PROPOSED

BEST DEMONSTRATED AND AVAILABLE TECHNOLOGY (BDAT)

BACKGROUND DOCUMENT

FOR WASTES FROM THE PRODUCTION OF

DINITROTOLUENE, TOLUENEDIAMINE, AND TOLUENE DIISOCYANATE

K027, K111-K116, U221, U223

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1.0 INTRODUCTION

The Hazardous and Solid Waste Amendments (HSWA) Act, enacted on November 8, 1984, amended the Resource Conservation and Recovery Act of 1976 (RCRA). Pursuant to HSWA, Section 3004(g) of RCRA requires EPA to promulgate regulations that restrict beyond specified dates the land disposal of untreated hazardous wastes. Under Section 3004(m) of RCRA, the Agency is required to set "levels or methods of treatment, if any, which substantially reduce the likelihood of migration of hazardous constituents from the waste so that short-term and long-term threats to human health and the environment are minimized." As specified in the promulgated regulatory framework for implementing the land disposal restriction, these "treatment standards" are based on the performance of the best demonstrated available technologies (BDAT) for a waste. If a waste or treatment residual, as generated or treated, meets the BDAT treatment standards established by EPA for that waste, then the prohibition on land disposal does not apply and the waste may be land disposed.

This background document provides the Agency's rationale and technical support for the proposed treatment standards for the listed wastes identified in 40 CFR 261.31 as K027, K113, K114, K115, K116, U221, and U223. K027, which is generated from the production of toluene diisocyanate (TDI), is part of the second-third of the scheduled listed wastes to be evaluated by the Agency for land disposal restrictions. Wastes listed as K111, K112, K113, K114, K115, and K116, which are generated from the production of dinitrotoluene (DNT), toluenediamine (TDA), or toluene diisocyanate (TDI), are "newly listed" (i.e., listed after the effective date of HSWA). Treatment standards for K113-K116 are being proposed as part of this second-thirds rulemaking. The Agency is not proposing treatment standards for the newly listed wastes K111 and K112 at this time. In addition, the Agency is proposing treatment standards for soft-hammered first-third U wastes, U221 and U223. This proposed regulation also addresses K027, K113-K116, U221, and U223 wastewaters generated from RCRA corrective actions and CERCLA remedial orders (as either contaminated ground or surface water).

In cases where EPA believes that constituents present in wastes represented by different codes can be treated to similar concentrations using the same technology, the Agency may combine the wastes into one treatability group (53 FR 31145, August 17, 1988). Based on a review of waste generation, waste management practices, and waste characterization data for the wastes, EPA believes that these wastes comprise two waste treatability groups: (1) the K027, K113-K116, U221, and U223 treatability group and (2) the K111 and K112 treatability group.

EPA may establish treatment standards either (1) as a specific treatment technology or (2) as a performance level of treatment monitored by measuring the concentration levels of the hazardous constituents in the waste, treatment residual, or an extract of the waste. While EPA prefers to establish treatment standards as performance levels, this approach is not always possible. As discussed in this background document, EPA is proposing BDAT treatment standards for the K027, K113-K116, U221, and U223 treatability group as a specific treatment technology, incineration or fuel substitution. For the K115 waste code, EPA also proposes to establish performance level treatment standards for nickel in wastewaters and nonwastewaters since this BDAT List metal constituent is present at treatable concentrations in the waste and treatment performance data are available for this constituent. The Best Demonstrated and Available Technologies (BDAT) for treatment of nickel in combustion residues from treatment of K115 are stabilization of K115 nonwastewaters (e.g. spent filter cartridges from filtering incineration scrubber waters) and lime and sulfide precipitation followed by vacuum filtration for K115 wastewaters. The Agency is soliciting characterization data for K115 combustion residues to verify the assumption that these wastes contain treatable concentrations of nickel.

The Agency's decision to establish proposed treatment standards as a specific treatment technology for the K027, K113-K116, U221, and U223 treatability group (except for nickel in K115 which is being proposed at a numerical performance treatment level) is based on the following rationale. The EPA does not have, at this time, any treatment performance data for any of the wastes in this treatability group. The Agency has not pursued testing of performance for these wastes because EPA currently lacks analytical methods that can satisfactorily analyze for toluidine, TDI, TDA, and other major organic constituents (i.e., the constituents that would be selected for regulation due to their presence in the untreated wastes) at high concentrations in complex waste matrices. Also, the Agency has not been able to identify any method, parameters, or indicator constituents for the hazardous organic constituents present in these wastes. Therefore, the Agency believes that meaningful concentration-based BDAT treatment standards for organic constituents comprising these wastes cannot be developed at this time.

The Agency is instead proposing treatment standards of incineration and fuel substitution as the specific BDAT methods of treatment for K027, K113, K114, K115, K116, U221, and U223 nonwastewaters and wastewaters other than scrubber waters. In order to specify a method of treatment, EPA must show that the technology is BDAT for those wastes. For a technology to be considered BDAT, it must be shown to provide substantial treatment of the constituents of concern. In the absence of treatment performance data, substantial treatment is determined by showing that the technology provides substantial treatment for a similar waste that is more difficult to treat than the waste of concern. This background document presents EPA's documentation that the demonstrated treatment technologies, incineration and fuel substitution for nonwastewaters and carbon adsorption for wastewaters, provide substantial treatment of hazardous constituents in the K027, K113-K116, U221, and U223 treatability group based on a review of treatment performance data for other wastes. However, K027, K113-K116, U221, and U223 wastewater residuals generated from incineration or fuel substitution will not require treatment by carbon adsorption and will not be prohibited from land disposal since these residuals do not require further treatment for hazardous organic constituents. K115 wastewater residuals generated from incineration or fuel substitution must also meet the numerical standard for nickel prior to land disposal.

Similarly, EPA does not have any treatment performance data for K111 or K112, and the Agency lacks analytical methods that can satisfactorily analyze for the major organic constituents in this treatability group. Unlike the K027, K113-K116, U221, and U223 treatability group, the Agency cannot presently show substantial treatment by specific treatment technologies for this treatability group. Therefore, the Agency has decided to address these wastes at a later date. Since these wastes were listed after the enactment of HSWA, land disposal of these wastes is not subject to either the "soft hammer" provisions or the May 8, 1990 "hard hammer" provisions.

Section 2.0 of this document presents information on the industry affected and waste characterization data available for K027, and K111-K116. A more detailed discussion is also included for the determination of waste treatability groups identified for the K027, K111-K116, U221, and U223 waste codes. Section 3.0 presents the applicable and demonstrated treatment technologies for the treatability groups while Section 4.0 presents treatment performance data used in determining BDAT for the treatability groups. (As discussed above, treatment performance data are not available for use in determining BDAT for the K111 and K112 treatability group.) Section 5.0 explains EPA's proposed determination of BDAT for the treatability groups. Section 6.0 discusses the selection of nickel being proposed for regulation in K115 and Section 7.0 explains the calculation of the proposed treatment standard for nickel in K115. The rationale for addressing the K111 and K112 treatability group at a later date is discussed in Section 8.0.

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

The following tables list the specific proposed BDAT treatment standards for the K027, K113-K116, U221, and U223 treatability group.

BDAT Treatment Standard

for K027, K113-K116, U221 and U223

(Nonwastewaters)

EITHER INCINERATION OR FUEL SUBSTITUTION AS A METHOD OF TREATMENT

BDAT Treatment Standard

for K027, K113-K116, U221 and U223

(Wastewaters*)

CARBON ADSORPTION AS A METHOD OF TREATMENT

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*Scrubber water residuals from incineration or fuel substitution units are not prohibited from land disposal; carbon adsorption treatment is not required for these scrubber waters.

