0.050	0.003	6	0.050	0.041	82
150. 1,2,4-Trichlorobenzene	DL	0.050	0.030	60	0.050	0.045	90
AVERAGE RECOVERY FOR SEMIVOLATILES (BASE/NEUTRAL FRACTION)				52.7			94.7
METALS@							
154. Antimony	DL	1.0	0.751	75	NA	NA	NA
155. Arsenic	0.006	0.1	0.146	140	NA	NA	NA
156. Barium	0.599	1.0	1.568	97	NA	NA	NA
158. Cadmium	DL	1.0	0.722	72	NA	NA	NA
159. Chromium (total)	1.08	1.0	1.846	77	NA	NA	NA
160. Copper	0.006	1.0	0.749	74	NA	NA	NA
161. Lead	DL	1.0	0.72	72	NA	NA	NA
163. Nickel	DL	1.0	0.698	70	NA	NA	NA
167. Vanadium	0.156	1.0	1.092	94	NA	NA	NA
168. Zinc	0.052	1.0	0.734	68	NA	NA	NA
AVERAGE RECOVERY FOR METALS				76.7			

*For constituents not detected above the detection limit (DL), the original amount found is considered as zero in calculating percent recovery.

**Percent recovery = 100 x $(C_i - C_o)/C_t$, where C_i = amount recovered, C_o = original amount found, and C_t = amount spiked.

NA - Not analyzed.

@ - Source: Waterways Onsite Engineering Report for K048 and K051 (Reference 21).

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1110-02.mlm.1

Table A-8 (Continued)

MATRIX SPIKE RECOVERIES FOR KILN ASH RESIDUE

Spike Constituent	Original Amount Found* (ppm)	Sample Result: Amount Spiked (ppm)	Sample Result: Amount Recovered (ppm)	Sample Result: Percent Recovery** (%)	Duplicate Sample Result: Amount Spiked (ppm)	Duplicate Sample Result: Amount Recovered (ppm)	Duplicate Sample Result: Percent Recovery** (%)
INORGANICS							
169. Cyanide	DL	4.97	3.93	79	5.00	6.25	125
170. Fluoride	2.11	4.91	7.04	100	4.99	7.44	107
171. Sulfide	DL	25	27.4	110	24.6	26.1	106
AVERAGE RECOVERY FOR INORGANICS				96.3			112.7
DIOXINS/FURANS							
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	DL		0.010	101		0.010	104
1,2,3,4,7,8-Hexachlorodibenzofuran	DL		0.0096	97		0.0098	98
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	DL		0.010	102		0.010	102
1,2,3,7,8-Pentachlorodibenzofuran	DL		0.0086	87		0.0086	86
2,3,7,8-Tetrachlorodibenzo-p-dioxin	DL		0.0099	100		0.0097	97
2,3,7,8-Tetrachlorodibenzofuran	DL		0.011	107		0.011	108
AVERAGE RECOVERY FOR DIOXINS/FURANS				99			99

*For constituents not detected above the detection limit (DL), the original amount found is considered as zero in calculating percent recovery.

**Percent recovery = 100 x $(C_i - C_o)/C_t$ where C_i amount recovered, C_o = original amount found, and C_t = amount spiked.

NA - Not analyzed.

Table A-9

MATRIX SPIKE RECOVERIES FOR COMBUSTION GAS SCRUBBER WATER

Spike Constituent	Original Amount Found* (ppm)	Sample Result: Amount Spiked (ppm)	Sample Result: Amount Recovered (ppm)	Sample Result: Percent Recovery** (%)	Duplicate Sample Result: Amount Spiked (ppm)	Duplicate Sample Result: Amount Recovered (ppm)	Duplicate Sample Result: Percent Recovery** (%)
VOLATILES							
4. Benzene	DL	0.050	0.043	86	0.050	0.045	90
9. Chlorobenzene	DL	0.050	0.055	110	0.050	0.056	112
24. 1,1-Dichloroethene	DL	0.050	0.040	80	0.050	0.040	80
43. Toluene	DL	0.050	0.057	114	0.050	0.057	114
47. Trichloroethene	DL	0.050	0.053	106	0.050	0.054	108
AVERAGE RECOVERY FOR VOLATILES				99.2			100.8
SEMIVOLATILES (BASE/NEUTRAL FRACTION)							
52. Acenaphthene	DL	0.050	0.039	78	0.050	0.032	64
88. 1,4-Dichlorobenzene	DL	0.050	0.032	64	0.050	0.029	58
102. 2,4-Dinitrotoluene	DL	0.050	0.057	114	0.050	0.057	114
105. N-Nitroso-di-n-propylamine	DL	0.050	0.066	132	0.050	0.058	116
145. Pyrene	DL	0.050	0.044	88	0.050	0.041	82
150. 1,2,4-Trichlorobenzene	DL	0.050	0.031	62	0.050	0.032	64
AVERAGE RECOVERY FOR SEMIVOLATILES (BASE/NEUTRAL FRACTION)				89.7			85.7
METALS@							
159. Chromium (total)	DL	0.050	0.035	70	0.050	0.034	68
161. Lead	DL	0.025	0.022	88	0.025	0.019	76
168. Zinc	2.64	10	12.6	100	10	12.4	98
AVERAGE RECOVERY FOR METALS				86			80.7
INORGANICS							
169. Cyanide	DL	0.100	0.014	14	0.100	0.022	22
170. Fluoride	153	160	330	111	160	336	114
171. Sulfide	DL	5.0	4.0	80	5.0	3.2	64
AVERAGE RECOVERY FOR INORGANICS			68.3				66.7

