DRAFT PROPOSED

BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT) BACKGROUND DOCUMENT FOR DYE AND PIGMENT PRODUCTION WASTES - DEFERRED WASTES K167 and K168

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NOTES ON CONFIDENTIAL BUSINESS INFORMATION (CBI)

This report does not contain information claimed as confidential business information (CBI). Some of the constituents of concern for K167 and K168 are identified as CBI and these have ben removed due to business confidentiality concerns. The CBI version of this report details constituent-specific information such as analytical data, treatment performance data, and chemical properties for all constituents of concern including those constituents identified with potential CBI claims. The current (non-CBI) version of this report removes these seven constituents (and information about them) from both tables and text. When information is removed from tables due to business confidentiality concerns, the following note appears at the base of, or in place of, the table: [CBI removed from table]. When information is removed from text, the following note appears in its place or at the end of the sentence: [CBI removed from text]. When a table is summarized in the text, the analysis only refers to constituents and information identified as non-CBI; a note similar to the following appears in these cases: [these counts refer only to non-CBI constituents].

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EXECUTIVE SUMMARY

This background document provides the Agency's rationale and technical support for developing Land Disposal Restriction (LDR) treatment standards for K167 and K168. EPA is proposing to list K167 and K168 as hazardous wastes:

- K167: Spent filter aids, diatomaceous earth, or adsorbents used in the production of azo, anthraquinone, or triarylmethane dyes, pigments, or FD&C colorants.
- K168: Wastewater treatment sludges from the production of triarylmethane dyes and pigments (excluding triarylmethane pigments using aniline as a feedstock).

A waste meeting these descriptions would only be a listed hazardous waste if it contains any of the constituents of concern at a concentration equal to or greater than the hazardous concentration identified for the constituent.

The Agency is prohibiting the land disposal of both nonwastewater and wastewater forms of hazardous wastes K167 and K168 and proposing LDR treatment standards for these wastes based on previously promulgated technology-specific standards. Specifically, the technology standard of combustion (CMBST) is being proposed as the treatment standard for nonwastewater forms of K167 and K168. The treatment train consisting of wet air oxidation (WETOX) or chemical oxidation (CHOXD) followed by carbon adsorption (CARBN) is being proposed as the treatment standard for wastewater forms of K167 and K168; alternatively treatment by combustion (CMBST) may be used (if finalized, any of the three alternatives may be used to meet the land disposal restriction requirements for wastewater forms of these wastes). The technologies of CMBST, WETOX, CHOXD, and CARBN have been previously promulgated and defined in 40 CFR §268.42.

In developing the LDR treatment standards proposed today, the Agency adhered to the following methodology. EPA first identified the Best Demonstrated Available Technology (BDAT) for the hazardous constituents present in the wastes. In identifying hazardous constituents, EPA limited its consideration to the 27 constituents identified in the proposed rule as potential constituents of concern in K167 and K168. [CBI removed from text]. EPA has previously investigated performance data for many of these constituents through its development of universal treatment standards (UTS) at 40 CFR §268.48 as well as its development of treatment standards for "U and P" listed wastes at 40 CFR §268.40. EPA found that 11 of the non-CBI constituents (10 as nonwastewater standards and 11 as wastewater standards) are already included in the list of Universal Treatment Standards (UTS) at 40 CFR 268.48, and additional non-CBI constituents (six as nonwastewater and five as wastewater) have technology-specific standards for their respective U- listed waste [these counts refer only to non-CBI constituents]. For other constituents in Table ES-1, EPA evaluated potential BDAT based on the properties of the individual compounds and existing treatment data as available.

EPA first considered the appropriateness of proposing numerical treatment standards. EPA considered using the existing UTS for compounds having such standards. For constituents without UTS, EPA developed possible numerical treatment standards using available treatment data for the constituents, BDAT treatment data for compounds with similar structures (or properties), and/or using analytical data obtained from the dyes and pigments record sampling activities. Thus, for all 27 constituents, EPA developed possible numerical treatment standards for wastewater and nonwastewater forms of K167 and K168. These are listed in Table ES-1.

In developing treatment standards, EPA must promulgate regulations specifying those levels or methods of treatment which substantially diminish the toxicity of the waste [RCRA §3004(m)]. To determine if the possible numerical treatment standards would meet this statutory requirement, EPA compared these possible numerical treatment standards to risk-based concentration levels proposed for K167 and K168. These levels will be used by generators to determine whether their waste meets the listing criteria in 40 CFR §261 for K167 and K168. EPA expected that if a particular constituent had a calculated treatment standard lower than the risk-based concentration level, then the toxicity of the waste would in fact be reduced when subjected to the proposed treatment standards. If a particular constituent had a calculated treatment standard higher than the risk-based concentration level, then the toxicity of the waste would not be affected by the proposed treatment standards. This comparison can only be conducted for nonwastewater forms of K167 and K168 since risk-based concentration levels are not being proposed for K167 and K168 wastewaters. For most of the compounds EPA found that the possible numerical treatment standards would be lower than the proposed risk-based concentration levels. For four non-CBI compounds [count refers only to non-CBI constituents], however, the numerical treatment value would be significantly above the risk-based level, and for these constituents the "minimize threat" statutory requirement of RCRA §3004(m) would not be met. These compounds are identified in Table ES-1 by the comment "numerical LDR treatment standard would not be effective." Table ES-1 compares the possible numerical treatment standards with the risk-based concentration levels for each constituent.

To meet the statutory requirements of RCRA, EPA is proposing technology-specific treatment standards for all constituents. EPA could have established numerical treatment standards for some constituents and technology-specific standards for others to meet its statutory obligations, but such a structure would have been unnecessarily complex. EPA determined that technology-based standards would diminish the overall toxicity of the wastes for all constituents of concern. Specifically, all of the constituents are organic and amenable to combustion [evaluation refers only to non-CBI constituents]. Therefore, a treatment standard of combustion is proposed for nonwastewaters. For K167 and K168 wastewaters, the constituents of concern are best treated using one of several technologies depending on the properties of the individual compound. For this reason, the proposed treatment standard for wastewater forms of K167 and K168 is any one of the following treatment trains:

- wet air oxidation followed by carbon absorption; or
- chemical oxidation followed by carbon absorption; or
- combustion.

Treatment standards for wastewater forms of K167 and K168 apply to wastewater forms of treatment residuals derived from wastes K167 and K168. Examples of such wastewaters could include scrubber waters or waters separated from wastewater treatment sludges during dewatering. Wastewaters generated during the *manufacturing* process are not being proposed for listing as a hazardous waste and would not be subject to the treatment standards being proposed today.

Table ES-1. Summary of Risk-Based Concentrations and Possible Numerical Treatment Standards for Constituents in Deferred Dyes and Pigments Waste Streams Proposed for Listing

Constituent of Concern	Risk-Based Concentration Level (40 CFR §261)		Possible Numerical Standard (40 CFR §268)		Conclusion (only for K168)
	K167 (mg/kg)	K168 (mg/kg)	WW (mg/L)	NWW (mg/kg)	
Aniline (U)		17	0.81	14	Protective LDR numerical standard
Benzaldehyde		5,000	0.39	6.2	Protective LDR numerical standard
Benzene (U)		370	0.14	10	Protective LDR numerical standard
Benzidine (T)		0.027	0.004	0.60	Numerical LDR standard would not be protective
Chloroaniline, 4- (U)		250	0.46	16	Protective LDR numerical standard
Chlorobenzene (U)		36	0.057	6	Protective LDR numerical standard
Chloroform (U)		100	0.046	6	Protective LDR numerical standard
Cresol, p- (U)		330	0.77	5.6	Protective LDR numerical standard
Dichlorobenzene, 1,2- (U)		1,100	0.088	6	Protective LDR numerical standard
Dimethoxybenzidine, 3,3'- (T)		520	0.023	3.2	Protective LDR numerical standard
Dimethylaniline, N,N-		300	0.81	14	Protective LDR numerical standard
Diphenylamine/ nitrosodiphenylamine A (U)		27,000 / 7,400	0.92	13	Protective LDR numerical standard
Diphenylhydrazine, 1,2- / Azobenzene B (U - WW only; T - NWW only)		31 / 720	0.087	15	Protective LDR numerical standard
Formaldehyde (T)		7,000	0.34	26	Protective LDR numerical standard
Naphthalene (U)		77	0.059	5.6	Protective LDR numerical standard
Phenol (U)		28,000	0.039	6.2	Protective LDR numerical standard
Phenylenediamine, o- (2-aminoaniline)c		61	No standard identified		Numerical LDR standard would not be protective
Phenylenediamine, p- (4-aminoaniline)		5,000	0.81	22	Protective LDR numerical standard

Toluidine, o- (2-aminotoluene) (T)		13	0.39	37	Numerical LDR standard would not be protective
Toluidine, p- (4-aminotoluene) (T)		23	0.39	37	Numerical LDR standard would not be protective

[CBI removed from table]

Proposed risk-based concentration levels are presented in the proposed rule. A filter aid or TAM sludge with constituent concentrations above these levels would be a hazardous waste (as proposed for 40 CFR §261).

Possible numerical standards are derived later in this report. Treatment standards are proposed as numerical or concentration-specific standards in 40 CFR §268.

(U) indicates that a UTS exists for this compound; the numerical standard in the table is equal to the UTS.

(T) indicates that a technology specific treatment standard exists for this constituent as a U-listed waste.

A. Diphenylamine and nitrosodiphenylamine are difficult to distinguish. See 40 CFR 268.48.

B. 1,2-Diphenylhydrazine and azobenzene are indistinguishable by GC/MS analysis (EPA SW-846 Method 8270).

C. This compound formerly had a UTS, which was deleted due to poor method performance (63 Federal Register 47410, September 4, 1998).

1.0 INTRODUCTION

RCRA Section 3004(m) specifies that treatment standards must minimize long- and short-term threats to human health and the environment arising from land disposal of hazardous wastes. EPA’s general approach for complying with this requirement was promulgated as part of the November 7, 1986 Solvents and Dioxins rule. More recently, EPA has presented its guidance in establishing treatment standards in the Final Best Demonstrated Available Technology (BDAT) Background Document for Quality Assurance/Quality Control Procedures and Methodology, October 1991.

EPA’s treatment standards for individual wastes are presented at 40 CFR 268.40. For a given waste, a treatment standard specifies (1) the concentration of each constituent in total or TCLP analysis, or (2) a technology which must be used for treating the waste. EPA establishes treatment standards for wastewaters and nonwastewaters, as well as any subgroups which may be appropriate (e.g., Ahigh mercury@ or Alow mercury@ categories for D009 wastes). EPA has also established universal treatment standards for underlying hazardous constituents; these are listed at 40 CFR 268.48.

The U.S. Environmental Protection Agency (EPA or the Agency) is proposing Land Disposal Restriction (LDR) treatment standards based the Best Demonstrated Available Technology (BDAT) for the regulation of listed hazardous wastes proposed to be identified in Title 40, Code of Federal Regulations, Section 261.32 (40 CFR 261.32) as K167 and K168. These BDAT treatment standards are being proposed 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. HSWA amended RCRA to require EPA to promulgate treatment standards for a waste within 6 months after determining it is hazardous [Section 3004(g)(4)].

Compliance with the proposed treatment standards is a prerequisite for land disposal, as defined in 40 CFR Part 268. In 40 CFR 268.44, EPA supplies provisions, that, if met, may justify granting a variance from the applicable treatment standards. In 40 CFR 268.6, EPA supplies provisions, that, if met, may justify granting waste- and site-specific waivers from the applicable treatment standards in 268.40.

The proposed Hazardous Wastes Numbers K167 and K168 are generated during production of dye and pigment products. These hazardous wastes are proposed to be defined as follows:

- K167 - Spent filter aid, diatomaceous earth, or adsorbents used in the production of azo, anthraquinone, or triarylmethane dyes, pigments, or FD&C colorants.
- K168 - Wastewater treatment sludges from the production of triarylmethane dyes and pigments (excluding triarylmethane pigments using aniline as a feedstock).

In both cases, the wastes are hazardous unless these wastes do not contain any of the constituents of concern at a concentration equal to or greater than the hazardous level set for that constituent as demonstrated by implementation procedures described in the rule. A total of 27 constituents have proposed risk-based concentration levels.

This background document provides the Agency's rationale and technical support for developing LDR treatment standards for K167 and K168.

1.1 Regulatory Background

Section 3001(e)(2) of RCRA requires EPA to determine whether to list as hazardous, wastes from the production of dyes, pigments, and FD&C colorants. In June of 1991, EPA entered into a proposed consent decree in a lawsuit filed by the Environmental Defense Fund, et al. (EDF v. Reilly, Civ. No. 89-0598 (D.D.C.), hereafter referred to as the consent decree). The consent decree sets out a series of deadlines for promulgating RCRA listing decisions, including a determination whether to list as hazardous certain wastes from the production of dyes and pigments.

There are three major classes of dyes and pigments identified in the consent decree: azo/benzidine, anthraquinone, and triarylmethane. The consent decree specifies that the listing is to address the azo, monoazo, diazo, triazo, polyazo, azoic, and benzidine categories of the azo/benzidine dye and pigment class; the anthraquinone and perylene categories of the anthraquinone dye and pigment class; and the triarylmethane, triphenylmethane, and pyrazolone categories of the triarylmethane dye and pigment class. The consent decree also specifies that the listing is to address the following types of wastes where they are found: spent catalysts, reactor still overheads, vacuum system condensate, process waters, spent adsorbent, equipment cleaning sludge, product mother liquor, product standardization filter cake, dust collector filter fines, recovery still bottoms, treated wastewater effluent, and wastewater treatment sludge.

The Agency initiated an investigation of the azo/benzidine, anthraquinone, and triarylmethane dye and pigment manufacturing industry. EPA's Office of Solid Waste developed a detailed RCRA §3007 questionnaire for distribution to dye and pigment manufacturing facilities. The questionnaire was coordinated with other EPA programs, and solicited feedback from industry trade associations. The questionnaire was distributed to domestic manufacturers in March of 1992, for wastes generated in 1991. EPA supplemented this information with a questionnaire update to collect information on wastes generated in 1997. EPA also collected information from engineering site visits, familiarization sampling, and record sampling activities conducted prior to 1994, as well as information from the general literature.

On December 22, 1994 (59 FR 66072), the Agency published a notice that proposed listing decisions for 11 of the wastes named in the consent decree, including a proposal to add five wastes to the lists of hazardous wastes in 40 CFR 261.32. In the 1994 proposed rule, the Agency deferred action on three waste streams based on insufficient characterization data, or lack of health-based levels for specific constituents of concern. The Adeferred@ dye and pigment waste streams are the subject of the current proposed rule. The three deferred wastes are:

- Spent filter aids, diatomaceous earth, or adsorbents used in the production of azo, anthraquinone, or triarylmethane dyes, pigments, or FD&C colorants. This waste is proposed to be listed as K167.

- Wastewater treatment sludge from the production of triarylmethane dyes and pigments (excluding triarylmethane pigments using aniline as a feedstock). This wastes is proposed to be listed as K168.

- Wastewater treatment sludge from the production of anthraquinone dyes and pigments. This waste is proposed to not be listed because the only chemicals detected in sludge that could be attributed to anthraquinone production in 1994 did not have health-based benchmarks. EPA has not found any suitable surrogates to estimate the toxicity of these compounds.

