FINAL

AMENDMENT TO THE

FINAL BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT)

BACKGROUND DOCUMENT

FOR

WASTES FROM THE PRODUCTION OF CHLORINATED ALIPHATIC HYDROCARBONS

F024

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1.0 INTRODUCTION

On June 8, 1989, in accordance with the amendments to the Resource Conservation and Recovery Act (RCRA) of 1976, enacted by the Hazardous and Solid Waste Amendments (HSWA) of November 8, 1984, the United States Environmental Protection Agency (EPA or Agency) established best demonstrated available technology (BDAT) treatment standards for the listed hazardous waste identified in Title 40, Code of Federal Regulations, Section 261.31 (40 CFR 261.31) as F024.

Compliance with these BDAT treatment standards is a prerequisite under 40 CFR Part 268 for placement of F024 in land disposal units. 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 are summarized in EPA's Methodology for Developing BDAT Treatment Standards (Reference 1). Under 40 CFR 261.31, wastes identified as F024 are listed as follows:

> F024 - Process wastes, including but not limited to, distillation residues, heavy ends, tars, and reactor clean-out wastes, from the production of certain chlorinated aliphatic hydrocarbons by free radical catalyzed processes. These chlorinated aliphatic hydrocarbons are those having carbon chain lengths ranging from one to and including five, with varying amounts and positions of chlorine substitution. (This listing does not include wastewaters, wastewater treatment sludges, spent catalysts, and wastes listed in 40 CFR 261.31 or 261.32).

(See the Second Third Final Rule, 54 Federal Register 26594, June 23, 1989 (Reference 4).)

After the close of the comment period on the proposed F024 regulation, the Agency completed chemical analysis of the Toxicity Characteristic Leaching Procedure (TCLP) extracts (leachate) obtained from the stabilization testing of F024 incinerator ash. However, since these data were not available at the time of public notice and comment, and since the resultant treatment standards were significantly different from the proposed standards, EPA reserved, and therefore did not issue, treatment standards for metal

constituents in nonwastewater forms of F024 in the Second Third Final Rule. The analytical data for the TCLP extracts obtained from the stabilization testing of F024 incinerator ash showed substantial reduction of metals concentrations in the ash after stabilization using a cement binder. Therefore, the Agency is establishing treatment standards for metal constituents in F024 nonwastewaters based on these data.

Since promulgation of the Second Third Rule, the Agency has received comments from industry that treatment firms are refusing to accept F024 for treatment largely due to the analytical costs of complying with the treatment standards for chlorinated dibenzodioxins and dibenzofurans and the perceived stigma of managing wastes containing these constituents. As discussed in this document, the Agency is deleting the chlorinated dibenzodioxins and dibenzofurans from regulation in F024. In addition, the concentration-based treatment standards in the Second Third promulgated rule for the remaining organic constituents in nonwastewater and wastewater forms of F024 are being revised to specify that these treatment standards must be met using incineration technologies. The Agency believes that incineration technologies will effectively destroy any of the chlorinated dibenzodioxins and dibenzofurans that may be present in F024, based on the results obtained from the EPA-sponsored incineration treatment test of F024 wastes containing these constituents. This regulatory approach should ensure that sufficient incineration capacity is available to treat F024 and that F024 is treated before land disposal to levels that adequately protect human health and the environment. The treatment standards in the Second Third promulgated rule for metal constituents in wastewater forms of F024 are not being revised at this time.

The specific regulated constituents and treatment standards for nonwastewater and wastewater forms of F024 are listed in Tables 1-1 and 1-2, respectively. The treatment standards reflect the total concentration of each organic constituent regulated in F024 nonwastewaters and the total concentration of each organic and metal constituent regulated in F024 wastewaters. The treatment standards for metal constituents in nonwastewaters

are based on the analysis of leachate obtained by the Toxicity Characteristic Leaching Procedure (TCLP) described in Appendix I of 40 CFR Part 268. The units used for total constituent concentration are mg/kg (parts-per-million on a weight-by-weight basis) for nonwastewaters and mg/l (parts-per-million on a weight-by-volume basis) for wastewaters. The units used for leachate analysis of nonwastewater are mg/l (parts-per-million on a weight-by-volume basis). If the concentrations of all of the regulated constituents in F024, as generated, are lower than or equal to the concentration-based treatment standards, then treatment of F024 is not required prior to land disposal. The revised and additional treatment standards will go into effect on May 8, 1990, the effective date of the Third Third promulgated rule.

This amendment to the Final Best Demonstrated Available Technology (BDAT) Background Document for F024 presents: (1) F024 incinerator ash stabilization data; (2) EPA's rationale and technical support for selecting the metal constituents being regulated in nonwastewater forms of F024 and for deleting the chlorinated dibenzodioxins and dibenzofurans as regulated constituents in F024; (3) EPA's approach to and technical support for developing treatment standards for metal constituents in nonwastewater forms of F024; and (4) EPA's rationale and technical support for revising the F024 treatment standards promulgated for organic constituents in the Second Third rule.

Sections 2.0 through 5.0 of this document supplement discussions in the Final BDAT Background Document for F024 by presenting treatment performance data, accuracy-corrected treatment performance data, constituents selected for regulation in F024, and treatment standard calculations, respectively. Section 6.0 contains acknowledgements, and Section 7.0 lists references. Appendix A lists plant codes, Appendix B contains quality assurance/quality control data, and Appendix C presents data from analysis of variance (ANOVA) tests that compared binders used in the stabilization tests. The detailed calculations of the treatment standards for metal constituents in F024 nonwastewaters are provided in Appendix D.