*For constituents not detected above the detection limit (DL), the original amount found is considered as zero in calculating percent recovery.

**Percent recovery = 100 x $(C_i-C_o)/C_t$, where C_i = amount recovered, C_o = original amount found, and C_t = amount spiked.

@ - Source: Onsite Engineering Report for Horsehead (Reference 35).
NA - Not analyzed.
F024 BGD-1
1110-02.mlm.2

Table A-9 (Continued)

MATRIX SPIKE RECOVERIES FOR COMBUSTION GAS SCRUBBER WATER

Spike Constituent	Original Amount Found* (ppm)	Sample Result		Duplicate Sample Result	
		Amount Recovered (ppm)	Percent Recovery** (%)	Amount Recovered (ppm)	Percent Recovery** (%)
DIOXINS/FURANS					
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	DL	0.0001	99	0.0001	101
1,2,3,4,7,8-Hexachlorodibenzofuran	0.0003	0.0010	101	0.0010	105
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	DL	0.0010	104	0.0010	102
1,2,3,7,8-Pentachlorodibenzofuran	0.0001	0.0009	89	0.0009	87
2,3,7,8-Tetrachlorodibenzo-p-dioxin	DL	0.0009	94	0.0009	95
2,3,7,8-Tetrachlorodibenzofuran	DL	0.0010	104	0.0011	106
AVERAGE RECOVERY FOR DIOXINS/FURANS			99		99

*For constituents not detected above the detection limit (DL), the original amount found is considered as zero in calculating percent recovery.

**Percent recovery = 100 x $(C_1-C_o)/C_t$, where C_1 = amount recovered, C_o = original amount found, and C_t = amount spiked.

NA - Not analyzed.

Table A-10

SUMMARY OF ACCURACY CORRECTION FACTORS

BDAT List Constituent		Accuracy Correction Factor* Kiln Ash Total Composition	Accuracy Correction Factor* Scrubber Water Total Composition
222.	Acetone	1.000	1.008
6.	Bromomethane	NA	1.008
10.	2-Chloro-1,3-butadiene	1.000	1.008
12.	Chloroethane	NA	1.008
15.	Chloromethane	NA	1.008
16.	3-Chloropropene	1.000	1.008
20.	trans-1,4-Dichloro-2-butene	1.000	1.008
21.	Dichlorodifluoromethane	1.000	1.008
23.	1,2-Dichloroethane	1.000	1.008
26.	1,2-Dichloropropane	1.000	1.008
27.	trans-1,3-Dichloropropene	1.000	1.008
28.	cis-1,3-Dichloropropene	1.000	1.008
34.	Methyl ethyl ketone	1.000	1.008
42.	Tetrachloroethene	1.000	1.008
46.	1,1,2-Trichloroethane	1.000	1.008
49.	1,2,3-Trichloropropane	1.000	1.008
59.	Benz(a)anthracene	1.899	1.167
62.	Benzo(a)pyrene	1.899	1.167
63.	Benzo(b)fluoranthene	1.899	1.167
64.	Benzo(ghi)perylene	1.899	1.167
65.	Benzo(k)fluoranthene	1.899	1.167
68.	Bis(2-chloroethyl)ether	1.899	1.167
70.	Bis(2-ethylhexyl)phthalate	1.899	1.167
80.	Chrysene	1.899	1.167
88.	1,4-Dichlorobenzene	1.389	1.724
92.	Diethyl phthalate	1.899	1.167
110.	Hexachlorobenzene	1.899	1.167
113.	Hexachloroethane	1.899	1.167
116.	Indeno(1,2,3-cd)pyrene	1.899	1.167
141.	Phenanthrene	1.899	1.167
169.	Cyanide	1.266	7.143
170.	Fluoride	1.000	1.000
171.	Sulfide	1.000	1.562
207.	Hexachlorodibenzo-p-dioxins	1.000	1.010

*The accuracy correction factor is equal to 1 divided by the percent recovery correction factor.