Additional BDAT Treatment Standards for K115
(Nonwastewaters)

Constituent	Maximum for any Single Grab Sample: Total Composition (mg/kg)	Maximum for any Single Grab Sample: TCLP (mg/l)
Nickel	Not Applicable	0.32

Additional BDAT Treatment Standards for K115
(Wastewaters)

Constituent	Maximum for any Single Grab Sample: Total Composition (mg/l)	Maximum for any Single Grab Sample: TCLP (mg/l)
Nickel	0.47	Not Applicable

2.0 INDUSTRY AFFECTED AND WASTE CHARACTERIZATION

The purpose of this section is to describe the industry affected by the land disposal restrictions for K027, K111, K112, K113, K114, K115, K116, U221, and U223 and to present available characterization data for these wastes.

Wastes identified as K027, K111, K112, K113, K114, K115, K116, U221, and U223 are specifically generated by the dinitrotoluene (DNT), toluenediamine (TDA), and toluene diisocyanate (TDI) manufacturing processes and are listed in 40 CFR 261.32 and 261.33(f) as follows:

K027: Centrifuge and distillation residues from toluene diisocyanate production (2nd 3rd).

K111: Product washwaters from the production of dinitrotoluene via nitration of toluene.

K112: Reaction by-product water from the drying column in the production of toluenediamine via hydrogenation of dinitrotoluene.

K113: Condensed liquid light ends from the purification of toluenediamine in the production of toluenediamine via hydrogenation of dinitrotoluene.

K114: Vicinals[1] from the purification of toluenediamine in the production of toluenediamine via hydrogenation of dinitrotoluene.

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[1]Vicinals are the ortho isomers of TDA. Ortho isomers are removed before phosgenation of TDA to TDI to avoid the formation of methylbenzimidazolone which reduces the reaction yield.

K115: Heavy ends from the purification of toluenediamine in the production of toluenediamine via hydrogenation of dinitrotoluene.

K116: Organic condensate from the solvent recovery column in the production of toluene diisocyanate via phosgenation of toluenediamine.

U221: Toluenediamine (1st 3rd).

U223: Toluene diisocyanate (1st 3rd).

2.1 Industry Affected and Process Description

The Agency estimates that there are eight domestic facilities that produce dinitrotoluene (DNT), toluenediamine (TDA), and/or toluene diisocyanate (TDI). The majority of these facilities are located in the Southern and Eastern parts of the United States. Table 2-1 lists the number of facilities for each product, along with potential wastes generated, by state and EPA region. A simplified flow diagram illustrating the manufacturing processes generating dinitrotoluene, toluenediamine, and toluene diisocyanate is presented in Figure 2-1. DNT and TDA are generally produced for use in TDI production. Additionally, TDA may be produced for use in the manufacture of dyes or other chemical products. The production level of TDA for these purposes, however, is believed to be quite low. Almost all TDI is used to make polyurethanes, including polyurethane foam products, coatings, elastomers, and adhesives.

Table 2-1

FACILITIES THAT MAY GENERATE K027, K111, K112, K113, K114, K115, AND/OR K116 BY STATE AND EPA REGION

State (EPA Region)	Number of Facilities			Wastes Potentially Generated
	DNT	TDA	TDI	
Louisiana (VI)	1	3	3	K027, K111, K112, K113, K114, K115, K116
New Jersey (II)	1	0	0	K111
Texas (VI)	2	2	2	K027, K111, K112, K113 K114, K115, K116
West Virginia (III)	1	1	1	K027, K111, K112, K115, K116

Sources:

References 38 and 39.

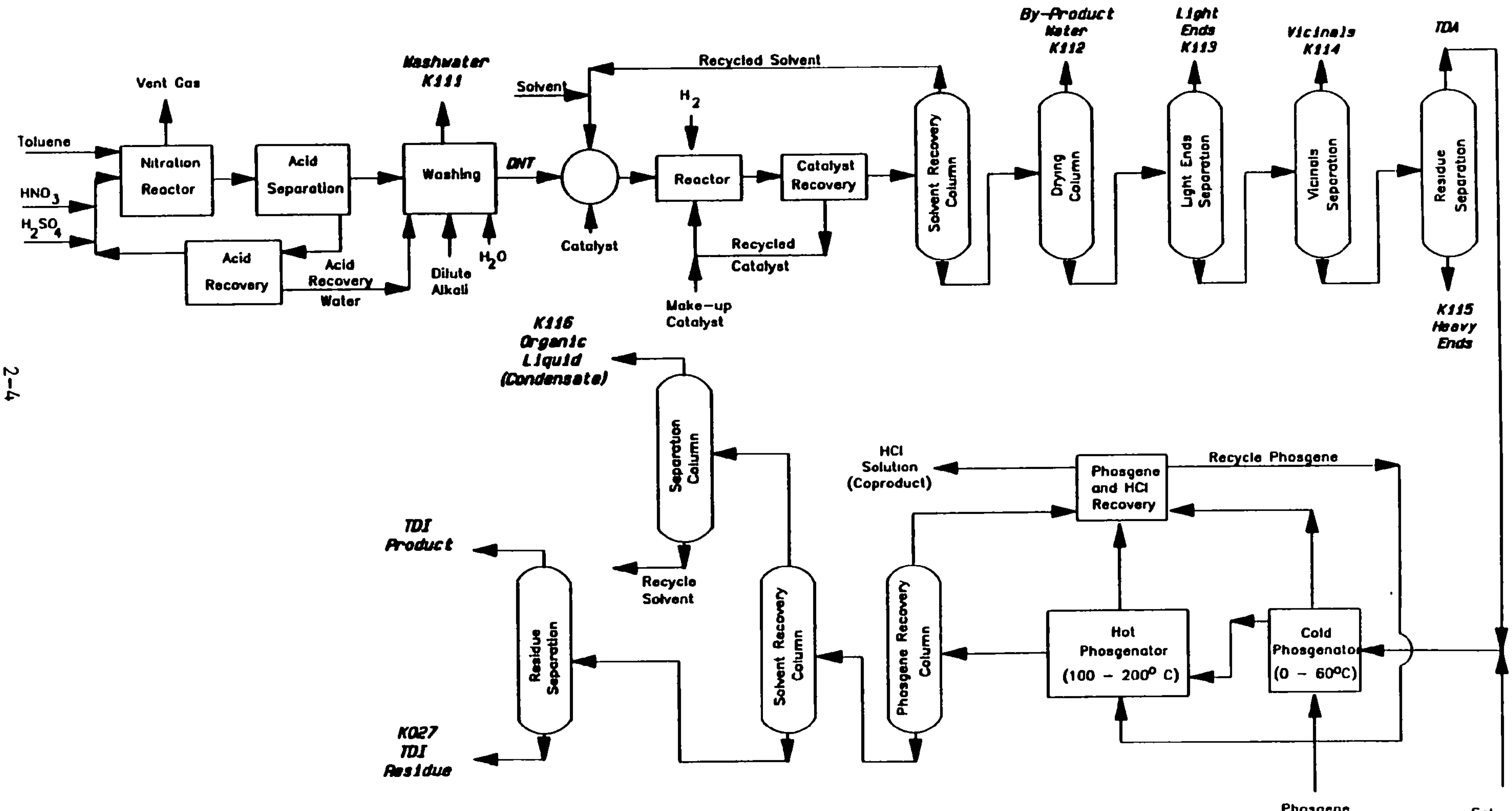


Figure 2-1
Flow Diagram of Processes Generating the
K027, K111 - K116 Waste Codes

The manufacturing of toluene diisocyanate typically involves three continuous chemical processes:

1. Nitration of toluene to form dinitrotoluene (DNT);
2. Hydrogenation of DNT to form toluenediamine (TDA); and
3. Phosgenation of TDA to form toluene diisocyanate (TDI).