Table 1-1

BDAT TREATMENT STANDARDS FOR F024

NONWASTEWATERS

(REVISED)

		Maximum for any Single Grab Sample	
	BDAT List Constituent	Total Composition Concentration[a] (mg/kg)	TCLP Leachate Concentration (mg/L)
10.	2-Chloro-1,3-butadiene	0.28	Not applicable
16.	3-Chloropropene	0.28	Not applicable
22.	1,1-Dichloroethane	0.014	Not applicable
23.	1,2-Dichloroethane	0.014	Not applicable
26.	1,2-Dichloropropane	0.014	Not applicable
28.	cis-1,3-Dichloropropene	0.014	Not applicable
27.	trans-1,3-Dichloropropene	0.014	Not applicable
70.	Bis(2-ethylhexyl)phthalate	1.8	Not applicable
113.	Hexachloroethane	1.8	Not applicable
159.	Chromium (total)	Not applicable	0.073
161.	Lead	Not applicable	0.021
162.	Nickel	Not applicable	0.088

[a] These concentration levels must be achieved for organic constituents using incineration technologies.

Table 1-2

BDAT TREATMENT STANDARDS FOR F024

WASTEWATERS

(REVISED)

		Maximum for any Single Grab Sample	
	BDAT List Constituent	Total Composition Concentration[a] (mg/L)	TCLP Leachate Concentration (mg/L)
10.	2-Chloro-1,3-butadiene	0.28	Not applicable
16.	3-Chloropropene	0.28	Not applicable
22.	1,1-Dichloroethane	0.014	Not applicable
23.	1,2-Dichloroethane	0.014	Not applicable
26.	1,2-Dichloropropane	0.014	Not applicable
28.	cis-1,3-Dichloropropene	0.014	Not applicable
27.	trans-1,3-Dichloropropene	0.014	Not applicable
70.	Bis(2-ethylhexyl)phthalate	0.036	Not applicable
113.	Hexachloroethane	0.036	Not applicable
159.	Chromium (total)	0.35	Not applicable
162.	Nickel	0.47	Not applicable

[a] These concentration levels must be achieved for organic constituents using incineration technologies.

2.0 AMENDMENT TO SECTION 4.0 (TREATMENT PERFORMANCE DATABASE) OF THE FINAL BDAT BACKGROUND DOCUMENT FOR F024

This section supplements the discussion in Section 4.0 (Treatment Performance Data Base) of the Final BDAT Background Document for F024, and presents the treatment performance data collected during stabilization of F024 incinerator ash. F024 incinerator ash was generated at Plant Y and was stabilized at Plant X. The names and locations of these plants are listed in Appendix A.

Tables 2-1, 2-2, and 2-3 each present three sample sets of treatment performance data from the stabilization of F024 incinerator ash using a cement binder, a lime/fly ash binder, and a kiln dust binder, respectively. Table 2-4 presents test conditions that existed during the stabilization tests.

Table 2-1

ANALYTICAL RESULTS FOR THE UNTREATED AND STABILIZED F024 INCINERATOR ASH SAMPLES

CEMENT BINDER

Binder-to-Ash Ratio: 0.55
Water-to-Ash Ratio: 0.2

BDAT List Constituent		Detection Limit (mg/l)	Concentration in the TCLP Extract of the Untreated Waste (mg/l) Sample Set 1	Sample Set 2	Sample Set 3	Concentration in the TCLP Extract of the Stabilized Waste (28-Day Cure) (mg/l) Sample Set 1	Sample Set 2	Sample Set 3
154.	Antimony	0.076	ND	ND	ND	ND	ND	ND
155.	Arsenic	0.002	0.013	0.015	0.014	0.004	0.002	0.002
156.	Barium	0.002	1.99	1.72	1.67	1.84	0.88	1.02
157.	Beryllium	0.001	0.002	0.002	0.002	ND	ND	ND
158.	Cadmium	0.003	0.021	0.021	0.021	ND	ND	ND
159.	Chromium (total)	0.007	0.4	0.41	0.42	0.031	0.01	0.013
221.	Chromium (VI)	0.006	0.34	0.075	0.049	0.19	0.15	0.14
160.	Copper	0.018	5.54	6.71	9.59	ND	ND	ND
161.	Lead	0.057	63.3	33.3	14.9	0.011	0.006	0.007
162.	Mercury	0.0003	0.0006	ND	ND	ND	ND	ND
163.	Nickel	0.025	4.39	3.96	3.93	ND	ND	ND
164.	Selenium	0.002	ND	ND	ND	ND	ND	ND
165.	Silver	0.004	ND	ND	ND	ND	ND	ND
166.	Thallium	0.004	ND	ND	ND	ND	ND	ND
167.	Vanadium	0.007	ND	ND	ND	ND	ND	ND
168.	Zinc	0.003	2.06	2.07	2.06	0.041	0.05	0.173

ND - Not detected.

Source: Onsite Engineering Report of Treatment Technology Performance and Operation for Waterways Experiment Station, Vicksburg, Mississippi, (Reference 2).

Table 2-2

ANALYTICAL RESULTS FOR THE UNTREATED AND STABILIZED F024 INCINERATOR ASH SAMPLES

LIME/FLY ASH BINDER

Binder-to-Ash Ratio: 0.5/0.5
Water-to-Ash Ratio: 0.2

BDAT List Constituent		Detection Limit (mg/l)	Concentration in the TCLP Extract of the Untreated Waste (mg/l) Sample Set			Concentration in the TCLP Extract of the Stablized Waste (28-Day Cure) (mg/l) Sample Set		
			1	2	3	1	2	3
154.	Antimony	0.076	ND	ND	ND	0.088	ND	ND
155.	Arsenic	0.002	0.013	0.015	0.014	0.004	0.003	0.002
156.	Barium	0.002	1.99	1.72	1.67	1.95	2.03	0.34
157.	Beryllium	0.001	0.002	0.002	0.002	ND	ND	ND
158.	Cadmium	0.003	0.021	0.021	0.021	ND	ND	ND
159.	Chromium (total)	0.007	0.4	0.41	0.42	0.097	0.024	ND
221.	Chromium (VI)	0.006	0.34	0.075	0.049	0.07	0.07	0.072
160.	Copper	0.018	5.54	6.71	9.59	ND	0.13	0.056
161.	Lead	0.057	63.3	33.3	14.9	0.069	0.23	0.3
162.	Mercury	0.0003	0.0006	ND	ND	ND	ND	ND
163.	Nickel	0.025	4.39	3.96	3.93	0.33	0.75	0.84
164.	Selenium	0.002	ND	ND	ND	ND	ND	0.005
165.	Silver	0.004	ND	ND	ND	ND	ND	ND
166.	Thallium	0.004	ND	ND	ND	ND	ND	ND
167.	Vanadium	0.007	ND	ND	ND	ND	ND	ND
168.	Zinc	0.003	2.06	2.07	2.06	0.15	0.65	0.23

ND - Not detected.