NA - Not applicable; this constituent was not detected in either the untreated F024 or the kiln ash residual.

Table A-10 (Continued)

SUMMARY OF ACCURACY CORRECTION FACTORS

BDAT List Constituent	Accuracy Correction Factor*	
	Kiln Ash Total Composition	Scrubber Water Total Composition
208. Hexachlorodibenzofurans	1.031	1.000
209. Pentachlorodibenzo-p-dioxins	1.000	1.000
210. Pentachlorodibenzofurans	1.163	1.149
212. Tetrachlorodibenzofurans	1.000	1.000
	Lime and Fly Ash Stabilization	Scrubber Water Total Composition
154. Antimony	1.33	1.09
155. Arsenic	0.71	1.00
156. Barium	1.03	1.11
158. Cadmium	1.39	1.15
159. Chromium (total)	1.31	1.47
160. Copper	1.35	1.20
161. Lead	1.39	1.32
163. Nickel	1.43	1.08
167. Vanadium	1.07	1.19
168. Zinc	1.47	1.02

*The accuracy correction factor is equal to 1 divided by the percent recovery correction factor.

Appendix B

PLANT CODES

Code	Plant	Location	References
A	DuPont Chemical Company	LaPlace, LA	27, 32
B	Shell Chemical Company	Norco, LA	28, 32
C	Vista Chemical Company	Lake Charles, LA	29, 32
D	Vulcan Chemical Company	Wichita, KS	30, 32
E	Velsicol Chemical Company	Memphis, TN	31
F	LCP Chemicals	Moundsville, WV	3
G	Dow Chemical Company	Freeport, TX	4
H	PPG Industries	Lake Charles, LA	5
I	Formosa Plastics	Baton Rouge, LA	6
J	Borden Chemical	Geismar, LA	7
K	Vulcan Materials Company	Geismar, LA	8
L	PPG Industries	Pittsburgh, PA	9
M	Dow Chemical Company	Plaquemine, LA	10
N	Shell Oil Company	Not Specified	11
O	FMC Corporation	Baltimore, MD	12
P	Denka Chemical Corporation	Houston, TX	13
X	ENSCO	El Dorado, AR	32
Y	Waterways Experiment Station	Vicksburg, MS	21
Z	Envirite Corporation	York, PA	33

Appendix C

WASTE CHARACTERISTICS AFFECTING PERFORMANCE

Table C-1

CONSTITUENT BOILING POINTS

	Constituent	Boiling Point (°C)	Reference
4.	Benzene	80.1	1
5.	Bromodichloromethane	90	2
7.	Carbon tetrachloride	76.7-77	1
9.	Chlorobenzene	131-132	1
10.	2-Chloro-1,3-butadiene	59.4	2
16.	3-Chloropropene	44-45	1
14.	Chloroform	61-62	1
20.	trans-1,4-Dichloro-2-butene	155.5	2
22.	1,1-Dichloroethane	57-57.3	1
23.	1,2-Dichloroethane	83-84	1
26.	1,2-Dichloropropane	96.4	2
27.	trans-1,3-Dichloropropene	112	1
28.	cis-1,3-Dichloropropene	108	1
34.	Methyl ethyl ketone	79.6	2
38.	Methylene chloride	39.75	1
40.	1,1,1,2-Tetrachloroethane	146.5	1
41.	1,1,2,2-Tetrachloroethane	146.5-147	1
42.	Tetrachloroethene	121	1
43.	Toluene	110.6	1
45.	1,1,1-Trichloroethane	74-74.1	1
46.	1,1,2-Trichloroethane	113-114	1
47.	Trichloroethene	86.7-87	1
49.	1,2,3-Trichloropropane	156.8	2
50.	Vinyl chloride	-13.37	1
62.	Benzo(a)pyrene	310-312	1
68.	Bis(2-chloroethyl)ether	178	1
70.	Bis(2-ethylhexyl)phthalate	385	3
77.	2-Chloronaphthalene	256	1
86.	1,3-Dichlorobenzene	173	1
87.	1,2-Dichlorobenzene	180.5-181	1
88.	1,4-Dichlorobenzene	174-174.1	1
92.	Diethyl phthalate	298	4
104.	Di-n-octyl phthalate	385	1
110.	Hexachlorobenzene	323-326	1
111.	Hexachlorobutadiene	210-220	3
112.	Hexachlorocyclopentadiene	234	3
113.	Hexachloroethane	186.8-187	1
121.	Naphthalene	217.9-218	1
126.	Nitrobenzene	210-211	1