This report will refer to the first two wastes more simply as Afilter aids@ (or K167) and ATAM sludges@ (or K168), respectively. The third waste, wastewater treatment sludge from the production of anthraquinone dyes and pigments, will not be discussed in this report because EPA is not proposing to list this waste as hazardous, and therefore LDR treatment standards are not required.

1.2 Summary

The LDR program is designed to protect human health and the environment by prohibiting the land disposal of RCRA hazardous wastes unless specific treatment standards are met.

In RCRA Section 3004(m), Congress directed the Agency to: ". . . promulgate . . . levels or methods of treatment . . . which substantially diminish the toxicity of the waste or . . . the likelihood of migration of hazardous constituents . . . so that short-term and long-term threats to human health and the environment are minimized."

Key provisions of the LDR program require that: (1) treatment standards are met prior to land disposal, (2) treatment is not evaded by long-term storage, (3) actual treatment occurs rather than dilution, (4) record keeping and tracking follow a waste from "cradle to grave" (i.e., generation to disposal), and (5) certification verifies that the specified treatment standards have been met.

In developing the LDR treatment standards proposed today, the Agency adhered to the following methodology. EPA identified 27 constituents of concern that formed the basis for listing K167 and K168 as hazardous wastes. For each constituent, EPA calculated possible numerical treatment standards representing the best demonstrated available technology. In general, sources of these numerical standards include the Universal Treatment Standards (UTS) at 40 CFR 268.48, the use of treatment data previously developed by EPA, and the transfer of these treatment data for compounds with similar properties (details of this procedure are discussed in the following sections of the report). EPA then compared these possible numerical treatment standards to the concentration-based listing levels proposed in the rule and found that several of the numerical treatment standards would not be protective (i.e., the treatment level would have been higher than the concentration causing the waste to be hazardous). Therefore, the establishment of numerical standards would not minimize threats from contaminants as required by the statute. To meet the obligations of the statute, EPA developed technology-specific standards. The development of these standards are discussed later in this report.

1.3 Contents of This Document

Section 2.0 of this document describes the industry and processes generating Hazardous Waste Nos. K167 and K168, the basis for listing dye and pigment wastes as hazardous, and waste stream characteristics. Existing waste management practices for these wastes also are described in Section 2.0. Section 3.0 discusses the treatment technologies the Agency has designated as "applicable" and "demonstrated" for these wastes, and identifies BDAT for wastewater and nonwastewater forms of these wastes. Section 4.0 presents the calculation of the numerical treatment standards considered for these wastes, and EPA's reason not to propose numerical standards. References are listed in Section 5.0.

The treatment performance data employed for identifying the BDAT for nonwastewater forms of K167 and K168 are found in Appendix A. The treatment performance data employed for identifying the BDAT for nonwastewater forms of K167 and K168 are found in Appendix B. In calculating possible numerical standards for some constituents, EPA used non-CBI analytical data from the Agency's dye and pigment waste characterization program. These data are presented in Appendix C. Appendix D contains structural diagrams for many of the compounds referenced in this report, including the constituents proposed as a basis for listing these wastes.

2.0 DESCRIPTION OF DYES AND PIGMENT WASTE STREAMS

2.1 Industry Overview

The dye and pigment industries are comprised of three related industries: pigment manufacturers, dye manufacturers, and food, drug, and cosmetic (FD&C) colorant manufacturers. Each of these sectors potentially generate K167 or K168 wastes and are discussed below.

Dyes are colored or fluorescent organic substances that impart color to a substrate by selective absorption of light. When a dye is applied, it penetrates the substrate in a soluble form, after which it may or may not become insoluble. Dyes are used to color fabrics, leather, paper, ink, lacquers, varnishes, plastics, cosmetics, and some food items. U.S. International Trade Commission (USITC) production data showed total 1994 production of approximately 156,000 tons for all organic dyes.

Organic pigments possess unique characteristics that distinguish them from dyes and other colorants. The primary difference between pigments and dyes is that, during the application process, pigments are usually insoluble in the substrate. Pigments also retain a crystalline or particulate structure and impart color by selective absorption or by scattering of light. Pigments are used in a variety of applications; the primary use is in printing inks. There are fewer pigments produced than dyes, though pigment batches are generally larger in size. USITC production data showed total 1995 production of approximately 71,500 tons for organic pigments. EPA previously listed wastes from the production of inorganic pigments as K002 - K008, however K167 and K168 result from the production of organic dyes and pigments.

FD&C colorants are dyes and pigments that have been approved by the Food and Drug Administration (FDA) for use in food items, drugs, and/or cosmetics. Typically, FD&C colorants are azo or triarylmethane dyes and are similar or identical to larger-volume dye products not used in food, drugs, and cosmetics. Manufacture of FD&C colorants is typically the same as that for the corresponding dye or pigment, except that the colorant undergoes additional purification. Each FD&C colorant batch is tested and certified by the FDA.

2.2 Processes Generating Hazardous Wastes

In the current rule, two wastes are proposed for listing as hazardous:

K167 Spent filter aids, diatomaceous earth, or adsorbents used in the production of azo, anthraquinone, or triarylmethane dyes, pigments, or FD&C colorants.

K168 Wastewater treatment sludges from the production of triarylmethane dyes and pigments (excluding triarylmethane pigments using aniline as a feedstock).

A third waste, wastewater treatment sludge from the production of anthraquinone dyes and pigments, is being proposed to not be listed in the current rule. More detailed information on the two wastes proposed for listing is presented below.

These wastes are generated from dye and pigment production. Azo dyes are the most important class. They contain at least one azo group ($-\mathrm{N{=}N}-$) and less commonly, four or more. The azo group is attached to two radicals of which at least one, but more typically both, are aromatic. (Kirk-Othmer, 1993)

Triarylmethane dyes are typically used in the textile industry and pigments are used in ink production (59 FR 66080). Triarlymethane dyes are characterized by a central carbon atom joined to three aromatic rings. (Kirk-Othmer, 1993)

Anthraquinone dyes are the second most important class, with importance declining due to their higher cost. Anthraquinone dyes are based on 9,10-anthraquinone, which is essentially colorless (Kirk-Othmer, 1993). The structure of this compound is presented in Appendix D.

2.2.1 K167: Spent Filter Aids, Diatomaceous Earth, or Adsorbents

Manufacturers add filter aids (e.g., diatomaceous earth) to some reaction processes to remove particulate impurities. The spent filter aids then are collected in a filter press and the press cake, sometimes called a clarification sludge, is disposed as waste. In some cases, facilities also use filter aids following completed reactions to clarify and purify certain products. The Agency grouped spent filter aids, diatomaceous earth, and adsorbents used in the production of all relevant classes of dyes and pigments, because these wastes typically contain unreacted raw materials, by-products, and impurities. The constituent composition of these filter aids varies depending on the dye or pigment produced and the raw materials used.

2.2.2 K168: TAM Wastewater Treatment Sludge

The typical wastewater treatment sludge is generated via the treatment of the following process waste streams: equipment washdown, plant run-off, spent scrubber liquid and mother liquor. Wastewater treatment steps usually include: neutralization to adjust pH, clarification, and biological treatment. Pretreatment sludges may be generated from precipitation/filtration in neutralization tanks, and from treatment with adsorbents, such as activated carbon. Biological treatment can also lead to generation of a wastewater treatment sludge. Sludge streams are further processed, typically through filtration and dewatering, prior to disposal.

2.3 Waste Stream Characteristics

Traditionally, EPA characterizes wastes by conducting record sampling, reviewing industry-submitted waste characterization data, and reviewing survey responses. EPA does have limited waste characterization data for these wastes using these data collection methods. However, in the 1994 proposal EPA noted several data shortcomings for these wastes. Specifically, for TAM wastewater treatment sludge, waste characterization data were available from only one generating facility, and due to the inherent batch operations of the industry, the facility was not manufacturing triarylmethane dyes or pigments at the time of record sampling (59 FR 66095, December 22, 1994). Similarly, for spent filter aids, EPA noted insufficient waste characterization information upon which to make a listing decision (59 FR 66103, December 22, 1994). For both wastes, EPA planned to collect additional waste characterization data, but this approach was abandoned soon after the 1994 proposal.

To account for a general lack of representative waste characterization data and to allow all interested stakeholders an opportunity for review and comment of the data used in rule development, EPA assessed the toxicity of constituents that could be present in the wastes. EPA initially considered all constituents that were found to present, or could potentially be present, in K167 and K168. This initial list was based on a review of record sampling data and industry-submitted waste characterization data. EPA subsequently revised this list to the 27 individual constituents proposed as a basis for listing. These constituents are presented in Table 2-1. The corresponding treatment standard information is presented for each compound, for use later in this report.

Table 2-1. Constituents Used as the Basis for Listing for K167 and K168

Constituent of Concern	**CAS Number**	**UTS WW (mg/L)**	**UTS NWW (mg/kg)**
Aniline	62-53-3	0.81	14
Benzaldehyde	100-52-7	**C**	**C**
Benzene	71-43-2	0.14	10
Benzidine 1	92-87-5	**C** (T)	**C** (T)
Chloroaniline, 4-	106-47-8	0.46	16
Chlorobenzene	108-90-7	0.057	6
Chloroform	67-66-3	0.046	6
Cresol, p-	106-44-5	0.77	5.6
Dichlorobenzene, 1,2-	95-50-1	0.088	6
Dimethoxybenzidine, 3,3'- 2	119-90-4	**C** (T)	**C** (T)
Dimethylaniline, N,N-	121-69-7	**C**	**C**
Diphenylamine A	112-39-4	0.92	13
Diphenylhydrazine, 1,2- B	122-66-7	0.087	**C** (T)
Formaldehyde 3	50-00-0	**C** (T)	**C** (T)
Naphthalene	91-20-3	0.059	5.6
Phenol	108-95-2	0.039	6.2
Phenylenediamine, o-(2-aminoaniline)	95-54-5	**C** (D)	**C** (D)
Phenylenediamine, p-(4-aminoaniline)	106-50-3	**C**	**C**
Toluidine, o- (2-aminotoluene) 4	95-53-4	**C** (T)	**C** (T)
Toluidine, p- (4-aminotoluene) 5	106-49-0	**C** (T)	**C** (T)

[CBI removed from table]

C: No UTS available

(T): A technology-based standard is available for the corresponding U or P code waste as follows:

1 U021; 2 U091; 3 U122; 4 U328; 5 U353

(D): The UTS for this compound deleted due to poor method performance (September 4, 1998).

A: Compound is difficult to distinguish from N-nitrosodiphenylamine. See 40 CFR § 268.48.

B: Compound is difficult to distinguish from azobenzene. See Section 2.3.2 of this report.

2.4 Waste Management Practices

The various management methods reported for K167 and K168 are summarized in Table 2-2. This information is from the results of the industry questionnaires for calender years 1991 and 1997. Intermediate steps such as storage are not presented here. The purpose of Table 2-2 is to show the management methods and waste treatment, if any, actually employed for these wastes. Any management methods involving waste treatment, such as combustion, would therefore be Ademonstrated@ for the purposes of considering the technology for treatment standard development.

Table 2-2. Reported Management Methods for K167 and K168

Final Management	Comment
1991 Original Data	
Hazardous waste incineration	Expected to continue following promulgation of proposed land disposal restrictions
[CBI removed from table]	
1997 Updated Data	
[CBI removed from table]	

3.0 BDAT Treatment Standards for Dyes and Pigment Wastes

Presented in the sections below are the Agency's determination of applicable and demonstrated technologies and the best demonstrated available technology (BDAT) for treatment of nonwastewater and wastewater forms of K167 and K168. The constituents selected for proposed regulation in these wastes were identified in Section 2.3.

3.1 Determination of BDAT Treatment Standards for K167 and K168

In order to establish BDAT, the Agency first identifies which technologies are "applicable" for treatment of the constituents of interest. An applicable technology is one that, in theory, can treat the waste in question or a waste similar to the waste in question in terms of parameters that affect treatment selection. Identifying treatment technologies as applicable for treating each constituent is based on evaluation of current waste management practices, current literature sources, field testing, data submitted by equipment manufacturers and industrial concerns, plus engineering judgement of EPA technical staff personnel.

The Agency next determines which of the applicable technologies are "demonstrated" for treatment of the subject wastes. EPA prefers to designate as demonstrated a technology used in a full-scale operation for treatment of the waste of interest or a similar waste. Technologies that are available only at pilot- or bench-scale operations may not be considered demonstrated technologies. EPA may use, in limited circumstances, pilot- and bench-scale data in (1) designating a technology as demonstrated and in (2) developing treatment limits. This would be the case when EPA determines that the performance of pilot- or bench-scale technologies can be optimized to a full-scale operation.

The Agency determines which of the demonstrated technologies is "best" by comparing available treatment performance data from as many systems as possible for the constituents of interest, and determines whether this "best" demonstrated technology is also commercially "available." If the "best" demonstrated technology is "available," then the technology is determined to represent BDAT.

EPA is proposing technology-specific LDR treatment standards for both wastewaters and nonwastewaters. A description of these treatment standards, including a discussion of other applicable technologies considered and a discussion of why the technologies are effective for treating these wastes, are presented in Sections 3.2 and 3.3.

3.2 Identification of Best Demonstrated and Available Technologies (BDAT) for Nonwastewaters

3.2.1 Applicable and Demonstrated Technologies

All of the constituents of concern in K167 and K168 wastes, presented in Table 2-1, are organic. Applicable treatment technologies include those that destroy or reduce the total amount of organic constituents in the waste. The technologies listed below are applicable and have been demonstrated to treat organic constituents in nonwastewater forms of similar hazardous wastes. A thorough discussion of these technologies is presented in U.S. EPA's AFinal Best Demonstrated Available Technology (BDAT) Background Document for Universal Standards: Volume A: Universal Standards for Nonwastewater Forms of Listed Hazardous Wastes,@ July 1994. Only those technologies applicable to the physical and chemical characteristics of K167 and K168 are listed below:

- Incineration: This is a destruction technology in which heat is transferred to the waste to destabilize chemical bonds and destroy organic constituents. Offgases (following additional combustion in an afterburner) are fed to a scrubber system for cooling and for removal of entrained particles and acid gas. Typically, scrubber water and ash are generated from incineration. Further discussion of this technology is presented in Section 3.2.2.

- Fuel substitution: Fuel substitution involves using hazardous waste as fuel in industrial furnaces or boilers. Further discussion of this technology is presented in Section 3.2.2.

- Solvent extraction: Solvent extraction is a separation and recovery technology that removes organic constituents from a waste by mixing the waste with a solvent that preferentially dissolves and removes the constituents of concern from the waste.

- Critical fluid extraction: This is a separation and recovery technology in which a solvent is brought to its critical state (liquified gas) to extract organic constituents from a waste.

- Pressure filtration: Pressure filtration, also known as sludge dewatering, is a separation and recovery technology used for wastes that contain high concentrations (greater than 1 percent) of suspended solids. It separates particles from a fluid/ particle mixture by passing the fluid through a medium that permits the flow of the fluid but retains particles.

- Thermal drying of biological treatment sludge: This is a destruction technology which uses controlled flame combustion or indirect heat transfer to elevate the temperature of the waste and, thereby, volatalize organic constituents. Off-gas from the dryer is sent to an afterburner to complete combustion of the volatile component.

- Thermal desorption: This is a separation and recovery technology in which heat is used to volatalize organic constituents from wastes. The offgas contains steam and volatilized organics.

- Total recycle or reuse: Total recycle or reuse within the same process or an external process eliminates waste generation and subsequently generates no treatment residuals requiring further management.