As shown in Figure 2-1, toluene is nitrated with nitric acid in the presence of sulfuric acid, which acts as a solvent and a catalyst. The two-phase product from the nitration reactor is separated into organic and acid layers. Spent acid is sent to a recovery unit where the recovered acid solution is recycled to the reactor. Water, a by-product of the nitration reaction, is separated in the acid recovery step and used in the DNT washing process following acid separation. The organic layer from the acid separation step, containing the desired product dinitrotoluene (DNT), is purified through a two- or three-stage washing process. Washwaters from the washing process form the listed waste K111.

The DNT product is dissolved in a solvent (typically methanol) and is combined with a catalyst (either palladium on carbon or Raney nickel). The mixture is then sent to a pressurized reactor where hydrogen is introduced. The product from the hydrogenation reaction is sent to a catalyst recovery unit where the catalyst is recovered. The crude TDA product is then distilled through a series of columns. Solvent is removed from the solvent recovery column and is completely recycled. By-product water resulting from the hydrogenation of dinitrotoluene is removed in the TDA drying column. The by-product water forms the listed waste K112. Light ends are removed from the light ends separation column and form the listed waste K113. Vicinals (the ortho isomers of TDA) are removed from the vicinals separation column and form the listed waste K114. In the final distillation step, heavy ends are removed from the residue separation column and form the listed waste K115.

Following distillation, the purified TDA is dissolved in a solvent, typically chlorobenzene or o-dichlorobenzene. The resulting mixture is sent to a series of reactors. Phosgene liquid is fed into the bottom of these reactors, which are referred to as phosgenators. The crude TDI product from the phosgenation reaction is then distilled through a series of columns. Phosgene is recovered in the phosgene recovery column and recycled to the phosgenators. Solvent is removed from the solvent recovery column and sent to a separation column where the organic liquid condensate (K116) is separated. The organic condensate from the solvent recovery step forms the listed waste K116. Bottoms from the solvent recovery column are sent to the residue separation column where TDI residue is separated from the overhead TDI product. The TDI residue forms the listed waste K027.

U221 and U223 are generated from spills, leaks, or discard of chemicals associated with the production of a commercial chemical product or manufacturing chemical intermediate having the generic name of TDA or TDI. For example, a formulator of polyurethanes who disposes of an up-dated stock of TDI should report this waste as U223.

While the reaction of amines with phosgene is the most common method of manufacture for isocyanates, other processes exist that may produce a TDA or TDI product or manufacturing intermediate. Examples of other isocyanate processes are the Curtius, Hofmann, and Lossen Rearrangements, Metathesis, preparation from isocyanate derivatives, and preparation from isocyanic acid. Regardless of the method of production, U221 and U223 will be generated when either disposal or release of TDA or TDI commercial chemical products or off-specification commercial products occur. U221 and U223 wastes are then subject to the proposed regulations discussed in this background document.

2.2 Waste Characterization

Table 2-2 presents a summary of the publicly available characterization data for K027, K111, K112, K113, K114, K115, and K116. Characterization data are not available for U221 or U223. The summary in Table 2-2 was compiled from data in the Listing Background Document for DNT, TDA, and TDI Production, data based on theoretical calculations, and patent information supported by unspecified industry data. All available data for each waste code may be found in the RCRA Confidential Business Information (CBI) Appendix A. This Appendix can be found in the confidential portion of the docket for this rulemaking.

As shown in Table 2-2: (1) K027 contains high levels of TDI and TDA and up to 100% polymers and tar-like materials; (2) K111 and K112 contain

Table 2-2

SUMMARY OF PUBLICLY AVAILABLE WASTE CHARACTERIZATION DATA
FOR WASTE CODES K027, K111, K112, K113, K114, K115, AND K116

Major Constituents	Estimated Untreated Waste Concentration (%)++						
	K027	K111	K112	K113	K114	K115	K116
ORGANIC CONSTITUENTS							
BDAT List Constituents							
7. Carbon tetrachloride	--	--	--	--	--	--	0-75
14. Chloroform	--	--	--	--	--	--	0-7
42. Tetrachloroethene	--	--	--	--	--	--	0-15
43. Toluene	--	--	--	--	--	--	CBI
56. Aniline	--	--	CBI	0.01-0.1	0-5	--	--
Non-BDAT List Constituents							
Toluenediisocyanate	0-50	--	--	--	--	--	--
Isocyanates	3	--	--	--	--	--	--
Dinitrotoluenes	--	0-0.3*	--	--	--	--	--
Mononitrotoluenes	--	0.0045	--	--	--	--	--
Dinitrocresols (mostly 2,6-dinitro p-cresol)	--	0.06	--	--	--	--	--
Nitrophenols	--	0.0035	--	--	--	--	--
Nitroaromatics (nitrobenzoic acids and nitrocresols)	--	0.0035	--	--	--	--	--
2,4-TDA & 2,6-TDA	10-50+	--	0.05-0.3	0-37.5	4.5-50	10-50	--
3,4-TDA & 2,3-TDA	--	--	0.05-0.3	0-37.5	40-95	0-2.5	--
o-Toluidine	--	--	0-0.06	0.6-6	0-3	--	
p-Toluidine	--	--	0-0.04	0.4-4	0-2	--	--
Polymers & Tar-Like Materials	90	--	--	--	--	--	--
Phosgene	--	--	--	--	--	--	0-30
Karathane**	10-50	--	--	--	--	--	--
Methylcyclohexylamine	--	--	CBI	--	--	--	--
Methylcyclohexanone	--	--	CBI	--	--	--	--

TDA = Toluenediamine
+2,4-TDA isomer only.
*Includes nitrophenolics.
**Karathane is the common name of the compound Dinocap
++Most of the data shown for K027 and K111-K116 represent analysis for organics using capillary GC/MS Method 8270. One facility reported analysis of K027 using "Total Amine equivalent ASTM Method D-1638".
CBI = Confidential Business Information.
--Data are not available for these constituents.

Table 2-2 (Continued)

SUMMARY OF PUBLICLY AVAILABLE WASTE CHARACTERIZATION DATA
FOR WASTE CODES K027, K111, K112, K113, K114, K115, AND K116

Major Constituents	Estimated Untreated Waste Concentration (%) K027	K111	K112	K113	K114	K115	K116
INORGANIC CONSTITUENTS							
Water	CBI	CBI	CBI	CBI	--	--	CBI
Ferric chloride	6	--	--	--	--	--	--
Inorganics (H_2SO_4 + HNO_3, Sulfate + Nitrate Salts)	--	1-4	--	--	--	--	--
Spent Catalyst (Ni)	--	--	--	--	--	0-5	--
OTHER PARAMETERS							
Ash content (%)	6	--	--	--	--	--	--
Specific gravity	1.22	--	--	--	--	--	--
Heating value (Btu/lb)	6020-9993	--	--	--	--	--	--

TDA = Toluenediamine
+2,4-TDA isomer only.
*Includes nitrophenolics.
**Karathane is the common name of the compound Dinocap
++Most of the data shown for K027 and K111-K116 represent analysis for organics using capillary GC/MS Method 8270. One facility reported analysis of K027 using "Total Amine equivalent ASTM Method D-1638".
CBI = Confidential Business Information.
--Data are not available for these constituents.

water and 0-1% organic compounds; (3) K113, K114, and K115 are organic waste streams that contain high levels of TDA; and (4) K116 contains high levels of chlorinated hydrocarbons including carbon tetrachloride and chloroform. Additionally, based on manufacturing processes generating K027 and K111-K116, these wastes are expected to contain very low concentrations of metals, if any, except for K115 which may contain 0-5% spent nickel catalyst. As indicated in Table 2-2, K027 has a low ash content of 6 percent. Waste codes K113-K116 are also expected to have low ash contents based on the manufacturing processes generating these wastes.