Table C-1 (Continued)

CONSTITUENT BOILING POINTS

	Constituent	Boiling Point (°C)	Reference
136.	Pentachlorobenzene	275-277	3
137.	Pentachloroethane	161-162	1
141.	Phenanthrene	340	1
150.	1,2,4-Trichlorobenzene	213	1
222.	Acetone	56.5	1
226.	Ethyl benzene	136.3	1
207.	Hexachlorodibenzo-p-dioxins	400-500	5
208.	Hexachlorodibenzofurans	400-500	5
209.	Pentachlorodibenzo-p-dioxins	400-500	5
210.	Pentachlorodibenzofurans	400-500	5
212.	Tetrachlorodibenzofurans	400-500	5

References

1. Windholz, Martha, editor. 1983. The Merck Index, 10th edition. Rahway, NJ: Merck and Company.

2. Weast, R.C., editor. 1984. CRC Handbook of Chemistry and Physics, 65th edition. pp. C-184, -195, -371, -465. Boca Raton, FL: CRC Press, Inc.

3. Verschueren, Karel. 1983. Handbook of Environmental Data on Organic Chemicals, 2nd edition. pp. 575-576. NY: Van Nostrand Reinhold Company, Inc.

4. Hawley, Gessner G. 1971. The Condensed Chemical Dictionary, 8th edition. NY: Van Nostrand Reinhold Company, Inc.

5. Rordorf, Berchtold F. 1986. Thermal Properties of Dioxins, Furans, and Related Compounds. Chemosphere. 15:1325-1332.

Table C-2

CONSTITUENT BOND DISSOCIATION ENERGIES

	Constituent	Bond Dissociation Energy (kcal/mole)
4.	Benzene	1,340
5.	Bromodichloromethane	330
7.	Carbon tetrachloride	320
9.	Chlorobenzene	1,330
10.	2-Chloro-1,3-butadiene	955
14.	Chloroform	340
16.	3-Chloropropene	810
20.	trans-1,4-Dichloro-2-butene	1,075
22.	1,1-Dichloroethane	645
23.	1,2-Dichloroethane	645
26.	1,2-Dichloropropane	930
27.	trans-1,3-Dichloropropene	790
28.	cis-1,3-Dichloropropene	790
34.	Methyl ethyl ketone	1,230
38.	Methylene chloride	360
40.	1,1,1,2-Tetrachloroethane	605
41.	1,1,2,2-Tetrachloroethane	605
42.	Tetrachloroethene	465
43.	Toluene	1,620
45.	1,1,1-Trichloroethane	625
46.	1,1,2-Trichloroethane	625
47.	Trichloroethene	485
49.	1,2,3-Trichloropropane	910
50.	Vinyl chloride	525
68.	Bis(2-chloroethyl)ether	1,290
70.	Bis(2-ethylhexyl)phthalate	6,465
77.	2-Chloronaphthalene	2,115
86.	1,3-Dichlorobenzene	1,295
87.	1,2-Dichlorobenzene	1,295
88.	1,4-Dichlorobenzene	1,295
92.	Diethyl phthalate	3,145
104.	Di-n-octyl phthalate	6,565
110.	Hexachlorobenzene	1,305
111.	Hexachlorobutadiene	855
112.	Hexachlorocyclopentadiene	1,025
113.	Hexachloroethane	565
121.	Naphthalene	2,120
126.	Nitrobenzene	1,435

Table C-2 (Continued)

CONSTITUENT BOND DISSOCIATION ENERGIES

Constituent		Bond Dissociation Energy (kcal/mole)
136.	Pentachlorobenzene	1,310
137.	Pentachloroethane	585
141.	Phenanthrene	2,900
150.	1,2,4-Trichlorobenzene	1,320
222.	Acetone	945
226.	Ethyl benzene	1,905
207.	Hexachlorodibenzo-p-dioxins	2,470
208.	Hexachlorodibenzofurans	960
209.	Pentachlorodibenzo-p-dioxins	2,490
210.	Pentachlorodibenzofurans	980
212.	Tetrachlorodibenzofurans	1,000

Sources:

1. Sanderson, R.T., Chemical Bonds and Bond Energy, Arizona State University, Academic Press, New York and London, 1971.

2. Dean, J.A. (ed.), Lange's Handbook of Chemistry, 12th ed., McGraw-Hill, 1979. pp. 8-11.

3. Weast, R.C., editor. 1980. CRC Handbook of Chemistry and Physics, 61st edition. Boca Raton, FL: CRC Press, Inc.