Except for total waste recycle and reuse, all of the treatment methods listed above generate additional wastes in liquid or solid form. Such wastes would require additional management, including additional treatment to meet applicable land disposal restriction treatment standards if necessary.

3.2.2 BDAT for K167 and K168

For nonwastewater forms of K167 and K168, EPA has identified combustion as BDAT. The justification for this determination is as follows:

- Incineration is commercially available. EPA's ABackground Document for Capacity Analysis for Land Disposal Restrictions: Newly Identified Dye and Pigment Manufacturing Wastes (proposed rule),@ June 1999, shows that commercial facilities have historically used incineration for a variety of wastes.

- Incineration is demonstrated for K167 and K168. Data from the 1995 Biennial Reporting System (BRS) shows that the types of hazardous wastes most likely to be associated with K167 and K168 (i.e., adsorbents, organic sludges, and biological treatment sludges) are incinerated. Additionally, as shown in Section 2, incineration is used as a management method for K167 and/or K168 according to EPA data.

- In developing its universal treatment standards, the Agency has identified incineration as BDAT for all organic constituents selected for regulation, with the exception of five pesticides, diphenylamine, and diphenylnitrosoamine. Many constituents of concern in K167 and K168 have universal treatment standards based on incineration and therefore are appropriately treated using incineration.

Incineration was briefly discussed in Section 3.2.1; a more detailed discussion is presented here. This discussion is from U.S. EPA "Final Best Demonstrated Available Technology (BDAT) Background Document for Universal Standards: Volume A: Universal Standards for Nonwastewater Forms of listed Hazardous Wastes," July 1994. Incineration is a destruction technology in which heat is transferred to the waste to destabilize chemical bonds and destroy hazardous organic constituents. Three incineration technologies are applicable and demonstrated for organics in nonwastewaters: liquid injection, rotary kiln, and fluidized-bed.

In a liquid injection incinerator, liquid wastes are atomized and injected into the incinerator, where additional heat is supplied to destabilize chemical bonds in the presence of air or oxygen. Once the chemical bonds are broken, these constituents react with oxygen to form carbon dioxide and water vapor. Liquid injection is applicable to wastes with low viscosity values, small waste particle size, and low suspended solids content. Since only wastes with low or negligible ash contents are amenable to liquid injection incineration, this technology does not normally generate an ash residual, but does generate a scrubber water residual.

In a rotary kiln incinerator, solid and/or semi-solid wastes are fed into the elevated slope-end of the kiln. The rotation of the kiln mixes the waste with hot gases. Eventually, the waste reaches its ignition temperature, and the waste is converted to gas and ash through volatilization and combustion reactions. Ash is removed from the lower slope-end of the kiln. Combustion gases from the kiln, containing volatilized and partially combusted waste constituents, enter an afterburner for further combustion to complete the destruction of the organic waste constituents. Other wastes may also be injected into the afterburner.

In a fluidized-bed incinerator, solid and/or semi-solid wastes are injected into a fluidized material (generally sand and/or incinerator ash), where they are heated to their ignition temperature. In the incinerator, the waste is converted to gas and ash through volatilization and combustion reactions. Heat energy from the combustion reaction is then transferred back to the fluidized-bed. The velocity of the combustion gases is reduced in a wider space above the bed, known as the "freeboard", allowing larger ash and unburned waste particles to fall back into the bed. Ash is removed periodically both during operation and during bed change-outs.

Combustion gases from incineration are fed into a scrubber system for cooling and removal of any entrained particles and acid gases. In general, with the exception of liquid injection incineration, two residuals are generated by incineration processes: ash and scrubber water.

Not all of the constituents of concern in K167 and K168 have previously been shown to be best treated using incineration in EPA’s previous development of treatment standards. Specifically, some constituents do not have any treatment standards (i.e., have not previously been studied by EPA), while one compound, diphenylamine, has a universal treatment standard based on fuel substitution. Fuel substitution and incineration are similar, however, in that they involve the complete destruction of the compound. Fuel substitution is a destruction technology in which heat is transferred to a waste to destabilize chemical bonds and destroy organic constituents. Fuel substitution involves using hazardous waste as fuel in industrial furnaces or boilers. The hazardous waste may be blended with other nonhazardous wastes (e.g., municipal sludge) and/or fossil fuels. Fuel substitution has been used in the treatment of industrial waste solvents, refinery wastes, synthetic fibers/petrochemical wastes, waste oils, and wastes produced during the manufacture of pharmaceuticals, pulp and paper, and pesticides. Fuel substitution generates two residuals: ash and scrubber water. Fuel substitution is similar to incineration in that destruction of the compound occurs at high temperature. For the remaining compounds without any treatment standards, EPA expects incineration to adequately treat these constituents. Section 3.2.3 presents justification that all of the constituents of concern in K167 and K168 nonwastewaters can be adequately treated by incineration.

3.2.3 Ability of Combustion to Treat the Constituents of Concern

Of the 27 constituents proposed as constituents of concern in K167 and K168 nonwastewaters, 10 non-CBI chemicals have UTS for nonwastewaters (where UTS is based on either incineration or fuel substitution) and 6 non-CBI chemicals have a specified method of treatment (where combustion is specified1) [these counts refer only to non-CBI constituents]. The constituents of concern are listed in Table 3-1.

Table 3-1. Existing Treatment Standards for Constituents of Concern in K167 and K168 Nonwastewaters

Constituent of Concern	CAS Number	Existing Standard	Treatment Technology Basis for Standard
Aniline	62-53-3	14 mg/kg (UTS)	Incineration
Benzaldehyde	100-52-7	**C**	**C**
Benzene	71-43-2	10 mg/kg (UTS)	Incineration
Benzidine	92-87-5	(T)	Combustion
Chloroaniline, 4-	106-47-8	16 mg/kg (UTS)	Incineration
Chlorobenzene	108-90-7	6 mg/kg (UTS)	Incineration
Chloroform	67-66-3	6 mg/kg (UTS)	Incineration
Cresol, p-	106-44-5	5.6 mg/kg (UTS)	Incineration

Dichlorobenzene, 1,2-	95-50-1	6 mg/kg (UTS)	Incineration
Dimethoxybenzidine, 3,3'-	119-94-4	(T)	Combustion
Dimethylaniline, N,N-	121-69-7	**C**	**C**
Diphenylamine A	112-39-4	13 mg/kg (UTS)	Fuel Substitution
1,2-Diphenylhydrazine B	112-66-7	(T)	Combustion
Formaldehyde	50-00-0	(T)	Combustion
Naphthalene	91-20-3	5.6 mg/kg (UTS)	Incineration
Phenol	108-95-2	6.2 mg/kg (UTS)	Incineration
Phenylenediamine, o- (2-aminoaniline)	95-54-5	**C**	**C**
Phenylenediamine, p- (4-aminoaniline)	106-50-3	**C**	**C**
Toluidine, o- (2-aminotoluene)	95-53-4	(T)	Combustion
Toluidine, p- (4-aminotoluene)	106-49-0	(T)	Combustion

[CBI removed from table]
A. Nitrosodiphenylamine is a proposed constituent of concern related to diphenylamine.
B. Azobenzene is a proposed constituent of concern related to 1,2-diphenylhydrazine.
(T) Technology specific standard for the respective U-listed hazardous waste.

The universal treatment standards for these constituents were based on incineration performance data for all constituents except diphenylamine, which was based on fuel substitution performance data. These data represent the BDAT for wastes included in previous rulemakings and therefore have been judged to meet the Agency's requirement of BDAT. Although data from the thermal treatment of these constituents in nonwastewater forms of K167 and K168 are not available, the thermal destruction technologies can routinely achieve destruction to levels below the detection limit as shown in Appendix A. Based on the results for these constituents with UTS, and the evaluation of the remaining chemicals described further in this section, EPA is confident that all 27 constituents can be adequately treated by incineration at levels below detection limit.

Two measures or indices were used to determine the difficulty of treating each compound via incineration. They are the incinerability index and the thermal stability index. The Agency has utilized each index in past assessments involving incineration of hazardous compounds. The Agency used the incinerability index in EPA's *Best Demonstrated Available Technology (BDAT) Background Document for Newly Listed or Identified Wastes from the Production of Carbamates and Organobromines* (March 2, 1995) while the thermal stability index was cited in EPA's *Guidance on Setting Permit Conditions and Reporting Trial Burn Results: Volume II of the Hazardous Waste Incineration Guidance Series - Appendix D* (January 1989). The following paragraphs discuss these indices in greater detail.

Incinerability Index

The incinerability index is a function of the heat of combustion and the percent concentration of the compound in the waste, given by the following equation:

$$I = C + 100/H$$

where

I = incinerability index
C = percent concentration in waste
H = negative heat of combustion of compound (kcal/gram)

Concentration values (C) were not used because they are expected to be less than 1 percent in the subject wastes and therefore were assumed to have negligible effect on the calculation. The higher the incinerability index, the more difficult it is to destroy the compound.

Thermal Stability Index

The thermal stability index (developed by Dellinger and Taylor and described in EPA, 1989) ranks the thermal stability of compounds using several factors, including heat of combustion. The fact that this index uses several parameters in calculating a value to assess ease of combustion may make it more reliable than the incinerability index. The lower the value (closer to one), the more thermally stable the compound and therefore the more difficult to destroy. Based on this argument, it can be concluded that if a compound with a certain ranking is known to be adequately treated by incineration (e.g., 10) then all compounds with values greater than 10 can also be destroyed. Values for the thermal stability index and the incinerability index are presented in Table 3-2.

Table 3-2. Combustion Indices for the Constituents of Concern in K167 and K168

Constituent of Concern	CAS Number	Negative Heat of Combustion A (kcal/g)	Inciner-ability Index B	Thermal Stability Index Rank C
Aniline (U)	62-53-3	8.71	11.48	46-50
Benzaldehyde	100-52-7	7.94	12.59	C
Benzene (U)	71-43-2	9.99	10.00	3
Benzidine	92-87-5	8.44	11.84	60-64
Chloroaniline, 4- (U)	106-47-8	6.01	16.63	37
Chlorobenzene (U)	108-90-7	6.61	15.13	19
Chloroform (U)	67-66-3	0.95	105.60	B
Cresol, p- (U)	106-44-5	8.17	12.24	103
Dichlorobenzene, 1,2- (U)	95-50-1	4.82	20.75	23-24
Dimethoxybenzidine, 3,3'-	119-90-4	B	B	B
Dimethylaniline, N,N-	121-69-7	9.40	10.63	B
Diphenylamine (U)	122-39-4	9.07	11.03	42-44
Diphenylhydrazine, 1,2-	122-66-7	8.64	11.57	B
Formaldehyde	50-00-0	4.55	21.98	46-50
Naphthalene (U)	91-20-3	9.60	10.42	B
Phenol (U)	108-95-2	7.75	12.90	100-101
Phenylenediamine, o- (2-aminoaniline)	95-54-5	7.83	12.77	57-59
Phenylenediamine, p- (4-aminoaniline)	106-50-3	7.76	12.89	57-59
Toluidine, o- (2-aminotoluene)	95-53-4	9.00	11.11	B
Toluidine, p- (4-aminotoluene)	106-49-0	9.05	11.04	B

[CBI removed from table]

A. The heat of combustion in kcal/g was calculated by dividing the heat of combustion in kcal/mol by the molecular weight of the compound. The heats of combustion were taken from the National Institute of Standards and Technology AChemistry Webbook@ at http://webbook.nist.gov/chemistry.

B. Incinerability Index (I) = C + 100/H, where C is equal to the constituent's percent concentration in the waste (assumed to be negligible) and H is the negative heat of combustion in kcal/g. Constituents with higher incinerability index values are more difficult to treat.

C. The constituents with lower thermal stability index values (closest to 1) are more stable and therefore are more difficult to treat. From EPA, AGuidance on Setting Permit Conditions and Reporting Trial Burn Results, volume 2 of the Hazardous Waste Incineration Guidance Series,@ June 1989 (EPA 625 6-89 019), Appendix D.

(U) indicates constituent has a UTS for nonwastewaters.

B: Index/Rank/Data not available.

EPA obtained values for the incinerability index and the thermal stability index for as many of the constituents of concern in K167 and K168 wastes as available. Values were available for constituents with and without UTS, however for some constituents without UTS no data were available. While incineration performance data are available for constituents with UTS (identified in Appendix A), similar performance data are not available for constituents without UTS. To use the available data, the Agency has taken a two-fold approach to addressing the treatability of compounds without UTS. The first approach involves using the thermal stability ranking system in determining the treatability of the constituents of concern and is most appropriate for constituents with index values. The second approach involves dividing the constituents without UTS into groups based on physical and chemical similarity to compounds with UTS and is most appropriate for assessing the incinerability of non-UTS constituents without index values. Please refer to Appendix D for the chemical structures of all constituents of concern.

The first approach uses the fact that benzene has the lowest thermal stability index value (3) for any of the constituents of concern, thus it is the most stable and can be expected to be the most difficult to destroy via incineration. The UTS for benzene was developed using incineration as BDAT, with data showing the constituent was not detected in the treated waste. Therefore, it can be expected that all of the remaining less stable compounds will be sufficiently destroyed through incineration. Table 3-2 shows that 11 of the non-CBI compounds have thermal stability indices greater than 3 (i.e., greater than benzene's), and therefore would be less stable, and easier to treat, than benzene. No data are available for the remaining 8 non-CBI compounds [counts in this paragraph refer only to constituents identified as non-CBI].

The same logic can be applied using the incinerability index. The higher the incinerability index, the more difficult the compound is to treat via incineration. The UTS for chloroform also was established using incineration as BDAT, and Appendix A shows that chloroform can be treated to below detection using incineration. Since chloroform has the highest incinerability index (106), it can be expected that all compounds with lower incinerability index values can be destroyed via combustion. Table 3-2 shows that 18 of the compounds have incinerability index values less than 106 (i.e., less than chloroform's), and therefore would be less stable, and easier to treat, than chloroform. No data are available for the remaining compound. A thermal stability index value and/or an incinerability index value are available for 19 of the 20 non-CBI constituents of concern [counts in this paragraph refer only to constituents identified as non-CBI].

The second approach involves grouping similar compounds and assuming that compound within each group are of similar thermal stability. This is particularly useful for evaluating the one constituent without any combustion index value. If similar chemical structures and chemical and physical properties are exhibited by the constituents in each treatability group, incineration should be able to destabilize and destroy each of the compounds in a similar fashion. This approach relies on the fact that incineration is the BDAT for 9 of the 10 non-CBI compounds with UTS2 (EPA's *Final Best Demonstrated Available Technology (BDAT) Background Document for Universal Standards Volume A: Universal Standards for Nonwastewater Forms of Listed Hazardous Wastes*, July 1994) [counts refer only to constituents identified as non-CBI]. The treatability groups that were developed based on similar chemical structure are presented in Table 3-3.