Source: Onsite Engineering Report of Treatment Technology Performance and Operation for Waterways Experiment Station, Vicksburg, Mississippi, (Reference 2).

Table 2-3

ANALYTICAL RESULTS FOR THE UNTREATED AND STABILIZED F024 INCINERATOR ASH SAMPLES

KILN DUST BINDER

Binder-to-Ash Ratio: 0.4
Water-to-Ash Ratio: 0.2

BDAT List Constituent		Detection Limit (mg/l)	Concentration in the TCLP Extract of the Untreated Waste (mg/l) Sample Set			Concentration in the TCLP Extract of the Stablized Waste (28-Day Cure) (mg/l) Sample Set		
			1	2	3	1	2	3
154.	Antimony	0.076	ND	ND	ND	ND	ND	ND
155.	Arsenic	0.002	0.013	0.015	0.014	0.002	0.002	0.003
156.	Barium	0.002	1.99	1.72	1.67	0.54	0.55	4.62
157.	Beryllium	0.001	0.002	0.002	0.002	ND	ND	ND
158.	Cadmium	0.003	0.021	0.021	0.021	ND	ND	ND
159.	Chromium (total)	0.007	0.4	0.41	0.42	0.19	ND	0.033
221.	Chromium (VI)	0.006	0.34	0.075	0.049	0.12	0.11	0.15
160.	Copper	0.018	5.54	6.71	9.59	ND	0.024	ND
161.	Lead	0.057	63.3	33.3	14.9	0.059	0.065	0.08
162.	Mercury	0.0003	0.0006	ND	ND	ND	ND	ND
163.	Nickel	0.025	4.39	3.96	3.93	0.07	ND	ND
164.	Selenium	0.002	ND	ND	ND	0.006	0.006	ND
165.	Silver	0.004	ND	ND	ND	ND	ND	ND
166.	Thallium	0.004	ND	ND	ND	ND	ND	ND
167.	Vanadium	0.007	ND	ND	ND	ND	ND	ND
168.	Zinc	0.003	2.06	2.07	2.06	0.074	0.16	0.13

ND - Not detected.

Source: Onsite Engineering Report of Treatment Technology Performance and Operation for Waterways Experiment Station, Vicksburg, Mississippi, (Reference 2).

Table 2-4

TEST CONDITIONS FOR THE STABILIZATION TESTS

Parameter	Specification
Mixing Vessels	Hobart K455S Mixer With Teflon Beaters 4-Liter Stainless Steel Bowl
Mixing Conditions	Mixing Procedure Used for All Batches: • Mix 5 minutes in mixing vessel • Scrape mixer by hand with stainless steel spatula
Cure Conditions	Hot Pack Model 41750 Large Capacity Humidity Chamber with set point conditions of: • Temperature: 23°C • Humidity: 95-98%

Source: Onsite Engineering Report of Treatment Technology Performance and Operation for Waterways Experiment Station, Vicksburg, Mississippi (Reference 2).

3.0 AMENDMENT TO SECTION 5.0 (IDENTIFICATION OF BEST DEMONSTRATED AVAILABLE TECHNOLOGY) OF THE FINAL BDAT BACKGROUND DOCUMENT FOR F024

This section supplements the discussion in Section 5.0 (Identification of Best Demonstrated Available Technology) of the Final BDAT Background Document for F024. As discussed in the Final BDAT Background Document for F024, stabilization was determined to be BDAT for metal constituents in nonwastewater forms of F024. This section presents accuracy-corrected concentration data for metal constituents detected in either the F024 incinerator ash or the extract of the stabilized waste, and discusses the statistical comparison of the stabilization performance data using three different binders.

3.1 Accuracy Correction of Stabilization Performance Data

Matrix spike recoveries were used to adjust the treatment performance data collected during the stabilization of F024 incinerator ash. These matrix spike recoveries are presented in Table B-1 of Appendix B. Duplicate matrix spikes were performed for selected BDAT List constituents in the treatment residual (the stabilized F024 incinerator ash). If a duplicate matrix spike was performed for a constituent, the matrix spike recovery used to adjust treatment performance data for that constituent was the lower of the two values from the first matrix spike and the duplicate spike.

Accuracy correction factors (100 divided by the matrix spike recovery expressed as a percent) were calculated for the stabilized F024 incinerator ash data and are presented in Table B-2 of Appendix B. Treatment performance data for each BDAT List metal constituent detected in either the untreated F024 incinerator ash or the stabilized F024 incinerator ash were corrected for accuracy and are presented in Table 3-1. Accuracy correction factors of less than 1.00 (i.e., factors resulting in a reduction in constituent concentration) were not used to correct treatment performance data. Instead, a correction factor of 1.00 was used in these cases to correct treatment performance data.

3.2 Statistical Comparison of Stabilization Performance Data

A comparison of the treatment performance of stabilization achieved by each of three binders was conducted using analysis of variance (ANOVA) tests (discussed fully in EPA's Methodology for Developing BDAT Treatment Standards (Reference 1)). The treatment performance data for each binder were corrected for accuracy (as discussed in Section 3.1) before the ANOVA tests were performed. Results of the ANOVA tests are presented in Appendix C. These results indicated that stabilization of F024 incinerator ash using a cement binder demonstrated significantly better treatment performance than stabilization of F024 incinerator ash using either a lime/fly ash binder or a kiln dust binder. Accordingly, stabilization using a cement binder has been identified as BDAT for metal constituents in nonwastewater forms of F024.