2.3 Determination of Waste Treatability Groups

In cases where EPA believes that constituents present in wastes represented by different codes can be treated to similar concentrations using the same technology, the Agency may combine the codes into one treatability group (53 FR 31145, August 17, 1988).

For waste codes K027, K111-K116, U221, and U223, a careful review of waste generation, waste management practices, and waste characterization data was conducted to determine whether these waste codes could be combined into one or more waste treatability groups. Based on this review, two waste treatability groups have been determined: (1) K027, K113-K116, U221, and U223 and (2) K111 and K112.

K027, K113-K116, U221, and U223 as generated are usually nonwastewaters containing high concentrations of aromatic organonitrogen compounds.

Specifically, the Agency believes that K027, K113-K116 are expected to contain high concentrations of TDA and TDI. K116 is also expected to contain high concentrations of chlorinated hydrocarbons such as carbon tetrachloride and phosgene. K027, K113, K114, and K116 are expected to contain very low concentrations of metals, if any. However, available data show that K115 may contain treatable concentrations of Raney nickel (up to approximately 5%). The Agency has information showing that facilities generating K027 and K113-K116 usually either treat or dispose these wastes in the same or similar units.

The Agency expects that the major organic constituents that will be present in these wastes are TDA in U221 and TDI in U223 given that these wastes contain commercial forms of TDA and TDI and so would be expected to contain high levels (percent levels) of these constituents. Since TDI and TDA products are generated from similar manufacturing processes, EPA believes that any impurities in either commercial products or off-specification products meeting the listing criteria for U221 and U223 will consist of constituents similar to those typically shown or expected to be contained in K027 and K113-K116. As a result, the Agency expects U221 and U223 to show treatment characteristics similar to these K wastes. Based on these similarities, the Agency believes that U221 and U223 are amenable to treatment by the same treatment technologies that are applicable to K027 and K113-K116. Therefore, K027, K113-K116, U221, and U223 are considered to represent a single waste treatability group.

K111 and K112 are generated by similar industries (production of nitrated aromatic compounds) and similar processes. These two wastes, as generated, are normally wastewaters containing low concentrations of organic compounds (0-1%). K111 and K112 are expected to contain very low concentrations of metals, if any. K111 and K112 are often co-disposed or co-treated in wastewater treatment systems. Therefore, based on waste generation, waste management practices, and waste characteristics, K111 and K112 comprise a separate, distinct waste treatability group.

3.0 APPLICABLE AND DEMONSTRATED TREATMENT TECHNOLOGIES

In the previous section of this document, the processes generating K027, K111-K116, U221, and U223 were described and characterization data were presented for the wastes. In addition, two treatability groups were identified. This section identifies the treatment technologies that are applicable for treatment of wastes in these treatability groups and determines which of the applicable technologies can be considered demonstrated for the purpose of establishing BDAT.

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

3.1 Applicable Treatment Technologies

The following subsections present applicable treatment technologies for (1) the nonwastewater and wastewater forms of K027, K113-K116, U221, and U223 organics, (2) the nonwastewater and wastewater forms of K115 metals, and (3) the wastewater and nonwastewater forms of K111 and K112 organics. For the purpose of the land disposal restrictions rule, wastewaters are defined as wastes containing less than 1% (weight basis) filterable solids and less than

1% (weight basis) total organic carbon (TOC). Wastes not meeting this definition are classified as nonwastewaters.

3.1.1 K027, K113-K116, U221, and U223 Treatability Group

Nonwastewaters

As generated, K027, K113-K116, U221, and U223 are generally nonwastewaters containing high concentrations of aromatic organo-nitrogen compounds. Applicable treatment technologies, therefore, include those that destroy or reduce the total amount of various organic compounds in the waste. The Agency has identified the following technologies as potentially applicable for treatment of K027, K113-K116, U221, and U223 nonwastewaters: incineration, fuel substitution, solvent extraction followed by recovery or incineration of the contaminated solvent, and recycle or reuse.

The Agency believes that incineration of K027, K113-K116, U221, and U223 may generate a nonwastewater residual that may be classified as K027, K113-K116, U221, or U223 such as incinerator ash or filtrate from the filtration of scrubber water.

Wastewaters.

Incineration of K027, K113-K116, U221, and U223 nonwastewaters may result in the generation of a scrubber water residual that may be classified as K027, K113-K116, U221 and U223 wastewaters. These scrubber waters would contain nondetectable levels of organic constituents since organics are destroyed during incineration. Therefore, additional treatment of these residuals for hazardous organic constituents would not be required.

Additionally, the Agency believes that RCRA corrective actions and CERCLA remedial orders may result in the generation of K027, K113-K116, U221, and U223-containing wastewaters (as either contaminated ground water, surface water or leachates). These types of wastewaters are "derived from" K027, K113-K116, U221, and U223 and are also subject to the land disposal restrictions. The Agency has identified the following technologies as potentially applicable for treatment of hazardous organic constituents in these wastewaters: biological treatment, solvent extraction, and carbon adsorption. These applicable technologies destroy or reduce the total amount of hazardous organic compounds in the waste (biological treatment) or selectively remove hazardous organic compounds from the waste stream (solvent extraction and carbon adsorption).

3.1.2 K115 Metals

Nonwastewaters

K115 as generated is usually a nonwastewater and may contain 0-5% spent nickel catalyst. Incineration or fuel substitution of K115 nonwastewaters would be expected to generate small amounts of ash that may contain concentrated levels of nickel (since nickel is not destroyed in the combustion process). A nonwastewater residual may also be generated from treatment of incineration/fuel substitution scrubber waters (e.g., spent filter cartridges). The Agency has identified stabilization as a potentially applicable technology for treatment of these K115 nonwastewater residuals.

Wastewaters

Incineration or fuel substitution of K115 nonwastewaters may result in the generation of a scrubber water residual. The residual may contain concentrated levels of nickel (since nickel is not destroyed in the combustion process). The Agency has identified the following technology train as potentially applicable for treatment of nickel in this K115 wastewater residual: chemical precipitation followed by sludge dewatering.

3.1.3 K111 and K112 Treatability Group

Wastewaters

K111 and K112, as generated, are normally wastewaters containing low concentrations of organic compounds (less than 1%) and very low concentrations of metals. The Agency has identified the following technologies as potentially applicable for treatment of the organic constituents in these wastes: biological treatment, carbon adsorption, and solvent extraction.

Nonwastewaters

All of the treatment processes presented as potentially applicable for organic constituents in K111 and K112 wastewaters generate nonwastewater residuals (e.g., spent biomass, spent carbon, and solvent extract). The Agency has identified fluidized bed, multiple hearth, or rotary kiln incineration technologies as potentially applicable for treatment of these K111 and K112 nonwastewaters.

3.2 Demonstrated Treatment Technologies

3.2.1 K027, K113-K116, U221, and U223 Treatability Group

Nonwastewaters

Several of the facilities that generate one or more of the K027, K113-K116, U221, U223 wastes incinerate or burn them in high temperature boilers. The Agency is currently aware of three facilities that incinerate these wastes (two onsite and one offsite) and at least three facilities that treat these wastes by fuel substitution in high temperature boilers. (Two facilities that incinerate K027 also treat one or more of K113-K116 by fuel substitution, and one facility treats K027 by fuel substitution.) Based on this information, the Agency has determined that fuel substitution and incineration are demonstrated treatment technologies for nonwastewater forms of K027, K113-K116, U221, and U223.

The Agency has been unable to identify any facilities using solvent extraction for treatment of K027, K113-K116, U221, and U223 nonwastewaters. One facility recycles K116 nonwastewaters but also occasionally co-incinerates this waste with K027.