Table 3-3. Treatability Groups for Nonwastewaters A

Treatability Group	**Constituents of Concern With NWW UTS**	**Constituents of Concern Without NWW UTS**
Aniline Compounds and nonhalogenated derivatives	Aniline (I) Diphenylamine (I)	Benzidine (I) Dimethoxybenzidine, 3,3'- Dimethylaniline, N,N- (I) Diphenylhydrazine, 1,2- (I) Phenylenediamine, o- (2-aminoaniline) (I) Phenylenediamine, p- (4-aminoaniline)(I) Toluidine, o- (2-aminotoluene) (I) Toluidine, p- (4-aminotoluene) (I)
Chloroaniline Compounds	Chloroaniline, 4- (I)	C
Carbonyl Compounds	C	Benzaldehyde (I) Formaldehyde (I)
Aromatic Hydrocarbons	Benzene (I)	C
Chlorobenzene Compounds	Chlorobenzene (I) Dichlorobenzene, 1,2- (I)	C
Halogenated Aliphatic Compounds	Chloroform (I)	C
Phenolic Compounds	Cresol, p- (I) Phenol (I)	C
Polynuclear Aromatic Hydrocarbons	Naphthalene (I)	C

[CBI removed from table]

A. These constituent groupings are intended to apply only in evaluating the similarity of properties as applied to nonwastewaters. (I) Indicates the constituent has a thermal stability index value or an incinerability index value as indicated in Table 3-2.

For the first treatability group (aniline compounds and nonhalogenated derivatives), EPA believes these compounds have sufficiently similar structures and functional groups, and therefore believes that the BDAT (incineration) used in setting UTS for the two compounds (aniline and diphenylamine) can be applied to the remaining eight compounds. Using data from Table 3-2 for the compounds with index values, it was determined that the incinerability index values range from 10.63 to 12.89 while the thermal stability index values range from 42 to 64. These ranges were developed using nine data points for the incinerability index and four data points for the thermal stability index. Due to these sufficiently narrow index ranges, coupled with the similar structural and physical properties exhibited throughout this treatability group, the Agency is confident that incineration can be used in setting the UTS for the remaining non-UTS constituents. The index ranges are significantly lower than both the incinerability index value for chloroform (106), and higher than the thermal stability index value for benzene (3), therefore, as stated in previous discussions, it can be expected that these eight compounds can be sufficiently treated via incineration [counts and ranges in this paragraph refer only to non-CBI compounds].

Similar comparisons can be made for [CBI removed from text] of the remaining treatability groups: [CBI removed from text]. The compounds within each group have sufficiently similar structures and physical properties, and therefore incineration as BDAT (used in setting UTS for [CBI removed from text] of the compounds) can be used in setting UTS for the remaining [CBI removed from text] compounds. [CBI removed from text].

For the two remaining compounds without UTS, benzaldehyde and formaldehyde, no similar compounds in K167 and K168 with UTS were identified. However, the fact that the incinerability index value of these two compounds are lower than chloroform, and the thermal stability index value of formaldehyde is higher than benzene, supports the conclusion that these two compounds can appropriately be treated using incineration [all counts in this paragraph only refer to constituents identified as non-CBI].

In conclusion, the Agency believes that the BDAT of incineration can reasonably be transferred to all nonwastewater constituents without UTS based on (1) the thermal stability index ranking system and incinerability index (because the most difficult constituents of concern, benzene and chloroform, can be destroyed via incineration then all less stable constituents can also be destroyed); and (2) because similar chemical structures and chemical and physical properties are exhibited by the constituents in each treatability group, incineration should be able to destabilize and destroy each of the compounds in a similar fashion.

3.3 Identification of Best Demonstrated and Available Technologies (BDAT) for Wastewaters

3.3.1 Applicable and Demonstrated Technologies

All of the constituents of concern in these wastes, presented in Exhibit 3-1, are organic [evaluation refers only to constituents identified as non-CBI]. Applicable treatment technologies are those that destroy or reduce the total amount of organic constituents in the waste. The technologies listed below are applicable and have been demonstrated to treat organic constituents in wastewater forms of other hazardous wastes. A thorough discussion of these technologies is presented in U.S. EPA’s AFinal Best Demonstrated Available Technology (BDAT) Background Document for Universal Standards: Volume B: Universal Standards for Wastewater Forms of Listed Hazardous Wastes.@ Only those technologies applicable to the physical and chemical characteristics of K167 and K168 are listed below:

- Biological treatment (including aerobic fixed film, aerobic lagoon, activated sludge, anaerobic fixed film, rotating biological contactor, sequential batch reactor, and trickling filter technologies);
- Carbon adsorption treatment (including activated carbon and granular activated carbon technologies);
- Chemically assisted clarification treatment (including chemical precipitation technology)
- Chemical oxidation
- PACT® treatment (including powdered activated carbon addition to activated sludge and biological granular activated carbon technologies);
- Reverse osmosis treatment
- Solvent extraction treatment (including liquid/liquid extraction)
- Stripping treatment (including steam stripping and air stripping technologies); and
- Wet air oxidation treatment (including supercritical oxidation technology)
- Total recycle or reuse.

The concentrations and type(s) of constituents present in the waste generally determine which technology is most applicable. Carbon adsorption, for example, is often used as a polishing step following primary treatment by biological treatment, solvent extraction, or wet air oxidation. Typically, carbon adsorption is applicable for treatment of wastewaters containing less than 0.1%

total organic constituents. Wet air oxidation, PACT® treatment, biological treatment, and solvent extraction are generally applicable for treatment of wastewaters containing up to 1% total organic constituents. Some K167 and K168 wastewaters may not be treated effectively by biological treatment or PACT® if they contain constituents that are too toxic to support biomass growth.

Biological Treatment

Biological treatment is a destruction technology that biodegrades hazardous organic constituents in wastewaters. This technology generates two treatment residuals: a treated effluent and a waste biosludge. Waste biosludge may be land disposed without further treatment if it meets the applicable BDAT treatment standards for regulated constituents.

Carbon Adsorption

Carbon adsorption is a separation technology that selectively adsorbs organic constituents in wastewaters onto activated carbon. This technology generates two treatment residuals: a treated effluent and spent activated carbon. The spent activated carbon may be reactivated, recycled, incinerated, or land disposed without further treatment if it meets the applicable BDAT treatment standards for regulated constituents.

Chemically Assisted Clarification

Chemically assisted clarification, including chemical precipitation, is a separation technology that removes organic and inorganic constituents from wastewater by the addition of chemicals that cause precipitates to form. The solids formed are then separated from the waste water by settling, clarification, and/or polishing filtration. This technology generates two treatment residuals: treated wastewater effluent and separated solid precipitate. The solid precipitate may be land disposed without further treatment if it meets the applicable BDAT treatment standards for the regulated constituents in nonwastewater forms of waste.

Chemical Oxidation

Chemical oxidation is a destruction technology that oxidizes inorganic cyanide, some dissolved organic compounds, and sulfides to yield carbon dioxide, water, salts, simple organic acids, and sulfates. This technology generates one treatment residual: treated effluent.

PACT® Treatment

PACT® treatment combines carbon adsorption and biological treatment to biodegrade hazardous organic constituents and selectively adsorb them onto powdered activated carbon. This technology generates two treatment residuals: a treated effluent and spent carbon/biosludge. The spent carbon is often regenerated and recycled to the process or incinerated. PACT® technology has been applied to the treatment of wastewaters from the textile and dyes industries (U.S. Filter/Zimpro Products; www.zimpro.com).

Reverse Osmosis

Reverse osmosis is a separation technology that removes dissolved organics (usually salts) from a wastewater by filtering the waste water through a semipermeable membrane at a pressure greater than the osmotic pressure caused by the dissolved organics in the wastewater. This technology generates two treatment residuals: the treated effluent and the concentrated organic salt materials which do not pass through the membrane.

Solvent Extraction

Solvent extraction is a separation technology that removes organic compounds from a waste due to greater constituent solubility in a solvent phase than in the waste phase. This technology generates two residuals: a treated waste residual and an extract. The extract may be recycled or treated by incineration. The treated residual may need to undergo further treatment for metals, such as stabilization. Recovered solvent may be recycled back into the process.

Stripping Treatment

Stripping treatment is a separation technology in which volatile organic constituents in a liquid waste are physically transferred to a flowing gas or vapor. In steam stripping, steam contacts the waste, strips the volatile organics, and carries them to a condenser where the mixture of organic vapors and steam is condensed and collected in an accumulator tank. In air stripping, air contacts the waste and strips the volatile organic constituents. Stripping generates one treatment residual: treated effluent. Emissions from stripping treatment may require further treatment.

Wet Air Oxidation

Wet air oxidation is a destruction technology that oxidizes hazardous organic constituents in wastes under pressure at elevated temperatures in the presence of dissolved oxygen. This technology is applicable for wastes comprised primarily of water and with up to 10% total organic constituents. Wet air oxidation generates one treatment residual: treated effluent. The treated effluent may require further treatment for hazardous organic constituents by carbon adsorption or PACT® treatment. Trapped air emissions from wet air oxidation may also require further treatment.

Total Recycle or Reuse

Total recycle or reuse within the same process or an external process eliminates waste generation and subsequently generates no treatment residuals requiring for the management

3.3.2 BDAT for K167 and K168

For K167 and K168, EPA has identified the following treatment train as BDAT: wet air oxidation or chemical oxidation, followed by carbon adsorption. Alternatively, treatment using combustion can also be used. While a single technology, combustion, was shown to be BDAT for a wide variety of constituents in nonwastewaters, BDAT differs for organic constituents in wastewaters according to the chemical's physical and chemical properties (such as vapor pressure and solubility). The justification for determining that this treatment train is BDAT is as follows:

- As discussed in Section 3.2, combustion is being proposed as BDAT for nonwastewater forms of K167 and K168. The same constituents of concern are expected to be present in wastewater forms of these wastes, and liquids such as wastewater can be adequately treated using technologies such as liquid injection incineration. Therefore, combustion is being proposed as one alternative to treating K167 and K168 wastewaters.

- Wastewater treatment is commercially available as described in EPA's ABackground Document for Capacity Analysis for Land Disposal Restrictions: Newly Identified Dye and Pigment Manufacturing Wastes (proposed rule),@ June 1999. Although this report does not describe the specific technologies in use by the commercial treatment industry, all of the data used in developing universal treatment standards are from technologies that have been demonstrated at full scale (including wet air oxidation, chemical oxidation, and carbon adsorption). Therefore, these technologies are demonstrated.

- Two of the treatment trains includes an oxidation step followed by an adsorption step. As shown in the next section, this train has the ability to treat a wide range of organic constituents of varying properties.

Not all of the constituents of concern in K167 and K168 have previously been shown to be best treated using the above treatment train in EPA's previous development of treatment standards. Specifically, other constituents do not have any treatment standards (i.e., have not previously been studied by EPA), while others have treatment standards based on different technologies (most often activated sludge or biological treatment). Section 3.3.3 below presents EPA's justification that all of the constituents of concern in K167 and K168 are adequately treated by the above treatment train.

3.3.3 Ability of Proposed Train to Treat the Constituents of Concern

Of the 20 non-CBI constituents proposed as constituents of concern in wastewater forms of K167 and K168, 11 chemicals have UTS (for wastewaters), 5 have a technology-specific standard, and the remaining 4 compounds do not have any existing treatment standard [evaluation refers only to non-CBI constituents]. These constituents are summarized in Table 3-4.

Table 3-4. Existing Treatment Standards for Constituents in K167 and K168 Wastewaters

Constituent of Concern	CAS Number	UTS WW (mg/kg)	Technology Standard or Technical Basis for UTS
Aniline	62-53-3	0.81	Liquid liquid extraction plus steam stripping plus activated carbon
Benzaldehyde	100-52-7	---	---
Benzene	71-43-2	0.14	Steam stripping
Benzidine	92-87-5	---	(WETOX or CHOXD) fb CARBN; or CMBST
Chloroaniline, 4-	106-47-8	0.46	Wet air oxidation plus PACT®
Chlorobenzene	108-90-7	0.057	Biological treatment
Chloroform	67-66-3	0.046	Steam stripping
Cresol, p-	106-44-5	0.77	Activated sludge
Dichlorobenzene, 1,2-	95-50-1	0.088	Biological treatment
3,3'-Dimethoxybenzidine	119-94-4	---	(WETOX or CHOXD) fb CARBN; or CMBST
N,N-Dimethylaniline	121-69-7	---	---
Diphenylamine*	112-39-4	0.92	Activated sludge
Diphenylhydrazine, 1,2- **	122-66-7	0.087	Activated sludge plus biological treatment

Formaldehyde	50-00-0	---	WETOX or CHOXD) fb CARBN; or CMBST
Naphthalene	91-20-3	0.059	Biological treatment
Phenol	108-95-2	0.039	Biological treatment
Phenylenediamine, o-(2-aminoaniline)	95-54-5	---	---
Phenylenediamine, p-(4-aminoaniline)	106-50-3	---	---
Toluidine, o-(2-aminotoluene)	95-53-4	---	CMBST; or CHOXD fb (BIODG or CARBN); or BIODG fb CARBN
Toluidine, p-(4-aminotoluene)	106-49-0	---	CMBST; or CHOXD fb (BIODG or CARBN); or BIODG fb CARBN

[CBI removed from table]

*: Compound is difficult to distinguish from N-nitrosodiphenylamine. See 40 CFR § 268.48.

**: Compound is difficult to distinguish from azobenzene. See Section 4.3 of this report.

Table 3-4 lists many different technologies identified as 'best' depending on the compound being treated. Many of the volatile compounds (e.g., chloroform) are best treated using steam stripping. Other compounds have UTS developed based on the performance of some type of biological activity system (e.g., biological treatment, activated sludge). Finally, EPA previously determined that other constituents are best treated using oxidation and carbon adsorption in series. In developing treatment standards for K167 and K168 wastewaters, EPA considered all of the technologies listed in Table 3-4 as well as other applicable technologies described in Section 3.3.1.

Stripping processes rely on the transfer of contaminants from the aqueous phase to the gas phase.   Additionally, the contaminants that are transferred to the resulting gas must be further treated or destroyed prior to release to the environment. For these reasons, steam stripping is not an appropriate treatment technology for the many nonvolatile components potentially present in K167 to K168 wastewaters and was not considered further in the development of BDAT for these wastes. Systems relying on biological activity (such as biological treatment, PACT® or activated sludge treatment) are advantageous because it is flexible enough to treat a wide variety of organic constituents, and does so by destruction (rather than removal to another medium). A disadvantage of this treatment is that the performance of all constituents included as constituents of concern is not known. Specifically, it is possible that some of the constituents would be toxic to the organisms in the biological treatment system at certain concentrations, and EPA has no data regarding what this concentration would be. If a control influent concentration were identified for each constituent, treatment unit operators could not necessarily monitor the levels of constituents in the influent if analytical measurement at very low levels were necessary. For these reasons, EPA is not proposing that biological treatment be proposed as a treatment standard for these wastes. These reasons primarily relate to uncertainty in the performance of biological treatment in treating these constituents.

General Performance of Chemical Oxidation, Wet Air Oxidation, and Carbon Adsorption

Both wet air oxidation and chemical oxidation provide treatment by destroying hazardous constituents in wastewaters. These technologies are part of the treatment standards for many U and P wastewaters (e.g., many of the technology-based treatment standards in Exhibit 3-4 include these technologies as part of the treatment train). As discussed in Section 3.3.1, wet air oxidation involves the mixing of oxygen with waste at elevated temperature, converting hydrocarbons to carbon dioxide and water (a process with some similarities to combustion). Chemical oxidation uses oxygen or stronger oxidants (such as chlorine or ozone) to similarly convert hydrocarbons to oxidation products. These processes are effective in reducing indicator parameters (such as chemical oxygen demand) when measurement of individual compounds is not, or cannot, be performed (Stephenson, 1993). Carbon adsorption is capable of treating a wide variety of organic contaminants, both volatile and nonvolatile.