Table 3-1

BDAT LIST CONSTITUENT CONCENTRATIONS IN STABILIZED INCINERATOR ASH, CORRECTED FOR ACCURACY[a]

CEMENT BINDER

BDAT List Constituent	Corrected Concentration in the TCLP Extract of the Stabilized F024 Incinerator Ash (mg/l) Sample Set 1	2	3
155. Arsenic	0.004	0.002	0.002
156. Barium	1.974	0.944	1.094
157. Beryllium	<0.001	<0.001	<0.001
158. Cadmium	<0.004	<0.004	<0.004
159. Chromium (total)	0.036	0.011	0.015
221. Chromium (VI)	0.209	0.165	0.154
160. Copper	<0.021	<0.021	<0.021
161. Lead	0.014	0.008	0.009
162. Mercury	<0.0003	<0.0003	<0.0003
163. Nickel	<0.031	<0.031	<0.031
168. Zinc	0.052	0.064	0.221

[a] This table presents data for the BDAT List metal constituents detected in either the untreated F024 incinerator ash or the stabilized F024 incinerator ash. These data were obtained by multiplying the constituent concentration in the stabilized waste (Table 2-1 in Section 2.0) by the accuracy correction factor for that constituent (Table B-2 in Appendix B).

Table 3-2

BDAT LIST CONSTITUENT CONCENTRATIONS IN STABILIZED INCINERATOR ASH, CORRECTED FOR ACCURACY[a]

LIME/FLY ASH BINDER

BDAT List Constituent	Corrected Concentration in the TCLP Extract of the Stabilized F024 Incinerator Ash (mg/l) Sample Set 1	2	3
155. Arsenic	0.004	0.003	0.002
156. Barium	2.11	2.20	0.37
157. Beryllium	0.001	0.001	0.001
158. Cadmium	0.004	0.004	0.004
159. Chromium (total)	0.119	0.029	0.008
221. Chromium (VI)	0.07	0.07	0.072
160. Copper	0.021	0.15	0.065
161. Lead	0.085	0.28	0.4
162. Mercury	0.0006	0.0003	0.003
163. Nickel	0.41	0.93	1.04
168. Zinc	0.17	0.75	0.27

[a] This table presents data for the BDAT List metal constituents detected in either the untreated F024 incinerator ash or the stabilized F024 incinerator ash. These data were obtained by multiplying the constituent concentration in the stabilized waste (Table 2-2 in Section 2.0) by the accuracy correction factor for that constituent (Table B-2 in Appendix B).

Table 3-3

BDAT LIST CONSTITUENT CONCENTRATIONS IN
STABILIZED INCINERATOR ASH, CORRECTED FOR ACCURACY[a]

KILN DUST BINDER

BDAT List Constituent	Corrected Concentration in the TCLP Extract of the Stabilized F024 Incinerator Ash (mg/l) Sample Set 1	2	3
155. Arsenic	0.002	0.002	0.003
156. Barium	0.56	0.57	4.82
157. Beryllium	0.001	0.001	0.001
158. Cadmium	0.004	0.004	0.004
159. Chromium (total)	0.24	0.009	0.041
221. Chromium (VI)	0.12	0.11	0.15
160. Copper	0.021	0.028	0.021
161. Lead	0.084	0.092	0.11
162. Mercury	0.0006	0.0003	0.0003
163. Nickel	0.09	0.032	1.032
168. Zinc	0.09	0.19	0.16

[a] This table presents data for the BDAT List metal constituents detected in either the untreated F024 incinerator ash or the stabilized F024 incinerator ash. These data were obtained by multiplying the constituent concentration in the stabilized waste (Table 2-3 in Section 2.0) by the accuracy correction factor for that constituent (Table B-2 in Appendix B).

4.0 AMENDMENT TO SECTION 6.0 (SELECTION OF REGULATED CONSTITUENTS) OF THE FINAL BDAT BACKGROUND DOCUMENT FOR F024

This section supplements the discussion in Section 6.0 (Selection of Regulated Constituents) of the Final BDAT Background Document for F024. This section presents a discussion of the selection of metal constituents for regulation in nonwastewater forms of F024. This section also discusses the deletion of the chlorinated dibenzodioxins and dibenzofurans as regulated constituents in nonwastewater and wastewater forms of F024.

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

(1) The constituent must be on the BDAT List of regulated constituents. Presence on the BDAT List means that EPA-approved methods exist for analysis of the constituent in treated waste matrices.

(2) The constituent must be present in, or be suspected of being present in, the untreated waste. 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.

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 may select for regulation only those constituents that (1) are the most difficult to treat; or (2) are present in the untreated waste in the highest concentrations. Selecting a subset of constituents for regulation is done to facilitate implementation of the compliance and enforcement program.

4.1 Metal Constituents Selected for Regulation in Nonwastewater Forms of F024

The Agency initially considered all metal constituents on the BDAT List for proposed regulation in nonwastewater forms of F024. Available F024 characterization data for the BDAT List metal constituents are summarized in Table 4-1. When data were available for more than one sample set, a range of concentrations was listed in the table for all constituents quantified in the untreated F024. Constituents that were not detected in the untreated F024 but were detected in the treated F024 are identified in the table by the symbol "*." The Agency is not regulating all of the BDAT List metal constituents considered for regulation, as discussed in the following subsections.

4.1.1 BDAT List Metal Constituents Deleted From Further Consideration for Regulation in Nonwastewater Forms of F024

A BDAT List metal constituent was deleted from further consideration for regulation if (1) the constituent was not detected in the untreated and treated F024, (2) the constituent did not show effective treatment by BDAT in available F024 treatment performance data, (3) the constituent was not present at treatable concentrations in the untreated F024, or (4) for other reasons, as described below. BDAT List constituents that remained after the deletions described in this subsection were further considered for regulation.

Hexavalent chromium, silver, and thallium were not detected in the untreated and treated wastes and were therefore deleted from further consideration for regulation in F024 nonwastewaters. Antimony, barium, and mercury were deleted from further consideration for regulation in F024 nonwastewaters because the BDAT treatment performance data obtained from stabilization of F024 incinerator ash did not show effective treatment for these constituents. Arsenic, beryllium, cadmium, and selenium were deleted from further consideration for regulation in F024 nonwastewaters because they were not present in the untreated waste at treatable concentrations.