Wastewaters

The Agency is not aware of any facilities that treat wastewater forms of the K027, K113-K116, U221, and U223 treatability group. As discussed in Section 3.1.1, additional treatment of hazardous organic constituents in scrubber waters generated from incineration/fuel substitution is not required. However, K027, K113-K116, U221, and U223 wastewaters generated from RCRA corrective actions and CERCLA remedial orders contain hazardous organic constituents that require treatment. Biological treatment, solvent extraction, and carbon adsorption are demonstrated on a full-scale level for treatment of wastes that contain organonitrogen compounds (e.g., K103 and K104 wastewaters, reference 28, and the Solvents Rule, reference 40). The Agency therefore believes that since these technologies are demonstrated for treatment of wastes containing similar organic constituents, the technologies are also demonstrated for treatment of wastewater forms of wastes in the K027 treatability.

3.2.2 K115 Metals

Nonwastewaters

The Agency is not aware of any facilities that treat nickel in K115 nonwastewater residuals using any of the applicable technologies identified in Section 3.1.2. However, EPA has examined its BDAT treatment performance data base and determined that stabilization is demonstrated for a similar waste, F006 nonwastewaters, as described in Section 4.0. Nonwastewater residues from treatment of K115 are expected to include incinerator ash, filtrate from the filtration of scrubber water, and spent carbon from activated carbon adsorption of scrubber water. F006 nonwastewaters include wastewater treatment sludge from electroplating operations. Both wastes are expected to be comprised of solid particles or precipitate mixed with water. Both wastes also contain high concentrations of nickel. The Agency also believes that none of the constituents present in K115 nonwastewater residuals are likely to interfere with the treatability of nickel.

Wastewaters

The Agency is not aware of any facilities that treat nickel in K115 wastewater residuals using any of the applicable technologies identified in Section 3.1.2. However, EPA has examined its BDAT performance data base and determined that chemical precipitation followed by sludge dewatering of wastewaters is demonstrated for the following similar waste, K062 wastewaters, as described in Section 4.0. Wastewater residues from incineration or fuel substitution of K115 include scrubber waters that contain high concentrations of nickel. K062 wastewaters also contain high concentrations of nickel. The Agency also believes that none of the constituents present in K115 scrubber waters are likely to interfere in the treatability of nickel.

3.2.3 K111 and K112 Treatability Group

Wastewaters

The Agency has been unable to identify any facilities that currently use solvent extraction to treat either K111 or K112 wastewaters. However, facilities have been identified that treat these wastes by biological treatment or carbon adsorption on a full-scale level. Of the several facilities that generate K111 and/or K112 wastewaters, three facilities currently treat these wastes in biological treatment units and three facilities use carbon adsorption either alone or as a polishing step prior to disposal. Therefore, the Agency has identified biological treatment and carbon adsorption as the demonstrated technologies for wastewater forms of K111 and K112.

Nonwastewaters

The Agency has determined that incineration is the demonstrated treatment technology for nonwastewater forms of K111 and K112. The Agency is aware of at least one facility that currently treats the nonwastewater residual derived from the treatment of K111 and K112 by fluidized bed incineration on a full-scale level.

4.0 TREATMENT PERFORMANCE DATA BASE

The Agency does not have any treatment performance data for treatment of K027, K113-K116, U221, or U223. For nickel in K115 nonwastewaters and wastewaters, treatment performance data were transferred from other previously tested wastes to develop treatment standards. The basis for this data transfer and the sources of treatment performance data are discussed below. For organic constituents in K027, K113-K116, U221, and U223 nonwastewaters and wastewaters, numerical treatment standards cannot be developed due to the lack of EPA analytical methods that can satisfactly analyze for the constituents of concern. To determine whether the demonstrated technologies identified in section 3.0 provide substantial treatment for the constituents of concern, EPA examined treatment performance data from other similar wastes previously tested using these technologies. These data are used in this document for determining which technologies represent proposed BDAT (Section 5.0) and for developing proposed treatment standards (Section 7.0).

Treatment performance data, to the extent that they are available to EPA, include the types and concentrations of constituents in the untreated and treated wastes, values of operating parameters that were monitored at the time the waste was being treated, values of relevant design parameters for the treatment system, and data on waste characteristics that affect performance of the treatment technology. Table 4-1 presents data on waste characteristics that affect performance of the demonstrated treatment technologies, incineration and fuel substitution, for waste codes K027, K113-K116. (As discussed in Section 2, characterization data are not available for U221 and U223; however, these wastes are expected to contain high concentrations of TDA and TDI.) Available treatment performance data and data for waste characteristics that affect performance for incineration for waste codes K015, K086, and F024 are presented in Tables 4-2 through 4-4, respectively. These data have not been corrected for analytical accuracy. Accuracy-adjustment of data is discussed in Section 7.0 of this background document. Table 4-5 summarizes the operating data that correspond to the information presented in Tables 4-1 through 4-4. A discussion of the methodology used to identify treated wastes from which treatment performance data are being transferred is included in Appendix B of this document. Table 4-6 presents available treatment performance data and operating data for carbon adsorption treatment of K103 and K104 wastewaters. These data have not been corrected for analytical accuracy. Accuracy-adjustment of data is discussed in Section 7.0 of this background document.

Sources of treatment performance data for nickel for potential transfer to K115 include those wastes previously tested by stabilization and lime and sulfide precipitation followed by vacuum filtration. (These technologies were identified as applicable and demonstrated for treatment of nickel in K115 nonwastewaters and wastewaters in Section 3.0 of this document.)

EPA presented data for stabilization of metals in nonwastewaters in the California List Notice of Data Availability (52 Federal Register 29992, August 12, 1987). EPA screened these data to determine whether any wastes are generated from similar industries or similar processing steps or have similar waste characteristics as expected for ash generated from the incineration of K115. Stabilization of wastewater treatment sludge from electroplating operations, F006, is the best source of data for transfer to stabilization of ash generated from incineration of K115 because both wastes contain similar concentrations of nickel. Treatment performance data for stabilization of F006 are included in Table 4-7. These data have been corrected for analytical accuracy. Accuracy-adjustment of data is discussed in Section 7.0 of this background document.

EPA's database for chemical precipitation in wastewaters is included in the California List Notice of Data Availability (52 Federal Register 29992, August 12, 1987). EPA screened these data to determine whether any wastes are generated from similar industries or similar processing steps or have similar waste characteristics as expected for scrubber water generated from the incineration of K115. Lime and sulfide precipitation followed by vacuum filtration of K062 and other metal-bearing characteristic wastes is the best source of data for transfer to chemical precipitation followed by sludge dewatering of scrubber water generated from incineration of K115 because both wastes are expected to contain similar concentrations of nickel. Treatment performance data for lime and sulfide precipitation followed by vacuum filtration of K062 are included in Table 4-8. These data have not been corrected for analytical accuracy. Accuracy-adjustment of data is discussed in Section 7.0 of this background document.

Table 4-1

WASTE CHARACTERIZATION DATA FOR K027, K113-K116+

Constituents in Untreated Wastes	Concentration in Untreated Waste++ (ppm)	Boiling Point (^oC)	Bond Dissociation Energy (kcal/mole)
K027			
TDI	0-500,000	134	2,350
Polymerized TDI	900,000	NA	NA
2,4-TDA	100,000-500,000	283-285	1940
Karathane	100,000-500,000	138-140	4911
K113-K115			
2,4- & 2,6-TDA	0-500,000	283-285	1940**
2,3- & 3,4-TDA	0-950,000	283-285	1940**
o- p-Toluidine*	0-100,000	200-202	2480**
Aniline*	100-50,000	184-186	1495
K116			
Phosgene	0-300,000	8.2	335
Carbon tetrachloride	0-750,000	76.7-77	320
Chloroform	0-70,000	61-62	340
Tetrachloroethene	0-150,000	121	465
U221			
TDA	NA	283-285	1940
U223			
TDI	NA	283-285	2350

+ Performance data are not available for treatment of K027.
++ Data are from Table 2-2, Section 2.0. Data sources include the Listing Background Document for DNT, TDA, and TDI Production, data based on theoretical calculations, and patent information supported by unspecified industry data.
* Constituent in K113 and K114 only
** Bond dissociation energy for each isomer

NA = Not available.