As discussed in Section 3.2.3, K167 and K168 nonwastewaters can be adequately treated by incineration. Because wet air oxidation similarly involves oxidation of these components at elevated temperatures, EPA expects the technology to treat many of the K167 and K168 contaminants (notwithstanding the obvious difference of the physical state of the waste between wet air oxidation and incineration).

Several vendors were identified that currently perform wet air oxidation, chemical oxidation, and/or carbon adsorption on wastewaters. These companies include: US Filter/Zimpro, Calgon Carbon Corporation, Vulcan Peroxidation Systems, Inc., Sumas, Mantech Environmental Corporation, Stablex Services, Van Waters & Rogers, and Cameron Environmental. Vulcan Peroxidation Systems, Inc. has applied their Perox-Pure chemical oxidation process to forty full-scale industrial applications (Yang, 1998). Two of these company’s services are discussed in detail below.

US Filter/Zimpro (http://www.zimpro.com) uses a wet air oxidation process in which oxidation reactions occur at moderated temperatures of 275°F to 600°F and at pressures from 150 to 3000 pounds per square inch. This process can convert organic contaminants to water, carbon dioxide, and biodegradable short chain organic acids. The Calgon Carbon Corporation (http://www.calgoncarbon.com) uses chemical oxidation in series with carbon adsorption. Their chemical oxidation system incorporates the generation of hydroxyl radicals (OH·) for the destruction of organic compounds, generated from hydrogen peroxide activated by ultraviolet (UV) light. Rates of reaction of organic pollutants with hydroxyl radicals are often orders of magnitude faster than rates involving ozone, or hydrogen peroxide only, and can be carried out at ambient temperature and pressure. Such systems have been commercially available since the early 1980s.

Wet air oxidation is used for high strength wastewater steams prior to final biological treatment. Specific examples include: ethylene and refinery spent caustic liquors, high strength petrochemical wastewater streams, and coke oven gas liquors. The types of contaminants destroyed include chlorinated alkenes, aromatics, phenols, PAHs, PCBs, and alcohols, with concentrations ranging from a few ppb to several hundred ppm.

In addition, *Kirk-Othmer* (1993) states that wet air oxidation and chemical oxidation using chlorine, bleach, ozone, and hydrogen peroxide are demonstrated methods to treat wastewaters from dye manufacturing. The subject of dyes wastewater treatment techniques has been well-studied in the literature. Two recent papers have discussed chemical oxidation, specifically with the use of hydroxyl radicals (OH·) generated from ultraviolet light and hydrogen peroxide (Kang, 1999 and Yang, 1998). Indicator parameters such as total organic carbon, chemical oxygen demand, and color are reduced from 90 to 100 percent for both azo and triarylmethane dye classes. In addition, dye manufacturing wastewater was oxidized using UV light, hydrogen peroxide, and ferrous ions (known as the advanced oxidation process). It was concluded that this oxidation process reduced color and COD by nearly 100 percent. Both of these papers discussed results at the bench-scale level.

It is expected that the physical/chemical properties of the currently treated dye wastewaters will overlap with the physical/chemical properties of K167/168 wastewaters. The aforementioned examples of commercial oxidation along with the *Kirk-Othmer* discussion show that oxidation is a demonstrated and effective treatment process for a variety of organic wastewaters including contaminants or chemical classes specific to K167/168. Therefore, the technologies of oxidation and carbon adsorption could be applied or optimized to treat contaminants in wastewater forms of K167/168.

Treatment Data for Chemical Oxidation, Wet Air Oxidation, and Carbon Adsorption

EPA acknowledges that it does not have performance data for many of the constituents of concern in K167 and K168 using these technologies. Available data regarding the removal efficiency for chemical oxidation and wet air oxidation are presented in Appendix B, for 11 of the 27 constituents of concern. Available data on the removal efficiency for carbon adsorption are presented in Appendix B, for 10 of the 27 constituents of concern. In summary, treatment data for one of these three technologies are available for 13 of the 27 constituents of concern. EPA evaluated these data to assess the effectiveness of the proposed treatment train.

For the oxidation technologies, 9 of the 11 constituents with data exhibit exceptional percent reduction standards (of greater than or equal to 88 percent), and another compound's reduction (p-chloroaniline) could not be accurately calculated because the effluent concentration was below detection. Formaldehyde is the one constituent with data showing a relatively low reduction of 43 percent. The nine other constituents with data (and demonstrating excellent performance) are aniline, benzene, chlorobenzene, chloroform, 1,2-dichlorobenzene, diphenylamine, 1,2-diphenylhydrazine, naphthalene, and phenol.

In regard to the remaining constituents, some are sufficiently similar in structure and properties to constituents with data so that the performance data for oxidation can be extrapolated. This was generally assessed using the treatability groups defined for nonwastewaters in Section 3.2.3. The uncertainty associated with this analysis is high because of the lack of data for many of the compounds, particularly for the benzidine derivatives. However, only for formaldehyde do the data show a potential concern regarding this technology. By extrapolation, similar concerns may also exist for benzaldehyde due to its having the same functional group. These concerns may, in part, be due to difficulties in accurately analyzing for formaldehyde, or because the technology was demonstrated on a waste stream with over 1000 mg/L of formaldehyde, which is orders of magnitude greater than the concentration expected to be present in K167 and K168 wastewaters.

For the carbon adsorption technology, the effectiveness of treatment ranges from very low to near complete. The data are presented in Appendix B, as percent reduction. Specifically, 6 of the 10 constituents with data exhibited percent reduction standards greater than or equal to 81 percent. One of the compounds, formaldehyde, exhibited low reduction of 9 percent and the remaining three compounds (aniline, chlorobenzene, and p-cresol) exhibited reductions ranging from 56 to 75 percent. The six constituents with data (and demonstrating good performance) are benzaldehyde, benzene, chloroform, 1,2-dichlorobenzene, naphthalene, and phenol.

The advantage of using carbon adsorption as a final treatment step, following oxidation, is shown by the expected performance of benzaldehyde. There is no performance data for benzaldehyde for wet air or chemical oxidation, and therefore there is uncertainty in the effectiveness of this technology towards this particular constituent. However, the removal efficiency using carbon adsorption is very high (94 percent). Therefore, the use of carbon adsorption will help to remove additional contaminant that may be remaining following oxidation.

As shown in Appendix B and discussed above, available performance data for formaldehyde for both wet air oxidation and carbon adsorption show removal efficiency of 43 percent and 9 percent, respectively, which are not indicative of effective treatment. Wet air and chemical oxidation are versatile technologies and are expected to be adaptable to treating wastewaters containing formaldehyde. As one example, a catalytic wet oxidation system is in use to treat industrial wastewaters containing acetic acid, formaldehyde, phenol, and glucose. Although formaldehyde removal was not measured, the chemical oxygen demand (an indicator parameter for organics in general) was reduced 99 percent (Chowdhury, 1992).

Conclusion

The 27 constituents of concern in wastewater forms of K167 and K168 have diverse physical and chemical properties. There are many wastewater treatment technologies on the market, some of which are extremely specific or limited in the types of constituents which can be treated. Wet air oxidation and chemical oxidation are technologies which are shown to have been used for a variety of wastes and contaminants, including some of those contaminants expected to be present in K167 and K168 wastewaters.

EPA is confident that wet air oxidation or chemical oxidation is effective in treating many of the contaminants of K167 and K168 wastewaters, as evidenced by the reduction of indicator parameters such as chemical oxygen demand, and the documented removal of specific contaminants using NRMRL data. However, the Agency acknowledges that the effectiveness of these processes cannot be accurately judged on a constituent level basis for every contaminant. To better ensure effective treatment, EPA is proposing the K167/K168 wastewater treatment train to also include a carbon adsorption step. Carbon adsorption is intended to remove those contaminants left untreated by the oxidation step, as well as any oxidation by-products.

A third alternative treatment technique, incineration, is expected to result in near-complete destruction (to below detection limit) for all constituents of concern in K167 and K168. This was shown in Section 3.2.3 for nonwastewaters, and can be equally applied to wastewaters.

Available performance data regarding chemical oxidation, wet air oxidation, and carbon adsorption are presented in Appendix B. Data are only available for 13 of the 27 constituents of concern in K167 and K168, leading to some uncertainty regarding the ability of this treatment train in effectively treating the constituents of concern.

These technologies are commercially available and in use for treating a variety of constituents in wastewaters. EPA expects that their use can be optimized, if necessary, to treat the specific contaminants in K167 and K168 wastewaters.

4.0 Numerical Treatment Standard Development

As shown in Section 3, EPA has determined that incineration represents BDAT for nonwastewater forms of K167 and K168, while one of the following three treatment trains represent BDAT for wastewaters: chemical oxidation followed by carbon adsorption, or wet air oxidation followed by carbon adsorption, or combustion. In Sections 4.1 to 4.3, EPA shows how available data for these technologies were used to develop possible numerical treatment standards for these wastes. As discussed in the Executive Summary, and later in Section 4.4, EPA found that its numerical standards would not meet the statutory requirements of RCRA Section 3004(m), which requires that EPA set standards that substantially diminish the toxicity of the waste. For this reason EPA is proposing technology-specific standards for K167 and K168 wastewaters and nonwastewaters.

In developing numerical treatment standards for the 27 constituents of concern in nonwastewaters and wastewaters, the Agency followed a specific hierarchy, as follows:

- For constituents for which UTS have been promulgated, apply the existing UTS to the waste. UTS are available for 11 constituents in wastewaters and 10 constituents in nonwastewaters [these counts only refer to non-CBI constituents]. (This approach is provided in Section 4.1.)

- For constituents for which no prior BDAT analysis had been conducted and for which no existing treatment standards had been promulgated, calculate concentration-based treatment standards by using either (1) data on the treatment of the constituent or (2) transfer of data from constituents that are similar in elemental composition and chemical functional group, whichever resulted in the higher value. This was conducted for 3 of the constituents [this count only refers to non-CBI constituents]. (This approach is provided in Section 4.2.)

- For constituents for which specific methods of treatment had been established (e.g., due to poor analytical method performance in the past), establish concentration-based treatment standards based on the detection levels achievable by current analytical methods and achievability of the standard by treatment technologies. Technology-specific standards are available for 5 constituents in wastewaters and 6 constituents in nonwastewaters [these counts only refer to non-CBI constituents]. Treatment standard development from analytical data uses the detection limit in the appropriate matrix (i.e., aqueous or solid), a variability factor of 2.8, and an accuracy correction factor derived from matrix spike data consistent with the methodology described in EPA's AFinal Best Demonstrated Available Technology (BDAT) Background Document for Quality Assurance/Quality Control Procedures and Methodology,@ October 1991. (This approach is provided in Section 4.3.)

- For constituents for which current analytical methods perform poorly, defer establishing a numerical treatment standards. This was conducted for one constituent (p-phenylenediamine). (This constituent is discussed in Section 4.3.2.)

Table 4-1 presents the 27 constituents of concern and possible values of numerical treatment standards that were developed using the hierarchy outlined above. For example, in the case of aniline a universal treatment standard exists for this compound, so no other numerical standards were developed for consideration. In the case of N,N-dimethylaniline no UTS exists, and two techniques were used in developing a possible treatment standard value: transfer using a similar compound with UTS, and using analytical data from record sampling. To account for uncertainty, the higher of the two values were selected as a possible value for a numerical treatment standard. Finally, in the case of benzidine, only lab data were considered in treatment standard development because this constituent currently has a technology-specific standard.

The possible numerical treatment standards obtained, following use of the above hierarchy, are indicated in boldface. The standard is compared to the risk-based concentration level, which is being proposed as part of the definition of K167 and K168. The results of this comparison is presented in the final column, as an assessment regarding whether the numerical treatment standard would result in substantially lower toxicity of the waste as required by RCRA Section 3004(m). Conclusions which indicate that the RCRA Section 3004(m) criteria would not be met are also indicated in bolface.

Table 4-1. Summary of Possible Numerical Treatment Standards for Constituents in K167 and K168

Constituent of Concern	Risk-Based Concentration Level (mg/kg)		Universal Treatment Standard		Numerical Standard Based on UTS Transfer		Numerical Standard Calculated from Lab Data		
	K167	K168	WW (mg/L)	NWW (mg/kg)	WW (mg/L)	NWW (mg/kg)	WW (mg/L)	NWW (mg/kg)	
Aniline		17	**0.81**	**14**	C	C	C	C	Protective r
Benzaldehyde		5,000	C	C	**0.039**	**6.2**	C	C	Protective r
Benzene		370	**0.14**	**10**	C	C	C	C	Protective r
Benzidine		0.027	C	C	C	C	**0.004**	**0.60**	**Numerical not be prot**
Chloroaniline, 4-		250	**0.46**	**16**	C	C	C	C	Protective r
Chlorobenzene		36	**0.057**	**6**	C	C	C	C	Protective r
Chloroform		100	**0.046**	**6**	C	C	C	C	Protective r
Cresol, p-		330	**0.77**	**5.6**	C	C	C	C	Protective r
Dichlorobenzene, 1,2-		1,100	**0.088**	**6**	C	C	C	C	Protective r
Dimethoxybenzidine, 3,3'-		520	C	C	C	C	**0.023**	**3.2**	Protective r
Dimethylaniline, N,N-		300	C	C	**0.81**	**14**	0.12	9.5	Protective r
Diphenylamine/ nitrosodiphenylamine		27,000 / 7,400	**0.92**	**13**	C	C	C	C	Protective r
Diphenylhydrazine, 1,2- / Azobenzene		31 / 720	**0.087**	C	C	C	C	**15**	Protective r
Formaldehyde		7,000	C	C	C	C	**0.34**	**26**	Protective r
Naphthalene		77	**0.059**	**5.6**	C	C	C	C	Protective r
Phenol		28,000	**0.039**	**6.2**	C	C	C	C	Protective r
Phenylenediamine, o- (2-aminoaniline)		61	No standard identified						**Numerical not be prot**
Phenylenediamine, p- (4-aminoaniline)		5,000	C	C	**0.81**	14	0.32	**22**	Protective r
Toluidine, o- (2-aminotoluene)		13	C	C	C	C	**0.39**	**37**	**Numerical not be prot**
Toluidine, p- (4-aminotoluene)		23	C	C	C	C	**0.39**	**37**	**Numerical not be prot**

[CBI removed from table]

Each numerical standard developed by UTS transfer (in Section 4.2) was compared to the standards developed using laboratory data (in Section 4.3). EPA considered using the higher of the two standards, **marked in bold**, to signify the value of the possible numerical treatment standard. The treatment standards for constituents that already have UTS are similarly marked in bold.

C: Indicates that data were not available, or the analysis was not conducted.

4.1 Transfer of Existing Universal Treatment Standards

As shown in Table 4-1, 11 of the constituents in wastewaters and 10 of the constituents in nonwastewaters have numerical universal treatment standards (i.e., universal treatment standards are listed in 40 CFR 268.48) [counts refer only to non-CBI constituents]. EPA would transfer universal treatment standards for these constituents to K167 and K168, if it were to propose numerical treatment standards. A universal standard is a single concentration limit established for a specific constituent regardless of the waste matrix in which it was present.