Copper, vanadium, and zinc were considered for regulation in F024 nonwastewaters but were not selected as constituents for regulation. Although copper cyanide, vanadium pentoxide, and zinc cyanide are listed in Appendix VIII of 40 CFR Part 261, the metals are not listed individually. The Agency is only regulating copper, vanadium, and/or zinc when they are indicators of performance of treatment for other Appendix VIII constituents (i.e., copper cyanide, vanadium pentoxide, and zinc cyanide). For F024, copper, vanadium, and zinc have not been identified as indicators of treatment for other Appendix VIII constituents and are therefore not being regulated.

4.1.2 BDAT List Metal Constituents Selected for Regulation in Nonwastewater Forms of F024

Three remaining metal constituents were selected for regulation in F024 nonwastewaters. These constituents are total chromium, lead, and nickel.

4.2 Deletion of the Chlorinated Dibenzodioxins and Dibenzofurans as Regulated Constituents in F024

As discussed in the Final BDAT Background Document for F024, five chlorinated dibenzodioxin and dibenzofuran constituents, hexachlorodibenzo-p-dioxins, hexachlorodibenzofurans, pentachlorodibenzo-p-dioxins, pentachlorodibenzofurans, and tetrachlorodibenzofurans, were selected for regulation in nonwastewater forms of F024 in the Second Third rule. Since then, several commenters have confirmed EPA's inquiry in the Third Third proposed rule (54 FR 48450) that treatment facilities that had previously treated F024 were refusing to do so because the treatment standards for F024 included standards for chlorinated dibenzodioxins and dibenzofurans. Commenters documented the current refusals of commercial treatment facilities to accept F024, whether or not the waste actually contained any chlorinated dibenzodioxins and/or dibenzofurans. All of the commenters agreed that the existence of treatment standards for the chlorinated dibenzodioxins and dibenzofurans is the basis for the refusals to treat F024. These refusals have resulted in a capacity shortage for treatment of F024.

Commenters further stated that if the treatment standards for other organic constituents in F024 were met, they believed that the treatment standards for the chlorinated dibenzodioxins and dibenzofurans would also be met. Two commenters suggested specific constituents that may be used as surrogates for the chlorinated dibenzodioxin and dibenzofuran treatment standards.

Waste characteristics affecting the performance of the treatment technology (WCAPs) are used to identify the hardest to treat constituents present in the waste. These constituents may then be selected for regulation and used as surrogates for other non-regulated constituents of concern to ensure that they are adequately treated. For incineration technologies, WCAPs include a constituent's boiling point for nonwastewater residuals and a constituent's bond dissociation energy (BDE) for wastewater residuals. Constituents with higher boiling points and BDEs are considered to be more difficult to treat than those with lower boiling points and BDEs for nonwastewater and wastewater residuals, respectively.

The Agency does not believe that the surrogates suggested for the chlorinated dibenzodioxins and dibenzofurans in F024 by the two commenters were appropriate because they are not more difficult to treat than the chlorinated dibenzodioxin and dibenzofuran constituents, with boiling points ranging from 400-500°C and BDEs ranging from 960-2,490 kcal/mole, and therefore would not ensure adequate treatment of these constituents. The Agency also attempted to identify surrogates, but was unable to identify an appropriate surrogate that was present at treatable levels in all of the wastes containing the chlorinated dibenzodioxin and dibenzofuran constituents.

The concentration-based treatment standards that were promulgated for the chlorinated dibenzodioxins and dibenzofurans in F024 (54 FR 26615) may hinder effective treatment because of the refusal of treatment facilities to accept these wastes due to the analytical costs to determine compliance with the treatment standards for these constituents and the perceived stigma of

managing wastes containing chlorinated dibenzodioxins and dibenzofurans. Also, as noted, the Agency is unable to select an appropriate surrogate which would ensure adequate treatment of these constituents. Finally, the Agency believes that incineration technologies will effectively destroy any of the chlorinated dibenzodioxins and dibenzofurans that may be present in F024, based on the results obtained from the EPA-sponsored incineration treatment test of F024 wastes containing these constituents.

Therefore, based on the above considerations, the Agency is revising the F024 treatment standards promulgated as part of the Second Third Rule. The Agency is deleting the chlorinated dibenzodioxins and dibenzofurans as regulated constituents in F024 and, as discussed in more detail in Section 5.0, is requiring that the concentration-based treatment standards for organic constituents in F024 be achieved using incineration technologies. As such, treaters of F024 will not be required to analyze either the untreated F024 or the treated residuals for the chlorinated dibenzodioxin and dibenzofuran constituents. The Agency believes that these revisions will allay treatment firms' concerns with accepting F024. Additionally, the revised standards will reduce the analytical costs associated with compliance with this rule.

Table 4-1

STATUS OF BDAT LIST METAL CONSTITUENT PRESENCE
IN UNTREATED F024

BDAT List Constituent	Detection Status	Concentration in Untreated F024 (mg/kg)
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
159. Chromium (total)	X	<0.4-285
221. Chromium (hexavalent)	ND	<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	ND	<0.4
166. Thallium	ND	<10
167. Vanadium	X	<0.17-10
168. Zinc	X	0.73-443

X - Indicates that a constituent was quantified at or above its detection limit in one or more untreated F024 samples.
* - Not detected in the untreated F024, but detected in the incinerator ash.
ND - Not detected in either the untreated F024 or the incinerator ash.

Source: Final Best Demonstrated Available Technology (BDAT) Background Document for F024 (Reference 3).

5.0 AMENDMENT TO SECTION 7.0 (CALCULATION OF BDAT TREATMENT STANDARDS) OF THE FINAL BDAT BACKGROUND DOCUMENT FOR F024

This section supplements the discussion in Section 7.0 (Calculation of BDAT Treatment Standards) of the Final BDAT Background Document for F024. This section includes a discussion of the calculation of treatment standards for metal constituents in F024 nonwastewaters and the revisions to the treatment standards for organic constituents that were promulgated as part of the Second Third Rule.