Table 4-2

TREATMENT PERFORMANCE DATA FOR K015: LIQUID INJECTION INCINERATION

Regulated Constituent	Concentration (ppb)*		Boiling Point (°C)	Bond Dissociation Energy (kcal/mole)
	Untreated	Scrubber Water		
Anthracene	<5,000	<50-210	242	2,900
Benzal Chloride	910,000-1,100,000	<50-96	205	1,600
Benzo(b and/or k) fluoranthene	<5,000	<50-96	NA	3,990
Phenanthrene	<5,000	<50-58	340	2,900
Toluene	<10	15-59	110.6-111	1,620

NA - Not available.

* The operating ranges for the liquid injection incinerator and scrubbing system during the performance test are summarized in Table 4-5.

Source: Reference 27

Table 4-3

TREATMENT PERFORMANCE DATA FOR K086: ROTARY KILN INCINERATION

Regulated Constituent	Concentration in Waste (ppb)* Untreated	Scrubber Water	Boiling Point (°C)	Bond Dissociation Energy (kcal/mole)
Acetone	CBI	<0.005	56.5	945
Bis(2-ethylhexyl) phthalate	CBI	<0.010	385	6,565
n-Butyl alcohol	+	--	117-118	1,635
Cyclohexanone	CBI	<0.005	155.6	1,685
o-Dichlorobenzene	+	--	180.5-181	1,325
Ethyl acetate	**	--	77	1,305
Ethyl benzene	CBI	<0.005	136.3	1,905
Methanol	+	--	64.7	495
Methylene chloride	CBI	<0.005-<0.010	39.75	360
Methyl ethyl ketone	+	--	79.6	1,230
Methyl isobutyl ketone	CBI	--	117-118	1,800
Naphthalene	CBI	<0.010	217.9-218	2,120
Nitrobenzene	+	--	210-211	933
Toluene	CBI	<0.005-<0.010	110.6-111	1,620
1,1,1-Trichloroethane	+	--	74-74.1	625
Trichloroethylene	+	--	86.7-87	485

CBI = Confidential Business Information

+ Concentration unknown. This constituent was regulated because EPA believes it to be present in the untreated waste.
-- Treated waste concentration not available.
* The operating ranges for the rotary kiln incinerator during the performance test are summarized in Table 4-5.
** Untreated waste concentration not available.

Source: Reference 26

Table 4-4

TREATMENT PERFORMANCE DATA FOR F024: ROTARY KILN INCINERATION

Proposed Regulated Constituent	Concentration in Waste (ppm)*			Boiling Point (°C)	Bond Dissociation Energy (kcal/mole)
	Untreated Waste	Ash	Scrubber Water		
2-Chloro-1,3-butadiene	<0.5-139,721	<0.10	<0.1	59.4	955
3-Chloropropene	<0.5-285,486	<0.10	<0.1	44-45	810
1,1-Dichloroethane	<0.025-<10,000	<0.005	<0.005	57-57.3	645
1,2-Dichloroethane	<0.025-11,000	<0.005	<0.005	83-84	645
1,2-Dichloropropane	<0.025-230,000	<0.005	<0.005	96.4	930
cis-1,3-Dichloropropene	<0.025-160,000	<0.005	<0.005	108	790
trans-1,3-Dichloropropene	<0.025-290,000	<0.005	<0.005	112	790
Bis(2-ethylhexyl) phthalate	<172-7.63	<0.333-<0.351	<0.0104-<0.0121	385	6,465
Di-n-octyl phthalate	<0.351-<189	<0.333-<0.351	<0.0104-<0.0121	385	6,565
Hexachloroethane	<0.351-0.44	<0.333-<0.351	<0.0104-<0.0121	186.8-187	565
Pentachlorobenzene	<1.76-<945	<1.67-<1.79	<0.052-<0.061	275-277	1,310
Tetrachlorodibenzofurans	<0.0000002-0.012	<0.000032	0.00001	400-500	1,000
Pentachlorodibenzofurans	<0.0000002-0.029	<0.000029	0.00001	400-500	980
Pentachlorodibenzo-p-dioxins	<0.0000005-0.002	<0.000085	<0.0000056	400-500	2,490
Hexachlorodibenzofurans	<0.0000005-0.051	<0.000037	0.0003	400-500	960
Hexachlorodibenzo-p-dioxins	<0.0000005-0.01	<0.000079	<0.0000072	400-500	2,470

* The operating ranges for the rotary kiln incinerator during the performance test are summarized in Table 4-5.

ND = Not Detected.
NA = Not Available.

Source: Reference 21

Table 4-5

SUMMARY OF OPERATING DATA
FOR INCINERATION OF K015, K086, F024, AND K027

Waste Code:	K027	K027	K015	K086	F024
Type of Incinerators:	Liquid Injection (a)	Fluidized Bed (b)	Liquid Injection (c)	Rotary Kiln (d)	Rotary Kiln (e)
OPERATING PARAMETERS					
Incineration Chamber					
Temperature (^{o}F)	2,000-2,300	1585.4-1752.8++	1,780-2,077	1,880-2,053	1,201-1,604
Feed Rate (lb./min.)	83.3+	18.3-30.0	4.14-6.22	NA	NA
Residence Time (sec.)	1.7	NA	NA	0.2**	0.1-0.58**
Afterburner Chamber					
Temperature (^{o}F)	NA	NA	NA	2,032-2,056	1,803-2,142
Excess oxygen (%)	10-12	7.19-12.24	3.17-5.77*	5.0-6.2	5-15
Carbon monoxide (ppm)	75-150	28-255	0-614*	3.7-5.0	1-70
Off-Gas Scrubber					
Flow rate (gal./min.)	NA	11-18+++	17.44	NA	NA
Pressure drop (in. of H_2O)	NA	NA	38-44	NA	NA

* The liquid injection incinerator consists of a single chamber. These parameters were measured in that chamber.

** This number represents the rotational speed of the rotary kiln incinerator in rotations per minute, a surrogate measure of residence time.

\+ This number was calculated using a heating value of 10,000 Btu/lb.

++ This number represents the temperature range measured in the free board area of the fluidized bed incinerator.

+++ Make-up flow rate.

(a) Source: Reference 15.
(b) Source: Reference 16.
(c) Source: Reference 27.
(d) Source: Reference 26.
(e) Source: Reference 21.

Table 4-6

TREATMENT PERFORMANCE DATA FOR K103 AND K104:
CARBON ADSORPTION

Regulated Constituent	K103 and K104 Concentration (ppm) Untreated	Treated
Aniline	<1.5-<3.0	<0.03-0.96
Benzene	<0.005-0.008	<0.005-0.42
2,4-Dinitrophenol	16-57	0.23-0.38
Nitrobenzene	<3.0-4.5	<0.03
Phenol	<1.5-<3.0	<0.03-0.15
Cyanides (Total)	1.7-4.77	0.129-0.597

OPERATING PARAMETERS	Design Value	Operating Range
Feed Rate to the System (lbs/hr)	65,300 (max)	52,200-76,000
Feed pH to the System (standard pH units)	7.0 (min)	3.5-10.6
Feed Temperature to the System (^{o}C)	40	25-38
Total Organic Carbon in Treated Waste (mg/l)	250 (max)	7-79.3
Calculated Residence Time (minutes)	85 (min)	73-107

Source: Reference 28

Table 4-7

TREATMENT PERFORMANCE DATA FOR NICKEL TRANSFERRED FROM STABILIZATION OF F006 NONWASTEWATER

Untreated Waste Concentration		Treated Waste* Concentration
Total (mg/kg)	TCLP (mg/l)	TCLP (mg/l)
435	0.71	0.05
989	22.7	0.03
259	1.1	0.27
37	0.52	0.02
701	9.78	0.04
19,400	730	<0.06
13,000	152	0.11
23,700	644	0.04
5,730	16.1	0.02

* These are accuracy corrected values.