4.2 Treatment Standard Development for Previously Unregulated Compounds

Three of the non-CBI constituents of concern do not have UTS, nor did they have previously promulgated technology-specific standards [count and following list refers only to non-CBI constituents]. As indicated in Table 4-1, these constituents are as follows:

- Benzaldehyde
- N,N-Dimethylaniline
- p-Phenylenediamine

Also, o-phenylenediamine does not have a UTS, nor does it have a previously promulgated technology-specific standards. As discussed in Section 4.3.2, a possible numerical treatment standard will not be developed for o-phenylenediamine and will not be discussed further in this section.

As indicated in the beginning of Section 4, EPA's approach to calculating possible numerical treatment standards for these constituents is to use existing data for similar constituents that already have UTS. EPA would also use analytical data for these constituents, described in Section 4.3, for calculating a possible numerical treatment standard. Due to the uncertainty associated with treatment standard development for these particular constituents, the higher of the two calculated numerical standards was selected for each of the seven constituents.

The three compounds listed above were divided into [CBI removed from text] groups for the purpose of identifying similarities with UTS constituents: non-chlorinated phenolic compounds (which includes benzaldehyde), [CBI removed from text], and organo-nitrogen compounds (which includes the remaining two compounds). Phenol was considered sufficiently similar to benzaldehyde, and therefore the UTS for phenol was considered as a possible numerical treatment standard for benzaldehyde. [CBI removed from text]. Aniline was considered sufficiently similar to the two organo-nitrogen compounds, and therefore the UTS for aniline was considered as a possible numerical treatment standard for these two compounds. The appropriateness of transferring UTS for each of these [CBI removed from text] groups are presented in Sections 4.2.1. to 4.2.3. [Counts and evaluation in this paragraph refer only to non-CBI constituents].

4.2.1 Non-chlorinated Phenolic Compounds

Benzaldehyde (C7H6O) is structurally similar to phenol (C6H6O). Owing to their structural similarity, the Agency considered transferring the UTS for phenol to benzaldehyde. The universal standard for phenol in nonwastewaters is 6.2 mg/kg, based upon the F039 treatment standard data from performance of incineration (see Appendix A). As described in Section 3.2, the Agency believes that benzaldehyde is as difficult to treat as phenol, and thus considered a numerical treatment standard of 6.2 mg/kg for benzaldehyde.

The universal treatment standard for phenol in wastewaters is 0.039 mg/L. This is based on treatment performance data for biological treatment (BT), which resulted in the ability to treat the wastewater to 10 µg/L. The universal treatment standard for phenol was subsequently calculated using appropriate variability and accuracy correction factors.

4.2.2 [CBI removed from text]

[CBI removed from text].

4.2.3 Organo-Nitrogen Compounds

[References to CBI constituents are removed from this section. Counts and evaluation refer to non-CBI constituents only.]

N,N-Dimethylaniline and p-phenylenediamine (4-aminoaniline) are organo-nitrogen compounds. Based on their similarity to aniline in terms of elemental structure and functional groups, the Agency considered transferring the UTS for aniline to these two compounds. The universal standard for aniline in nonwastewaters is 14 mg/kg, based upon the F039 treatment standard data from performance of incineration (see Appendix A). As described in Section 3.2, the Agency believes that aniline is as difficult to treat as these two compounds, and thus considered a numerical treatment standard of 14 mg/kg for each of these compounds.

The universal treatment standard for aniline in wastewaters is 0.81 mg/L. This is based on treatment performance data for liquid/liquid extraction followed by steam stripping followed by activated carbon, which resulted in the ability to treat the wastewater to 262 µg/L. The universal treatment standard for aniline was subsequently calculated using appropriate variability and accuracy correction factors. The Agency believes that aniline is as difficult to treat as the two chemicals listed above, and thus considered a treatment standard of 0.81 mg/L for each of these compounds.

The nonwastewater and wastewater treatment standards calculated using the UTS transfer for aniline were compared to the numerical standards calculated using analytical data for two of the compounds; these results are in Section 4.3. The numerical treatment standards for wastewaters calculated using the analytical data for each of these two compounds were lower than the standard calculated based on UTS transfer of aniline. Similarly, the numerical treatment standards for nonwastewaters calculated using the analytical data for one of the compounds, N,N-dimethylaniline, were lower than the nonwastewater standard calculated based on UTS transfer of aniline. The analytical data show that numerical treatment standards based on wastewater UTS transfer of aniline are analytically feasible for the two compounds, and numerical treatment standards based on nonwastewater UTS transfer of aniline are analytically feasible for one of the compounds.

For the remaining compound, p-phenylenediamine, the numerical treatment standard for nonwastewaters calculated using the analytical data for this compound was higher than the standard calculated based on UTS transfer of aniline. For this compound EPA selected the higher calculated numerical treatment standard based on the analytical data. The higher standard was selected to account for the differences in method detection limits achievable for aniline and p-phenylenediamine.

4.3 Treatment Standard Development from Laboratory Data

In Section 3.2, EPA showed that nonwastewater forms of K167 and K168 are best treated using incineration and incineration is expected to routinely result in concentrations of the constituents of concern at levels below laboratory instrument detection. In developing possible numerical treatment standards, EPA uses data regarding achievable analytical detection limits for each constituent, on the assumption that incineration can completely destroy the contaminants. This is the reason that EPA uses the constituent detection limits in its calculation of numerical treatment standards for nonwastewaters. In Section 3.3, EPA showed that the treatment train selected is BDAT for wastewaters, but the available numerical treatment data were not as complete as that available for nonwastewaters. To develop numerical treatment standards for wastewater forms of K167 and K168, EPA also uses constituent detection limits. This section presents available data regarding the detection limits used, and the method used in subsequently calculating treatment standards.

EPA evaluated analytical data for the following 10 constituents that did not have both wastewater and nonwastewater UTS [count and subsequent list refers to non-CBI constituents only]:

- Benzaldehyde
- Benzidine
- Dimethoxybenzidine, 3,3'-
- Dimethylaniline, N,N-
- Diphenylhydrazine, 1,2- / Azobenzene
- Formaldehyde
- Phenylenediamine, o- (2-aminoaniline)

- -

- Toluidine, o- (2-aminotoluene)
- Toluidine, p- (4-aminotoluene)
- [CBI removed from list]

4.3.1 Possible Numerical Treatment Standards

EPA conducted record sampling analysis of dye and pigment wastes over a period of several months in 1993, broken into four rounds of sampling and analysis events. During this investigation, laboratory blank data and laboratory control spikes were analyzed for a variety of compounds. EPA used the following assumptions in developing possible numerical treatment standards from these data:

- For nonwastewaters, EPA has determined that incineration can be used to destroy all constituents of concern in the subject wastes, as described in Section 3.2 of this report.

- For wastewaters, EPA is assuming for purposes of numerical treatment standard development that application of the BDAT would result in none of the constituents being present at detectable levels, as described in Section 3.3 of this report.

- EPA assumes that the nonwastewater treatment residuals would resemble clean sand, and the wastewater treatment residuals would resemble clean water; detection limits from these matrices were used in treatment standard development.

It should be emphasized that development of these standards using the above assumptions represent a "best case," such that EPA would be unlikely to develop lower numerical treatment standards than those presented here. EPA compared numerical treatment standards developed using this methodology with the proposed risk levels in the proposed rule, and determined that the treatment standards exceeded the proposed risk levels for some of the constituents. Therefore, EPA’s conclusion that the possible numerical treatment standards would not meet the "minimize threat" requirements of RCRA §3004(m) would still be valid if more conservative assumptions regarding the analytical data were made (e.g., matrix interferences).

EPA does not have appropriate treatment residuals of incinerator ash or treated wastewater. Therefore, data demonstrating what the detection limit would be in such matrices are unavailable. However, as a result of record sampling activities, EPA has data resulting from the analysis of various solid wastes from dye manufacturing, as well as laboratory control samples representing a clean sand matrix. Although neither material duplicates an incineration residue, EPA believes that the incineration residue would more closely approximate the clean sand matrix than the wastes from dye manufacturing, because many of the organic contaminants present in the dye wastes (which would potentially result in matrix interference and elevated detection limits) would be absent following incineration. For wastewaters, EPA believes that the treated wastewater residue would more closely approximate the reagent water matrix than the wastes from dye manufacturing for similar reasons.

EPA conducted four separate record sampling and analysis events of the subject wastes over the period of several months in 1993, broken into four rounds of sampling and analysis events. All laboratory analytical testing was conducted by APPL Incorporated, Fresno, California. APPL used a variety of analytical techniques in determining sample concentrations. Specifically, the following relevant analyses of the above compounds were performed: SW-846 Method 8321 (HPLC/MS), SW-846 Method 8270 (GC/MS), and analyses for formaldehyde by SW-846 Method 8315 (HPLC) [CBI removed from text].

SW-846 Method 8321

APPL used SW-846 Method 8321 for a relatively limited list of compounds. This method was successfully used to quantify constituent concentrations in both solid and aqueous matrices. Although such a comparison is not presented in this report, superior detection limits were achieved using this method due to increased instrument sensitivity as compared to SW-846 Method 8270.

In each of the four rounds of sampling, APPL performed analysis of laboratory method blanks using distilled-reagent water and a clean sand matrix to represent an aqueous and solid matrix, respectively. Detection limits associated with the blank analyses were reported, however the basis of these limits were not provided. However, APPL generally applied detection limits reported in the SW-846 methodologies, and periodically conducted analysis of control standards to determine if the resulting detection limit calculated from these check standards would be at least as low as the reported values.

For each round of sampling, APPL performed an analysis of laboratory control spikes. These samples were prepared from distilled water (for aqueous matrix) or sand (for solid matrix), and spiked with known concentrations of the contaminants of concern. The control spikes were extracted and analyzed in the same manner as an actual waste sample in order to determine the percent recovery for each spiked constituent. These analyses are routinely performed in duplicate to monitor the analytical precision and accuracy. The following constituents of concern were analyzed using this method: benzidine and 3,3'-dimethoxybenzidine [CBI removed from text].

SW-846 Method 8270

APPL conducted two different analyses using SW-846 Method 8270. In one analysis, the standard analyte list from SW-846 was used. Several benzidine compounds on the Method 8321 analyte list above, and 1,2-diphenylhydrazine, were analyzed in this way. In a second analysis, a target analyte list was developed from industry-specific information supplied to EPA prior to record sampling. Constituents in this list included 2- / 4-aminoaniline (indistinguishable), N,N-dimethylaniline, 2- / 4-aminotoluene (indistinguishable), [CBI removed from text], and several analytes on the Method 8321 analyte list above. Both sets of analyses included some of the same constituents analyzed using Method 8321; because Method 8321 resulted in lower detection limits and better quality assurance performance, Method 8270 data for these compounds were not used in developing numerical treatment standards.

In using the standard SW-846 target analyte list to analyze for 1,2-diphenylhydrazine, APPL prepared and conducted analysis for laboratory method blanks and laboratory control spikes in the same way as described above, during each of the four sampling rounds. The reported detection limit of the blanks were equivalent or apparently derived from the detection limit reported in the method.

In preparing for its analysis of the industry-specific target analytes, APPL calculated appropriate detection limits for each compound, in an aqueous matrix. APPL determined the instrument detection limit for each compound based on the lowest achievable instrument response using a direct injection standard. Appropriate detection limits were subsequently calculated from this instrument detection limit and formed the basis for the low-level calibration standard. The original data from this study are not available, but the resulting calculated detection limits were presented with APPL's analytical data. A similar study of detection limits in a solid matrix was not conducted. Instead, APPL estimated detection limits in a solid matrix by multiplying by a factor of 66 to represent the dilution factor associated with extracting a solid matrix into an aqueous (solvent) medium.

For Method 8270 analyses using the standard SW-846 target analyte list and the industry-specific target analyte list, laboratory method blanks were analyzed in each round as were laboratory control spikes (appropriate for a solid and an aqueous matrix).

Analysis of Formaldehyde [CBI removed from text]

Analysis for this compound was conducted in only one or two of the four rounds. In general, the same type of data available for the Method 8321 data are available for this constituent: blanks representing aqueous and solid matrices were prepared, with the resulting detection limit reported, and laboratory control spikes from a water matrix and a sand matrix were analyzed. The basis for the reported detection limit was generally not available [CBI removed from paragraph].

Use of Data in Treatment Standard Development

Results of the analysis of laboratory control spikes and method blanks (which were referenced throughout this section) are detailed in Appendix C. Treatment standards based on these results are detailed in this section, although for reasons discussed in the beginning of Section 4, not all of the calculations are being used as the basis for treatment standards. Calculations for each of the constituents in nonwastewaters are presented in Table 4-2. Calculations for each of the constituents in wastewaters are presented in Table 4-3.

For the treatment standard calculation of nonwastewaters, EPA started with the highest reported detection limit for the aqueous blank analysis (use of the highest detection limit is consistent with the methodology described in Chapter 3 of *Final Best Demonstrated Available Technology (BDAT) Background Document for Quality Assurance/Quality Control Procedures and Methodology*, U.S. EPA, October 1991, for the calculation of the treatment standard for K061, when all treatment data were below detection). Detection limits associated with the aqueous blank analysis was used because, as explained above, detection limit data derived for a solid matrix were not reported and were unavailable. Instead, the detection limits reported for solid matrices were ultimately based on the same detection limits developed for the aqueous matrix. Therefore, for consistency the detection limits reported for aqueous blanks were used as a starting point for treatment standard calculations for both nonwastewaters and wastewaters.

To extrapolate the blank data from a liquid matrix to a solid matrix, EPA used an analytical dilution factor of 66 (the dilution factor associated with extracting a solid matrix into an aqueous medium). There is significant uncertainty in applying a constant factor to extrapolate from a liquid and a solid matrix, with actual detection limits being over- or under-predicted, but insufficient data are available to more closely approximate the detection limit in a solid matrix.

Next, a variability factor of 2.8 is applied, which is appropriate for non-detect data (Appendix D of the 1991 BDAT Background Document). The accuracy correction factor is then calculated from the lowest available percent recovery value from the sand matrix. Data associated with spike recovery values less than 20 percent are discarded (Appendix C of the 1991 BDAT Background Document). The accuracy correction factor, therefore, represents the inverse of the lowest laboratory control spike recovery result, from any of the four rounds of analysis.

The product of each of these values (aqueous matrix detection limit, dilution factor of 66, variability factor of 2.8, and accuracy correction factor) results in the treatment standard for wastewaters.

4.3.2 Amenability of Constituents to Chemical Analysis

EPA reviewed the list of constituents in Table 4-1 for their amenability to chemical analysis. Most constituents (e.g., benzene) are listed as target analytes for SW-846 methods. Other constituents are not specifically identified as target analytes using SW-846 methods but can nevertheless be quantified using these analytical methods, as demonstrated in EPA's record sampling and analysis activities. In its record sampling activities, EPA analyzed samples of dye and pigment wastes (including, but not limited to, K167 and K168) for most of these constituents. EPA's findings regarding the chemical analysis of these constituents are described below. This list however is not intended to be a comprehensive list of methods that can be used for the constituents proposed as a basis for listing.

[Only the 20 non-CBI constituents are listed and discussed below. All references and evaluation of CBI constituents have been removed from the text.]

Benzene
Chlorobenzene
Chloroform

These three volatile organic compounds are target analytes using SW-846 Method 8260. EPA successfully analyzed for these constituents in its record sampling activities using this method.

Formaldehyde
Benzaldehyde

Both of these compounds are target analytes of SW-846 Method 8315 (HPLC). EPA used this method in its record sampling activities for formaldehyde. EPA did not analyze for benzaldehyde in its record sampling program. The compound can be quantified using Method 8315 with a level of detection similar to formaldehyde.