5.1 Treatment Standards for Metal Constituents in Nonwastewater Forms of F024

BDAT treatment standards for metal constituents in F024 nonwastewater residuals were calculated based on three sample sets of treatment performance data collected during the stabilization of F024 incinerator ash using a cement binder. Table 5-1 presents the concentrations of metal constituents in the TCLP extract of the stabilized F024 rotary kiln incinerator ash. Concentration data are presented for only those constituents selected for regulation, as discussed in Section 4.0. The concentration data presented in Table 5-1 were corrected for accuracy to account for analytical recovery, as described in Section 3.0.

Treatment standards for F024 nonwastewaters were calculated for metal constituents selected for regulation in F024, as shown in Table 5-2. The following three steps were used to calculate the treatment standards:

(1) The arithmetic average of the accuracy-corrected concentrations for each regulated constituent in the treated F024 was calculated.

(2) Using the same data, a variability factor (discussed in EPA's Methodology for Developing BDAT Treatment Standards (Reference 1)) for each constituent was calculated. This factor represents the variability inherent in the performance of the treatment system, in the collection of treated samples, and in the analysis of samples. Where concentrations in the treated F024 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 actual concentrations could range from zero to the detection limit. In these cases, the Agency assumed a lognormal distribution of data points between the detection limit and a value one-tenth of the detection limit, and then calculated a variability factor of 2.8. Variability factor calculations are shown in Appendix D along with the detailed treatment standard calculations.

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

5.2 Revisions to the Treatment Standards for Organic Constituents in Nonwastewater and Wastewater Forms of F024

Concentration-based treatment standards for volatile and semi-volatile organic constituents in nonwastewater and wastewater forms of F024 were promulgated as part of the Second Third Rule (54 FR 26594). The Agency is revising these treatment standards to require that incineration technologies be used to meet these standards.

As discussed in the Final BDAT Background Document for F024, incineration is the BDAT technology for organic constituents in nonwastewater and wastewater forms of F024. EPA is specifying that the concentration-based treatment standards for F024 must be met via incineration because the Agency believes that incineration technologies will effectively destroy any of the chlorinated dibenzodioxins and dibenzofurans that may be present in F024, based on the results obtained from the EPA-sponsored incineration treatment test of F024 wastes containing these constituents. This regulatory approach should ensure that sufficient incineration capacity is available to treat F024 and that F024 is treated before land disposal to levels that adequately protect human health and the environment.

Table 5-1

CORRECTED CONCENTRATION DATA FOR METAL CONSTITUENTS IN STABILIZED F024 INCINERATOR ASH

CEMENT BINDER

BDAT List Constituent	Corrected Concentration in the TCLP Extract of the Stabilized F024 Rotary Kiln Incinerator Ash (mg/l)[a] Sample Set 1	2	3
159. Chromium (total)	0.036	0.011	0.015
161. Lead	0.014	0.008	0.009
163. Nickel	<0.031	<0.031	<0.031

[a]Constituent concentrations (presented in Table 2-1) have been adjusted for accuracy ("corrected"), to account for analytical recoveries using the data presented in Table B-2 of this document.

Table 5-2

CALCULATION OF TREATMENT STANDARDS FOR
METAL CONSTITUENTS IN F024 NONWASTEWATERS

Regulated Constituent	Arithmetic Average of Corrected Treatment Values (ppm)	Variability Factor (VF)	Treatment Standard[a] (Average x VF) (ppm)
159. Chromium (total)	0.021	3.5	0.073
161. Lead	0.010	2.0	0.021
163. Nickel	0.031	2.8	0.088

[a]The treatment standard values shown in this table have been rounded to show three significant figures.

6.0 ACKNOWLEDGEMENTS

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The following personnel from Radian Corporation were involved in preparing this document: John Williams, Program Manager; Mary Willett, Project Director; and Chrisanti Haretos, Task Leader.

The stabilization testing of F024 incinerator ash was conducted at the Waterways Experiment Station in Vicksburg, Mississippi. We greatly appreciate the efforts of Mark Bricka and Teresa Holmes of the Waterways Experiment Station in performing the stabilization tests, and those of PEI Associates in analyzing the samples from these tests.

7.0 REFERENCES

1. U.S. EPA. 1989. U.S. Environmental Protection Agency, Office of Solid Waste. Methodology for Developing BDAT Treatment Standards. June, 1989. Washington, D.C.: U.S. Environmental Protection Agency.

2. U.S. EPA. 1989. U.S. Environmental Protection Agency, Office of Solid Waste. Onsite Engineering Report of Treatment Technology Performance and Operation for Waterways Experiment Station, Vicksburg, Mississippi. December, 1989. Washington, D.C.: U.S. Environmental Protection Agency.

3. U.S. EPA. 1989. U.S. Environmental Protection Agency, Office of Solid Waste. Final Best Demonstrated Available Technology (BDAT) Background Document for F024. May, 1989. Washington, D.C.: U.S. Environmental Protection Agency.

4. U.S. EPA. 1989. U.S. Environmental Protection Agency, Office of Solid Waste. Land Disposal Restrictions for Second Third Scheduled Wastes. 54 Federal Register 26594. June 23, 1989. Washington, D.C.: U.S. Environmental Protection Agency.