Source: Reference 22

Table 4-8

TREATMENT PERFORMANCE DATA FOR NICKEL TRANSFERRED FROM LIME AND SULFIDE PRECIPITATION FOLLOWED BY VACUUM FILTRATION OF K062 WASTEWATER

Untreated K062 Waste Concentration (ppm)	Treated K062 Wastewater (ppm)
669	0.36
712	0.33
382	0.39

Source: Reference 23

5.0 IDENTIFICATION OF BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT)

This section presents the Agency's rationale for determining best demonstrated available technology (BDAT) for K027, K113, K114, K115, K116, U221, and U223 nonwastewaters and wastewaters. BDAT for K111 and K112 has not been identified, and this treatability group is not discussed in this section. BDAT must be specified for all streams associated with the management of the listed waste or wastes; this pertains to the original waste as well as any residual waste streams generated by the treatment process.

The Agency determines BDAT based on a review of the available treatment performance data. If data are available for only one technology treating a waste, then that technology is "best". If data are available for more than one technology, the data are examined to determine whether one or more of the technologies performs significantly better than the others. All treatment performance data used for determination of whether a technology performs significantly better is first corrected for accuracy, as discussed in EPA's publication Methodology for Developing BDAT Treatment Standards and in Section 7.0.

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

The determination of BDAT for organics in K027, K113-K116, U221, and U223 is discussed in Section 5.1 for nonwastewaters and in Section 5.2 for wastewaters. The determination of BDAT for nickel in nonwastewater and wastewater forms of K115 is presented in Section 5.3.

5.1 Determination of BDAT for K027, K113-K116, U221, and U223 Nonwastewater Organics

5.1.1 Identification of BDAT

As discussed in Section 3.2, incineration and fuel substitution are demonstrated technologies for treating organics in nonwastewater forms of K027, K113-K116, U221, and U223. The Agency has been unable to identify any other demonstrated technologies for these wastes; therefore, incineration and fuel substitution are the "best" technologies for treatment of organics in K027, K113-K116, U221, and U223 nonwastewaters.

The Agency evaluated these technologies to determine whether they meet the two criteria identified above and therefore can be considered "available" for these wastes. The first criteria is satisfied since incineration and fuel substitution are commercially available technologies. The Agency then evaluated available treatment performance data, to determine whether incineration and fuel substitution provide substantial treatment of the hazardous organic constituents in K027, K113-K116, U221, and U223. As described below and in Appendix B, incineration and fuel substitution do provide substantial treatment for these wastes and are therefore available technologies. The Agency has therefore determined that incineration and fuel substitution are BDAT for organics in K027, K113-K116, U221, and U223 nonwastewaters.

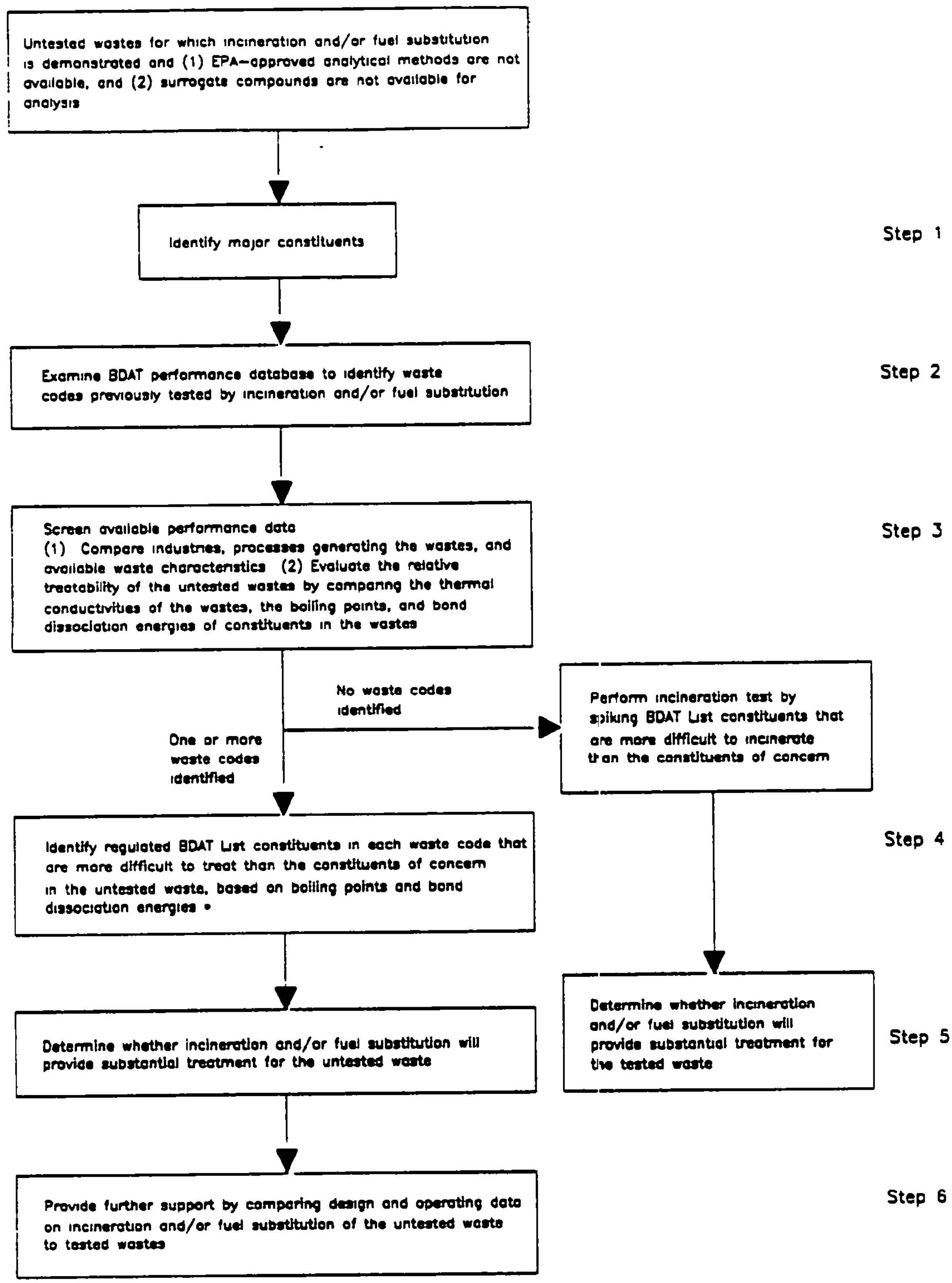
5.1.2 Evaluation of Substantial Treatment by Incineration and Fuel Substitution

The procedure described in this section and in more detail in Appendix B was used to show that incineration and fuel substitution provide substantial treatment for hazardous organic constituents in K027, K113-K116, U221, and U223. EPA developed the proposed methodology because (1) available analytical methods may not satisfactorily analyze for the constituents of concern in these wastes and (2) surrogate parameters or constituent indicators to measure performance have not been identified for the hazardous constituents in these wastes.