Aniline
p-Chloroaniline
p-Cresol
1,2-Dichlorobenzene
N,N-Dimethylaniline
Naphthalene
Phenol

These compounds are target analytes of SW-846 Method 8270 (GC/MS). EPA used this method in its record sampling activities for all of these constituents.

Benzidine
3,3'-Dimethoxybenzidine

-

o-Phenylenediamine
p-Phenylenediamine

o-Phenylenediamine was listed on the table of UTS in 40 CFR 268.48 until removed in a September 4, 1998 rule (63 FR 47410). This rule resulted from EPA and waste treatment industry testing and data to determine the availability of analytical standards, or the reliability of analytical test methods, for certain constituents used as the basis for listing of carbamate wastes. In this rule, EPA determined that o-phenylenediamine was not able to be analyzed reliably by available analytical methods. As a result, the compound was deleted as a constituent of concern in hazardous waste K157 (a carbamate waste) and was deleted from the UTS table. For this reason EPA did not develop a possible numerical treatment standard for this constituent in this report.

p-Phenylenediamine is a target analyte of SW-846 Method 8270. EPA used this method in its record sampling analysis. In its record sample analyses EPA could not separate o-phenylenediamine, p-phenylenediamine, and 2-methoxyaniline.

o-Toluidine
p-Toluidine

Of these two compounds, only o-toluidine is a target analyte of SW-846 Method 8270. EPA used this method in its record sampling analysis of both compounds. In its record sample analyses EPA could not separate o-toluidine, p-toluidine, and 3-methylaniline.

Diphenylnitrosamine
Diphenylamine

The table of universal treatment standards (40 CFR 268.48) notes that these two compounds are difficult to distinguish. Diphenylnitrosamine is a target analyte of SW-846. The method indicates that this compound breaks down to diphenylamine in the gas chromatographic inlet (note 1.4.5, SW-846 Method 8270C).

1,2-Diphenylhydrazine
Azobenzene

1,2-Diphenylhydrazine is a target analyte of SW-846 Method 8270. This compound readily oxidizes to form azobenzene under typical aerobic analytical conditions and can only be quantitated as a combination of the two compounds.

Table 4-2. Treatment Standard Calculation Summary for Nonwastewaters: Constituents without Existing Nonv					
Compound	Highest Detection Limit of Laboratory Blank, ug/L, in Aqueous Matrix	Dilution factor, Aqueous to Solid Matrix	Variability Factor	Accuracy Correction Factor, Solid Matrix A	C Tr St m
Benzaldehyde	Data not available				
Benzidine	1.0	66	2.8	3.27	0.
Dimethoxybenzidine, 3,3'-	5.0	66	2.8	3.42	3.
Dimethylaniline, N,N-	32	66	2.8	1.61	9.
Diphenylhydrazine, 1,2-	40	66	2.8	2.07	15
Formaldehyde	100	66	2.8	1.39	26
Phenylenediamine, o- (2- aminoaniline)	Documented as poor method performance in September 4, 1998 Federa				
Phenylenediamine, p- (4-aminoaniline)	70	66	2.8	1.69	22
Toluidine, o- (2- aminotoluene)	80	66	2.8	2.53	37
Toluidine, p- (4- aminotoluene)	80	66	2.8	2.53	37

[CBI removed from table]

Laboratory blanks were determined from a clean water matrix. Matrix spike results are from a sand matrix using APPL data.

A. Treatment standard is calculated by multiplying the aqueous blank detection limit times a dilution factor of 66 times a variability factor of 2.8 times the accuracy correction factor. The accuracy correction factor is the inverse of the lowest matrix spike recovery for the clean sand matrix. In this case, the matrix spikes were conducted at a later time than when the detection limit was determined.

Table 4-3. Treatment Standard Calculation Summary for Wastewaters: Constituents without Existing Wast

Compound	Highest Detection Limit of Laboratory Blank, ug/L, in Aqueous Matrix	Variability Factor	Accuracy Correction Factor, Aqueous Matrix A	Treatment Standard, A
Benzaldehyde	Data not available			
Benzidine	1.0	2.8	1.26	0.004
Dimethoxybenzidine, 3,3'-	5.0	2.8	1.64	0.023
Dimethylaniline, N,N-	32	2.8	1.35	0.12
Formaldehyde	100	2.8	1.23	0.34
Phenylenediamine, o- (2- aminoaniline)	Documented as poor method performance in September 4, 1998 Federal			
Phenylenediamine, p- (4-aminoaniline)	70	2.8	1.64	0.32
Toluidine, o- (2- aminotoluene)	80	2.8	1.74	0.39
Toluidine, p- (4- aminotoluene)	80	2.8	1.74	0.39

[CBI removed from table]

Laboratory blanks and matrix spike results were determined from a clean water matrix using APPL data.

A. Treatment standard is calculated by multiplying the detection limit times a variability factor of 2.8 times the accuracy correction factor. The accuracy correction factor is the inverse of the lowest matrix spike recovery for the (clean) matrix. In this case, the matrix spikes were conducted at a later time than when the detection limit was determined.

4.4 Conclusion

Using the methodologies described in Sections 4.1 to 4.3, EPA calculated numerical treatment standards for all 27 constituents (except for o-phenylenediamine). As required by RCRA Section 3004 (m), EPA must set treatment standards that substantially reduce the toxicity of the waste. To determine this, EPA compared the numerical treatment standards to the proposed risk based concentration levels for the constituents. The results are presented in Table 4-1. Different levels are proposed for each of the wastes K167 and K168. The risk-based concentration levels will be used by generators to determine whether their waste meets the listing criteria for K167 and K168. In conducting this comparison, EPA expected that if a particular constituent had a calculated treatment standard lower than the risk-based concentration level, then the toxicity of the waste would in fact be reduced when subjected to the proposed treatment standards. If a particular constituent had a calculated treatment standard higher than the risk-based concentration level, then the toxicity of the waste would not be affected by the proposed treatment standards. This comparison can only be conducted for nonwastewater forms of K167 and K168 since risk-based concentration levels are not being proposed for K167 and K168 wastewaters.

Table 4-1 showed that for 4 of the 20 non-CBI constituents of concern in nonwastewater forms of K167 and K168, the possible numerical treatment standards would not be below the risk based concentration levels proposed for inclusion in 40 CFR §261 [evaluation refers only to non-CBI constituents]. Therefore, for these constituents, threats to human health and the environment would not minimized, as required by Section 3004 (m), because the LDRs would only require treatment to a level which is greater than the minimum level presenting a risk.

Numerical treatment levels are calculated using the methodology described in EPA (1991). This methodology starts using analytical data, then applying accuracy and variability correction factors as described in Section 4.3. The result is that the calculated numerical treatment standard is always greater than the level which can be achieved when using the best demonstrated available technology (on which the numerical standards are based). Thus, the numerical treatment standards calculated in the accepted manner would arguably not meet the Aminimize threat@ criteria of RCRA section 3004(m).

Conversely, EPA expects that the corresponding BDAT for nonwastewater and wastewater forms of K167 and K168 would result in treatment of the contaminants to levels below the possible numerical standards presented in Table 4-1. Such a technology-specific standard would better meet the minimize threat@ criteria of RCRA section 3004(m). For this reason, technology-based standards are being proposed for both wastewater and nonwastewater forms of K167 and K168, rather than numerical treatment standards.

The technology of combustion (CMBST) is proposed for nonwastewater forms of K167 and K168. For wastewater waste forms, one of two alternatives are proposed: either a treatment train consisting wet air oxidation (WETOX) or chemical oxidation (CHOXD) followed by carbon adsorption (CARBN), or treatment by combustion (CMBST). These technologies, when applied in units subject to other RCRA Subtitle C requirements,, will substantially diminish the toxicity of the K167 and K168 wastes so that short-term and long-term threats to human health and the environment are minimized.

EPA had other alternatives than proposing technology-specific treatment standards for wastewater and nonwastewater forms of K167 and K168. Specifically, for nonwastewaters, EPA could have proposed numerical treatment standards for [CBI removed from text] of 27 contaminants (i.e., contaminants for which the numerical treatment standard was less than the risk-based concentration level of 40 CFR §261), and technology-specific standards applicable for the remaining constituents. Such a proposal would have been unnecessarily complex. EPA expects combustion to destroy the constituents of concern, and although the inclusion of testing requirements would ensure a minimum level of performance, the inclusion of both numerical and technology-specific standards would be burdensome and duplicative, because a facility would necessarily be using the specified technology to meet the numerical standards.

For wastewater forms of K167 and K168, EPA is not proposing risk-based concentration levels in 40 CFR §261. Therefore, any numerical treatment standards calculated for wastewaters would have likely met the RCRA section 3004(m) criteria of minimizing risk. For simplicity and consistency with the proposed treatment standards for nonwastewaters, however, technology-specific treatment standards are being proposed for wastewater forms as well. EPA expects the proposed technology to adequately treat wastewater forms of K167 and K168.

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Appendix A: Treatment Performance Data Base and Methodology Employed for Identifying the Nonwastewater Universal Treatment Standards

Treatment Performance Data for Certain Constituents in Nonwastewaters, Where Incineration was Identified as BDAT		
Constituent of Concern	**Waste Code(s)**	**Concentration in Treated Waste (mg/kg)**
Aniline	K103, K104	<2.0
	F039, U012	<5.0 a
	K083	<5.0 a
	K085, K105	<0.33
	K103, K104	<2.0
	K083	<2.0 a
	F039, U019, F001-F005	<10.0
Chloroaniline, 4-	F039, P024	<5.0 a
Chlorobenzene	K085, K105	<0.33
	F039, U037, F001-F005	<2.0 a
	K019	<2.0 a
Chloroform	F039, U044, K117, K118, K136	<2.0
	K009, K010, K019, K029	<2.0 a
	F025, K021, K073	<2.0 a
Cresol, p-	F039, U052, F001-F005	<1.0 a
Dichlorobenzene, 1,2-	K042, K085, K105	<0.33
	F039, K086, U070, F001-F005	<2.0 a
Diphenylamine	K083	<5.0
	K022	<3.1 a
Naphthalene	K001, U051	<0.5
	K086, F039, U165	<1.0
	K035, K060, K087	<1.0
	K019	<2.0 a
Phenol	K060	<1.0
	K105	<0.33
	K083	<2.0 a
	K103, K104	<2.0
	F039, U188	<2.0 a
	K022	<2.2

[CBI removed from table]
< - Indicates a detection limit value.
a - UTS based on these runs.
All data are for incineration, except diphenylamine which is for fuel substitution.
Source: *Final Best Demonstrated Available Technology (BDAT) Background Document for Universal Standards Volume A: Universal Standards or Nonwastewater Forms of Listed Hazardous Wastes*, EPA, July 1994.

Appendix B: Treatment Performance Data Base and Methodology Employed for Identifying the Wastewater Universal Treatment Standards

Performance of Wet Air Oxidation or Chemical Oxidation for Constituents in K167 and K168 Wastewaters			
Constituent of Concern	**CAS Number**	**Percent Reduction**	**Technology**
Aniline	62-53-3	>99	Chemical oxidation (with uv/ozone or ozone only)
Benzaldehyde	100-52-7	---	---
Benzene	71-43-2	94	Chemical oxidation (with chlorine)
		>99	Wet air oxidation
Benzidine	92-87-5	---	---
Chloroaniline, 4-	106-47-8	>75 A	Wet air oxidation
Chlorobenzene	108-90-7	94	Chemical oxidation (with ozone)
		92	Wet air oxidation
Chloroform	67-66-3	99	Chemical oxidation (with uv/ozone)
		>99	Wet air oxidation
Cresol, p-	106-44-5	---	---
Dichlorobenzene, 1,2-	95-50-1	90	Chemical oxidation (with ozone)
		99	Wet air oxidation
3,3'-Dimethoxybenzidine	119-94-4	---	---
N,N-Dimethylaniline	121-69-7	---	---
Diphenylamine*	112-39-4	>99	Chemical oxidation (with uv/ozone or ozone only)
Diphenylhydrazine, 1,2- **	122-66-7	39	Chemical oxidation (with ozone)
		>99	Wet air oxidation (batch process)
Formaldehyde	50-00-0	43	Chemical oxidation (with uv/ozone)
Naphthalene	91-20-3	88	Chemical oxidation (with uv/peroxide)
Phenol	108-95-2	98	Chemical oxidation (with ozone)
		99	Wet air oxidation
Phenylenediamine, o- (2-aminoaniline)	95-54-5	---	---
Phenylenediamine, p- (4-aminoaniline)	106-50-3	---	---
Toluidine, o- (2-aminotoluene)	95-53-4	---	---
Toluidine, p- (4-aminotoluene)	106-49-0	---	---

[CBI removed from table]

Source: NRMRL, 1994 unless otherwise indicated.

A. Effluent was not detected; removal efficiency reported is a minimum value based on the detection limit. From EPA's BDAT Background Document for Universal Standards Volume B: Universal Standards for Wastewater Forms of Listed Hazardous Wastes, July 1994.

*: Compound is difficult to distinguish from N-nitrosodiphenylamine. See 40 CFR § 268.48.

**: Compound is difficult to distinguish from azobenzene. See Section 4.3 of this report.

Performance of Carbon Adsorption for Constituents in K167 and K168 Wastewaters			
Constituent of Concern	**CAS Number**	**Percent Reduction**	**Reference**
Aniline	62-53-3	75	Stephenson, 1998 (page 151)

Benzaldehyde	100-52-7	94	Stephenson, 1998 (page 151)
Benzene	71-43-2	95	Stephenson, 1998 (page 151)
Benzidine	92-87-5	---	---
Chloroaniline, 4-	106-47-8	---	---
Chlorobenzene	108-90-7	56	NRMRL, 1994
Chloroform	67-66-3	98	NRMRL, 1994
Cresol, p-	106-44-5	>63	NRMRL, 1994
Dichlorobenzene, 1,2-	95-50-1	91	NRMRL, 1994
3,3'-Dimethoxybenzidine	119-94-4	---	---
N,N-Dimethylaniline	121-69-7	---	---
Diphenylamine*	112-39-4	---	---
Diphenylhydrazine, 1,2- **	122-66-7	---	---
Formaldehyde	50-00-0	9.2	Stephenson, 1998 (page 151)
Naphthalene	91-20-3	85	NRMRL, 1994
Phenol	108-95-2	80.6	Stephenson, 1998 (page 151)
Phenylenediamine, o- (2-aminoaniline)	95-54-5	---	---
Phenylenediamine, p- (4-aminoaniline)	106-50-3	---	---
Toluidine, o- (2-aminotoluene)	95-53-4	---	---
Toluidine, p- (4-aminotoluene)	106-49-0	---	---

[CBI removed from table]

*: Compound is difficult to distinguish from N-nitrosodiphenylamine. See 40 CFR § 268.48.

**: Compound is difficult to distinguish from azobenzene. See Section 4.3 of this report.

Appendix C: Laboratory Control Spike Data and Laboratory Blank Results for Constituents of Concern in K167 and K168

[Several tables in this appendix were removed due to the presence of constituents identified as CBI].