APPENDIX A

Plant Codes

Table A-1

PLANT CODES

Code	Plant	Location
X	Waterways Experiment Station	Vicksburg, Mississippi
Y	ENSCO	El Dorado, Arkansas

APPENDIX B

Quality Assurance/Quality Control Data

Table B-1

STABILIZED F024 INCINERATOR ASH MATRIX SPIKE RECOVERIES FOR METAL CONSTITUENTS

Cement Binder: Sample Set 2

BDAT List Constituent	Original Amount Found[a] (ppm)	Amount Spiked (ppm)	Sample Result		Duplicate Sample Result		Relative Percent Difference (%)
			Amount Recovered (ppm)	Percent Recovery[b] (%)	Amount Recovered (ppm)	Percent Recovery[b] (%)	
155. Arsenic	0.0036	0.1	0.105	101.3	0.109	105	3.7
156. Barium	1.84	2	3.70	93.2	3.78	97.2	2.1
157. Beryllium	<0.0009	2	1.74	87.1	1.75	87.6	0.6
158. Cadmium	<0.0027	2	1.61	80.3	1.62	80.9	0.8
159. Chromium (total)	0.0311	2	1.77	87.2	1.79	88.0	0.9
221. Chromium (VI)	0.00944	0.010	0.0185	90.8	0.185	90.8	0.0
160. Copper	<0.0179	2	1.71	85.6	1.71	85.6	0.0
161. Lead	0.0112	0.075	0.007	78.4	0.0735	83.1	4.9
162. Mercury	0	0.0005	0.000483	96.6	0.000497	99.4	2.9
163. Nickel	<0.0249	2	1.61	80.5	1.59	79.7	1.0
168. Zinc	0.0406	2	1.61	78.3	1.66	81.2	3.5

[a]For a constituent not detected in the treatment residual at or above the detection limit, the original amount found is considered zero in calculating percent recovery.
[b]Percent recovery = 100 x $(C_t-C_o)/C_t$, where C_t = amount recovered, C_o = original amount found, and C_t = amount spiked.

Source: Onsite Engineering Report of Treatment Technology Performance and Operation for Waterways Experiment Station, Vicksburg, Mississippi (Reference 2).

Table B-1 (Continued)

STABILIZED F024 INCINERATOR ASH MATRIX SPIKE RECOVERIES FOR METAL CONSTITUENTS

Lime/Fly Ash Binder: Sample Set 2

BDAT List Constituent	Original Amount Found[a] (ppm)	Amount Spiked (ppm)	Sample Result: Amount Recovered (ppm)	Sample Result: Percent Recovery[b] (%)	Duplicate Sample Result: Amount Recovered (ppm)	Duplicate Sample Result: Percent Recovery[b] (%)	Relative Percent Difference (%)
154. Arsenic	0.0877	4	3.96	96.9	3.93	96.1	0.7
155. Barium	0.0035	0.1	0.105	102	0.103	99.7	1.8
156. Beryllium	1.95	2	3.80	92.3	3.90	97.3	2.6
157. Cadmium	<0.0009	2	1.75	87.5	1.76	88.2	0.8
158. Chromium (total)	<0.0027	2	1.58	79.2	1.58	79.1	0.1
159. Chromium (VI)	0.0967	2	1.73	81.9	1.73	81.7	0.2
221. Copper	0.00357	0.010	0.0152	117	0.0138	103	9.8
160. Lead	<0.0179	2	1.73	86.6	1.74	87.1	0.6
161. Mercury	0.0693	0.075	0.131	82.3	0.130	80.8	0.8
162. Nickel	0	0.0005	0.000493	98.6	0.000502	100	1.8
163. Zinc	0.3251	2	1.94	80.9	1.95	81.4	0.5
164. Selenium	0	0.1	0.0438	43.8	0.0437	43.7	0.2
165. Silver	<0.0040	2	1.80	90.2	1.81	90.6	0.4
166. Thallium	0	0.075	0.0453	60.4	0.043	57.3	5.2
167. Vanadium	<0.0072	2	1.68	84.3	1.70	85.1	1.0
168. Zinc	0.151	2	1.92	88.3	1.88	86.2	2.2

[a]For a constituent not detected in the treatment residual at or above the detection limit, the original amount found is considered zero in calculating percent recovery.
[b]Percent recovery = 100 x $(C_t-C_o)/C_t$, where C_t = amount recovered, C_o = original amount found, and C_t = amount spiked.

Source: Onsite Engineering Report of Treatment Technology Performance and Operation for Waterways Experiment Station, Vicksburg, Mississippi (Reference 2).

Table B-1 (Continued)

STABILIZED F024 INCINERATOR ASH MATRIX SPIKE RECOVERIES FOR METAL CONSTITUENTS

Kiln Dust Binder: Sample Set 2

BDAT List Constituent	Original Amount Found[a] (ppm)	Amount Spiked (ppm)	Sample Result: Amount Recovered (ppm)	Sample Result: Percent Recovery[b] (%)	Duplicate Sample Result: Amount Recovered (ppm)	Duplicate Sample Result: Percent Recovery[b] (%)	Relative Percent Difference (%)
154. Arsenic	<0.0755	4	3.83	95.7	3.83	95.8	0.0
155. Barium	0.0015	0.1	0.1	98.5	0.100	98.6	0.1
156. Beryllium	0.540	2	2.46	95.8	2.46	96.0	0.2
157. Cadmium	<0.0009	2	1.67	83.7	1.68	84.2	0.6
158. Chromium (total)	<0.0027	2	1.55	77.5	1.57	78.6	1.3
159. Chromium (VI)	0.192	2	1.80	80.4	1.81	81.0	0.7
221. Copper	0.00290	0.010	0.0141	112	0.0141	112	0.0
160. Lead	<0.0179	2	1.71	85.6	1.71	85.7	0.1
161. Mercury	0.0588	0.075	0.112	70.5	0.11	75.2	3.1
162. Nickel	0	0.0005	0.000512	102	0.000507	101	1.0
163. Zinc	0.0696	2	1.63	78.1	1.65	79.2	1.4
164. Selenium	0.0061	0.1	0.061	54.9	0.0618	55.7	1.3
165. Silver	<0.0040	2	1.77	88.4	1.78	88.8	0.4
166. Thallium	0	0.075	0.0838	112	0.0669	89.2	22.4
167. Vanadium	<0.0072	2	1.66	82.9	1.68	84.2	1.6
168. Zinc	0.0738	2	1.66	79.2	1.74	83.4	5.0

[a]For a constituent not detected in the treatment residual at or above the detection limit, the original amount found is considered zero in calculating percent recovery.
[b]Percent recovery = 100 x $(C_t-C_o)/C_t$, where C_t = amount recovered, C_o = original amount found, and C_t = amount spiked.