Summary of Laboratory Blank Detection Limit Data and Matrix Spike Recovery Data

Compound	Highest Detection Limit for Aqueous Matrix, ug/L	Aqueous Matrix			
		Lowest Acceptable Matrix Spike Recovery (%)	Corresponding Accuracy Correction Factor	Calculated Treatment Standard, mg/L	Lowest Acceptable Matrix Spike Recovery (%)
2- and 4-Aminoaniline	70	61.0	1.64	0.32	59.0
2- and 4-Aminotoluene	80	57.5	1.74	0.39	39.6
Benzaldehyde	Data not available				
Benzidine	1.0	79.5	1.26	0.004	30.6
3,3'-Dimethoxybenzidine	5.0	61	1.64	0.023	29.2
N,N-Dimethylaniline	32	74	1.35	0.12	62.3
1,2-Diphenylhydrazine	40	Wastewater UTS is already established			48.4
Formaldehyde	100	81.2	1.23	0.34	72

[CBI removed from table]

Use of the highest detection limit is consistent with the methodology described in Chapter 3 of *Final Best Demonstrated Available Technology (BDAT) Background Document for Quality Assurance/Quality Control Procedures and Methodology*, U.S. EPA, October 1991, for the calculation of the treatment standard for K061, when all treatment data were below detection. A variability factor of 2.8 is appropriate to apply to non-detect data (Appendix D of the 1991 BDAT Background Document). The accuracy correction factor is calculated from the lowest available percent recovery value. Data associated with spike recovery values less than 20 percent are discarded (Appendix C of the 1991 BDAT Background Document).

Benzidine Results, Method 8321, Laboratory Control Spike in Aqueous Matrix

Sample Reference	Spike Value, ug/L		Percent Recovery
	Initial	Recovered	
Round 1: 930412M	21.6	23.5	109
	21.6	20.8	96.3
Round 1: 930407C	21.6	26.2	121
	21.6	30.3	140
Round 2: 930519LC	77.37	99.93	129.2
	77.37	76.95	99.5
Round 3: 930602W	1290	1118	87
	1290	1121	87
Round 4: 930614W	1290	1237	95.9
	1290	1026	79.5

Detection limit recorded for laboratory blanks: 1.0 ug/L (rounds 1 and 4)

Benzidine Results, Method 8321, Laboratory Control Spike in Solid Matrix

Sample Reference	Spike Value, mg/kg		Percent Recovery
	Initial	Recovered	
Round 1: 930414C	2.4	0.4	16.7
	2.4	0.4	16.7
Round 2: 930521	2.58	0.035	1.36
	2.58	0.116	4.51
Round 3: 930603W	43.00	13.16	30.6
	43.00	19.2	44.7
Round 4: 930618S	43.00	7.96	18.5
	43.00	4.84	11.3

Detection limit recorded for laboratory blanks: 0.03 mg/kg (rounds 1 and 4)

3,3'-Dimethoxybenzidine Results, Method 8321,
Laboratory Control Spike in Aqueous Matrix

Sample Reference	Spike Value, ug/L		Percent Recovery
	Initial	Recovered	
Round 1: 930412M	120	101	84.2
	120	102	85
Round 1: 930407C	120	115	95.8
	120	108	90.0
Round 2: 930519LC	137	117.1	85.4
	137	108.6	79.3
Round 3: 930602W	1402	858	61
	1402	857	61
Round 4: 930614W	1402	1073	76.5
	1402	1116	79.6

Detection limit recorded for laboratory blanks: 1.0 ug/L (round 1) 5.0 ug/L (round 4)

3,3'-Dimethoxybenzidine Results, Method 8321,
Laboratory Control Spike in Solid Matrix

Sample Reference	Spike Value, mg/kg	Percent Recovery

	Initial	Recovered	
Round 1: 930414C	4.8	1.5	31.3
	4.8	1.4	29.2
Round 2: 930521	4.57	0.428	9.38
	4.57	0.524	11.5
Round 3: 930603W	46.7	18.69	40.0
	46.7	24.18	51.7
Round 4: 930618S	46.7	26.65	57.0
	46.7	22.53	48.2

Detection limit recorded for laboratory blanks: 0.03 mg/kg (round 1) 0.17 mg/kg (round 4).

2-Aminoaniline, 4-Aminoaniline, 2-Methoxyaniline Results, Method 8270,
Laboratory Control Spike in Aqueous Matrix

Sample Reference	Spike Value, ug/L		Percent Recovery
	Initial	Recovered	
Round 1: 930412M	210	168	80.0
	210	26.7	12.7
Round 1: 930407C	210	128	61.0
	210	223	106
Round 2: 930519LC	No data	No data	No data
	No data	No data	No data
Round 3: 930602W	7165	8387	117
	7165	8302	116
Round 4: 930614W	7165	6393	89.2
	7165	6365	88.8

Detection limit recorded for laboratory blanks: 70 ug/L (rounds 1 and 4)

2-Aminoaniline, 4-Aminoaniline, 2-Methoxyaniline Results, Method 8270,
Laboratory Control Spike in Solid Matrix

Sample Reference	Spike Value, mg/kg		Percent Recovery
	Initial	Recovered	
Round 1: 930414C	8.3	5.2	62.7
	8.3	4.9	59.0
Round 2: 930521	No data	No data	No data
	No data	No data	No data
Round 3: 930603W	238.8	243.2	101.8
	238.8	267.5	112
Round 4: 930618S	238.8	181.2	75.9
	238.8	184.1	77.1

Detection limit recorded for laboratory blanks: 2.3 mg/kg (rounds 1, 2, and 4)

N,N-Dimethylaniline Results, Method 8270,
Laboratory Control Spike in Aqueous Matrix

Sample Reference	Spike Value, ug/L		Percent Recovery
	Initial	Recovered	
Round 1: 930412M	102	82.0	80.4
	102	88.9	87.2
Round 1: 930407C	102	89.7	87.6
	102	93.8	91.6
Round 2: 930519LC	No data	No data	No data

	No data	No data	No data
Round 3: 930602W	2466	1920	78
	2466	1815	74
Round 4: 930614W	2466	2653	107.6
	2466	2184	88.6

Detection limit recorded for laboratory blanks: 32 ug/L (rounds 1 and 4)

N,N-Dimethylaniline Results, Method 8270, Laboratory Control Spike in Solid Matrix			
Sample Reference	Spike Value, mg/kg		Percent Recovery
	Initial	Recovered	
Round 1: 930414C	3.8	2.6	68.4
	3.8	2.5	65.8
Round 2: 930521	No data	No data	No data
	No data	No data	No data
Round 3: 930603W	82.2	51.6	62.8
	82.2	51.2	62.3
Round 4: 930618S	82.2	69.37	84.4
	82.2	65.79	80.0

Detection limit recorded for laboratory blanks: 1.1 mg/kg (rounds 1, 2, and 4)

2-Aminotoluene, 4-Aminotoluene, 3-Methylaniline Results, Method 8270, Laboratory Control Spike in Aqueous Matrix			
Sample Reference	Spike Value, ug/L		
	Initial	Recovered	
Round 1: 930412M	132	82.9	62.8
	132	75.9	57.5
Round 1: 930407C	132	78.5	59.7
	132	122	92.5
Round 2: 930519LC	No data	No data	No data
	No data	No data	No data
Round 3: 930602W	1992	2112	106
	1992	1810	91
Round 4: 930614W	1992	1248	62.6
	1992	1232	61.9

Detection limit recorded for laboratory blanks: 80 ug/L (rounds 1 and 4)

2-Aminotoluene, 4-Aminotoluene, 3-Methylaniline Results, Method 8270, Laboratory Control Spike in Solid Matrix			
Sample Reference	Spike Value, mg/kg		Percent Recovery
	Initial	Recovered	
Round 1: 930414C	4.8	3.0	62.5
	4.8	2.8	58.3
Round 2: 930521	No data	No data	No data
	No data	No data	No data
Round 3: 930603W	66.40	65.0	97.9
	66.40	67.3	101.3
Round 4: 930618S	66.40	26.31	39.6
	66.40	30.66	46.2

Detection limit recorded for laboratory blanks: 2.6 mg/kg (rounds 1 and 2), 2.7 mg/kg (round 4)

1,2-Diphenylhydrazine Results, Method 8270, Laboratory Control Spike in Aqueous Matrix			
Sample Reference	Spike Value, ug/L		Percent Recovery
	Initial	Recovered	
Round 1: 930412M	100	68.2	68.2
	100	69.0	69.0
Round 1: 930407C	100	62.9	62.9
	100	60.8	60.8
Round 2: 930519LC	91.0	56.9	62.5
	91.0	53.5	58.8
Round 3: 930602W	91.0	86.2	95
	91.0	83.2	91
Round 4: 930614W	91.0	87.8	96.5
	91.0	84.8	93.2

Detection limit recorded for laboratory blanks: 40 ug/L (rounds 1 and 2), 40 ug/L (2 of 4 blanks from round 4), 20 ug/L (2 of 4 blanks from round 4)

1,2-Diphenylhydrazine Results, Method 8270, Laboratory Control Spike in Solid Matrix			
Sample Reference	Spike Value, mg/kg		Percent Recovery
	Initial	Recovered	
Round 1: 930414C	3.3	2.0	61.2
	3.3	1.9	57.0
Round 2: 930521	6.07	3.37	55.5
	6.07	2.94	48.4
Round 3: 930603W	6.07	4.26	70.2
	6.07	4.08	67.2
Round 4: 930618S	3.0	2.55	84.3
	3.0	2.53	83.6

Detection limit recorded for laboratory blanks: 2.6 mg/kg (rounds 1 and 2), 2.6 mg/kg (1 of 2 blanks from round 4), 1.3 mg/kg (1 of 2 blanks from round 4)

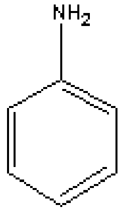
Formaldehyde Results, Method 8315, Laboratory Control Spike in Aqueous Matrix			
Sample Reference	Spike Value, ug/L		Percent Recovery
	Initial	Recovered	
Rounds 1 and 2	No data		
Round 3	1000	900	90.0
	1000	941	94.1
Round 4	1000	812	81.2
	1000	853	85.3

Detection limit recorded for laboratory blanks: 100 ug/L (round 4)

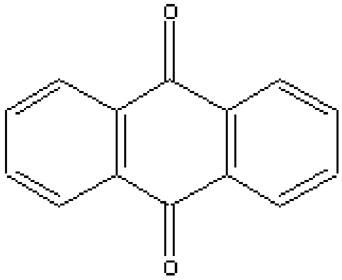
Formaldehyde Results, Method 8315, Laboratory Control Spike in Solid Matrix			
Sample Reference	Spike Value, mg/kg		Percent Recovery
	Initial	Recovered	
Rounds 1 and 4	No data		
Round 2	200	152	76
	200	144	72
Round 3	1.0	0.90	90.0
	1.0	0.96	96.0

Detection limit recorded for laboratory blanks: 20 mg/kg (round 2)

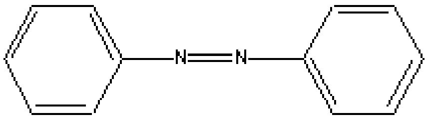
Appendix D: Structural Formulas for Organic Compounds Identified in this Document



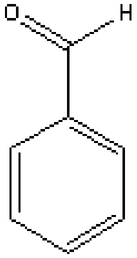
Aniline [62-53-3]



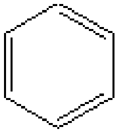
Anthraquinone, 9,10- [84-65-1]



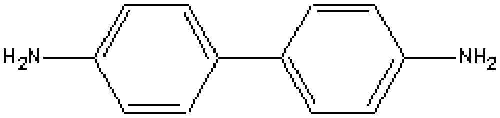
Azobenzene [103-33-3]



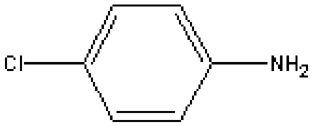
Benzaldehyde [100-52-7]



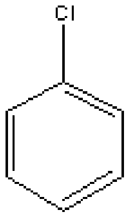
Benzene [71-43-2]



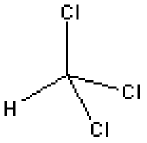
Benzidine [92-87-5]



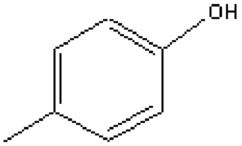
Chloroaniline, p- [106-47-8]



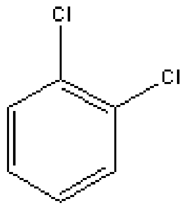
Chlorobenzene [108-90-7]



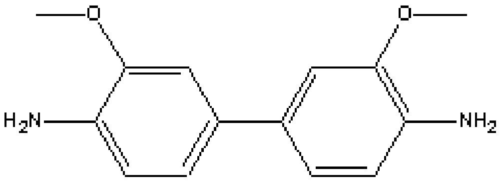
Chloroform [67-66-3]



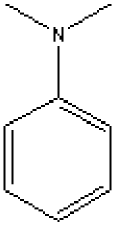
Cresol, p- [106-44-5]



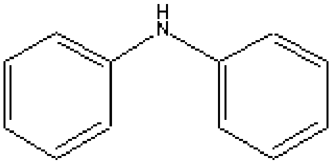
Dichlorobenzene, 1,2- [95-50-1]



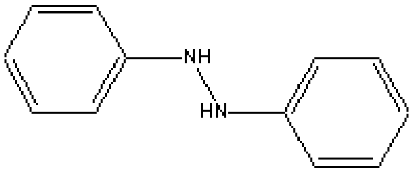
Dimethoxybenzidine, 3,3'- [119-90-4]



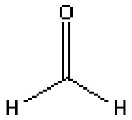
Dimethylaniline, N,N- [121-69-7]



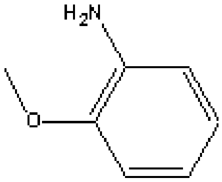
Diphenylamine [112-39-4]



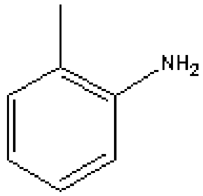
Diphenylhydrazine, 1,2- [122-66-7]



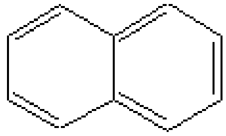
Formaldehyde [50-00-0]



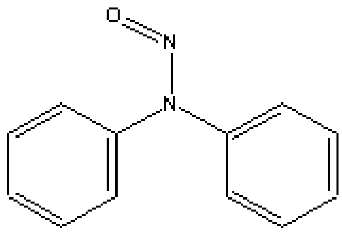
Methoxy aniline, 2- [90-04-0]



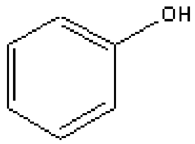
Methyl aniline, 3- [95-53-4]



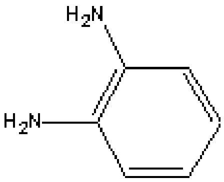
Naphthalene [91-20-3]



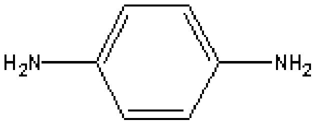
Nitrosodiphenylamine [86-30-6]



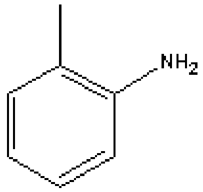
Phenol [108-95-2]



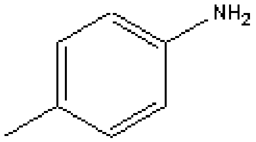
Phenylenediamine, o- (2-aminoaniline) [95-54-5]



Phenylenediamine, p- (4-aminoaniline) [106-50-3]



Toluidine, o- (2-aminotoluene) [95-53-4]



Toluidine, p- (4-aminotoluene) [106-49-0]