Source: Onsite Engineering Report of Treatment Technology Performance and Operation for Waterways Experiment Station, Vicksburg, Mississippi (Reference 2).

Table B-2

SUMMARY OF ACCURACY CORRECTION FACTORS
FOR METAL CONSTITUENTS IN STABILIZED F024 INCINERATOR ASH

BDAT List Constituent	Accuracy Correction Factor[a]		
	Cement Binder	Lime/Fly Ash Binder	Kiln Dust Binder
155. Arsenic	1.000	1.003	1.015
156. Barium	1.073	1.083	1.044
157. Beryllium	1.148	1.143	1.195
158. Cadmium	1.245	1.264	1.290
159. Chromium (total)	1.147	1.224	1.244
221. Chromium (VI)	1.101	1.000	1.000
160. Copper	1.168	1.155	1.68
161. Lead	1.276	1.238	1.418
162. Mercury	1.035	1.014	1.000
163. Nickel	1.255	1.236	1.280
168. Zinc	1.277	1.160	1.212

aThe accuracy correction factor is equal to 100 divided by the percent recovery (matrix spike recovery). An accuracy correction factor of 1.00 was used when matrix spike and duplicate matrix recoveries both exceeded 100%, so that the data were not adjusted to concentrations below the detection limits. If a duplicate matrix spike was performed for a constituent, the matrix spike recovery used to adjust treatment performance data for that constituent was the lower of the two values from the first matrix spike and the duplicate spike.

APPENDIX C

Results of the Analysis of Variance (ANOVA) Tests Comparing the Three Binders Used to Stabilize F024 Incinerator Ash

APPENDIX C

Results of the Analysis of Variance (ANOVA) Tests Comparing the Three Binders Used to Stabilize F024 Incinerator Ash

Analysis of variance (ANOVA) tests were conducted to compare the treatment performance achieved by three binders (cement, lime/fly ash, and kiln dust) used to stabilize F024 incinerator ash. The metal constituents selected for regulation were considered individually and collectively in these tests. Results of the ANOVA tests are summarized in Table C-1. As demonstrated in Table C-1, the cement binder performed as well as or better than either the lime/fly ash or kiln dust binder in all test cases.

Table C-1

SUMMARY OF ANALYSIS OF VARIANCE (ANOVA) TESTS COMPARING THE TREATMENT PERFORMANCE ACHIEVED BY STABILIZATION USING CEMENT, LIME/FLY ASH, AND KILN DUST BINDERS

Metal Constituent(s)	Binders Compared[a]	F-Ratio[b]	Critical Value[b]	Homogeneous (H) or Nonhomogeneous (N)	Statistical Interpretation
Chromium	2 vs. 3	0.10	7.71	H	No significant difference
	1 vs. 3	0.83	7.71	H	No significant difference
	1 vs. 2	0.39	7.71	H	No significant difference
Lead	2 vs. 3	2.87	7.71	H	No significant difference
	1 vs. 3	142.93	7.71	N	No significant difference
	1 vs. 2	37.49	7.71	N	Cement binder is best
Nickel	2 vs. 3	37.96	7.71	N	Kiln dust binder is best
	1 vs. 3	1.19	7.71	H	No significant difference
	1 vs. 2	116.38	7.71	N	Cement binder is best
Chromium, Lead and Nickel	2 vs. 3	2.91	4.49	H	No significant difference
	1 vs. 3	9.90	4.49	N	Cement binder is best
	1 vs. 2	15.27	4.49	N	Cement binder is best

[a]Binders:
1 - Cement
2 - Lime/fly ash
3 - Kiln dust

[b]These terms are discussed in the Agency's Methodology for Developing BDAT Treatment Standards (Reference 1).

APPENDIX D

Detailed Calculations of Treatment Standards for Metal Constituents in F024 Nonwastewaters

Table D-1

DETAILED CALCULATIONS OF TREATMENT STANDARDS FOR METAL CONSTITUENTS IN F024 NONWASTEWATERS

Regulated Constituent	Sample Set 1	Sample Set 2	Sample Set 3	ln of Values 1	ln of Values 2	ln of Values 3	Mean of Adjusted Values (mg/kg)	Mean of lns of Adjusted Values	Standard Deviation of lns	C99	Variability Factor (VF)	Treatment Standard (mg/kg)
159. Chromium (total)												
Unadjusted value (mg/kg)	0.031	0.010	0.013									
a or dl	a	a	a									
ACF	1.147	1.147	1.147									
Adjusted value (mg/kg)*	0.036	0.011	0.015	-3.337	-4.468	-4.206	0.021	-4.004	0.592	0.073	3.513	0.073
161. Lead												
Unadjusted value (mg/kg)	0.011	0.006	0.007									
a or dl	a	a	a									
ACF	1.276	1.276	1.276									
Adjusted value (mg/kg)*	0.014	0.008	0.009	-4.267	-4.873	-4.718	0.010	-4.619	0.315	0.021	2.013	0.021
163. Nickel												
Unadjusted value (mg/kg)	0.025	0.025	0.025									
a or dl	dl	dl	dl									
ACF	1.255	1.255	1.255									
Adjusted value (mg/kg)*	0.031	0.031	0.031	-3.462	-3.462	-3.462	0.031	-3.462	0.000	0.031	2.800	0.088

a - Actual concentration of the constituent in the treatment residual (if quantified above the detection limit).
dl - Detection limit of the constituent in the treatment residual (if not quantified above the detection limit).

* Adjusted value was calculated by multiplying the unadjusted value by the accuracy correction factor (ACF).

C99 = exp(mean of lns of adjusted values + (standard deviation of lns x 2.33))

Variability factor = C99/mean of adjusted value. A variability factor of 2.8 was used when a constituent was not detected (dl) in all sample sets for which it was analyzed.

Treatment standard = mean of adjusted values x variability factor.

Note: The unadjusted values and matrix spike data for these calculations were from stabilization of F024 incinerator ash at Waterways Experiment Station (Reference 2).