Figure 5-1 presents a flowchart illustrating the procedure that was used to show that incineration and fuel substitution provide substantial treatment for constituents of concern in K027, K113-K116, U221, and U223 nonwastewaters. This procedure is consistent with EPA's methodology for transfer of treatment data from a tested waste to an untested waste for the purpose of establishing treatment standards as performance levels. Each step shown in Figure 5-1 is described in Appendix B. The results of these steps for K027, K113-K116, U221, and U223 are discussed briefly below.

Step 1: Available waste characterization data for K027, K113-K116, U221, and U223 were examined to identify "major" constituents of concern. Major constituents generally consist of toxic constituents found in 40 CFR Part 261 Appendix VII identified for the waste as the basis for listing and other constituents of concern based on high toxicities, concentrations in the untested waste, and/or the relative difficulties of incineration (e.g., high boiling points and high BDE's (bond dissociation energies)). The major constituents of concern for K027 and K113-K116 are shown in Table 4-1. Waste characterization data are not available for U221 and U223; however, these wastes are expected to contain constituents similar to or the same as those listed for K027 and K113-K116.

Step 2: The BDAT treatment performance database was examined to identify all waste codes previously tested by incineration or fuel substitution. This database includes only those tests for which the treatment system was well-designed and well-operated during the treatment test and for which substantial treatment of hazardous organic constituents was demonstrated.



* Note that regulated constituents are, by definition, substantially treated by the BDAT treatment technology. Substantial treatment is demonstrated by comparing constituent concentrations in the untreated waste with corresponding concentrations in the treatment residuals.

Figure 5-1 Flow Chart Illustrating the Procedure Used to Show Substantial Treatment by Incineration or Fuel Substitution

Step 3: The tested wastes that were identified in Step 2 were "screened" to identify waste codes that are similar to K027, K113-K116, U221, and U223 and that are more difficult to treat than these wastes. Specifically, tested wastes were identified that:

(a) Are generated from similar industries or similar processes and/or have similar waste characteristics as K027, K113-K116, U221, and U223;

(b) Have similar or lower thermal conductivities than K027, K113-K116, U221, and U223; and

(c) Contain regulated BDAT List constituents that are equally or more difficult to incinerate with respect to bond dissociation energies and boiling points than the constituents of concern K027, K113-K116, U221, and U223.

The specific tested wastes that meet these criteria are listed in Table 5-1.

Generally, wastes that are generated from similar industries or similar processes, and/or that have similar waste characteristics such as chemical structure and ash content contain both similar waste constituents and similar waste treatability characteristics. Wastes generated by similar industries to that of the K027, K113-K116, U221, and U223 treatability group are K015, K019, K024, K037, K087, and F024 as discussed in Appendix B; however, none of these wastes are generated from similar processes.

EPA's BDAT methodology for determining the relative incinerability of a waste includes a comparison of the thermal conductivity, constituent boiling points, and constituent bond dissociation energies of the untested waste with those of other wastes that have been treated by incinerators or fuel substitution units and have been treatment tested. Thermal conductivity is a measure of heat transfer by conductivity in the waste. The lower the thermal conductivity, the greater the difficulty to heat the waste to volatilize the waste constituents. The boiling point of a constituent represents the degree of difficulty associated with volatilization. The lower the boiling point, the easier it is to volatilize the constituent in the incinerator or fuel substitution unit. Once volatilized, a constituent is destroyed by combustion. EPA believes that the energy required to destroy constituents can be assessed through a comparison of each constituent's activation energy. The Agency uses bond dissociation energies (BDE) as a surrogate measurement of activation energy because data on activation energy are rarely available, and the Agency believes that constituents with higher BDE's are more difficult to destroy than are those with lower BDEs. A detailed discussion of EPA's BDAT methodology for determining the relative incinerability of a waste and specific waste constituents is included in the Treatment Technology Background Document.

Wastes identified as equally or more difficult to incinerate than the K027, K113-K116, U221, and U223 treatability group are K015, K086, and F024 as discussed in Appendix B.

Step 4: Specific constituents that were regulated in the wastes identified in Step 3 that have higher boiling points and bond dissociation energies (and are therefore more difficult to treat) than the constituents of concern in K027, K113-K116, U221, and U223 were identified for each of the constituents of concern. The constituents of concern in K027, K113-K116, U221, and U223 and the corresponding constituents in K015, K086, and F024 that are more difficult to treat are listed in Table 5-1. Available treatment performance data for these wastes are included in Tables 4-2 through 4-4.

Constituents that have been regulated in K015, K086, and F024 (references 27, 26, and 21) are substantially treated by incineration since substantial treatment was a requirement for determination of incineration as BDAT for those wastes. Constituents are considered to be substantially treated if constituent concentrations in the untreated waste are significantly lower than corresponding concentrations in the treatment residuals. If incineration or fuel substitution has been shown to provide substantial treatment in a tested waste for a constituent that is equally or more difficult to treat than a constituent in an untested waste (with respect to boiling points and bond dissociation energies, as described above), then these technologies will also provide substantial treatment of the constituent of concern in the untested waste. EPA also believes that destruction of hazardous organic constituents in a waste is similar whether it occurs in an incinerator, high temperature boiler, or industrial furnace.

Step 5: As shown in Table 5-1, EPA has identified several constituents that were regulated in previously tested waste codes that are more difficult to treat than the constituents of concern in K027, K113-K116, U221, or U223. Therefore, based on the above analyses, EPA believes that incineration and fuel substitution provide substantial treatment of major

Table 5-1

COMPARISON OF CONSTITUENTS IN K015, K086, AND F024 THAT ARE MORE DIFFICULT TO TREAT THAN THE CONSTITUENTS OF CONCERN IN K027, K113-K116, U221, AND U223

Constituents of Concern in K027, K113-K116, U221, and U223			Constituents in K015, K086, and F024 That are More Difficult to Treat*		
Constituent	Boiling Point, °C	BDE Kcal/mole	Constituent	Boiling Point, °C	BDE kcal/mole
1. TDI	134	2350	Anthracene	242	2900
			Phenanthrene	340	2900
			Benzo(b and/or k) fluoranthene	NA	4030
			Bis(2-ethyl hexyl) phthalate	385	6465
			Di-n-octyl phthalate	385	6565
			Pentachlorodibenzo-p-dioxin	400-500	2490
2. TDA	283-285	1940	Phenanthrene	340	2900
			Benzo(b and/or k) fluoranthene	NA	4030
			Bis(2-ethylhexyl) phthalate	385	6465
			Di-n-octyl phthalate	385	6565
			Pentachlorodibenzo-p-dioxin	400-500	2490
			Hexachlorodibenzo-p-dioxin	400-500	2470

NA - Not available.
BDE - Bond dissociation energy.

*The listed constituents are more difficult to treat because they have higher boiling points and higher bond dissociation energies than the constituents of concern in K027, K113-K116, U221, and U223. The listed constituents are substantially treated by incineration and/or fuel substitute. Available treatment performance data for K015, K086, and F024 are included in Tables 4-2 through 4-4.

Table 5-1 (Continued)

COMPARISON OF CONSTITUENTS IN K015, K086, AND F024 THAT ARE MORE DIFFICULT TO TREAT THAN THE CONSTITUENTS OF CONCERN IN K027, K113-K116, U221, AND U223

Constituents of Concern in K027, K113-K116, U221, and U223			Constituents in K015, K086, and F024 That are More Difficult to Treat*		
Constituent	Boiling Point, °C	BDE Kcal/mole	Constituent	Boiling Point, °C	BDE kcal/mole
3. o- and p-Toluidine	200-202	2480	Anthracene	242	2900
			Phenanthrene	340	2900
			Benzo(b and/or k) fluoranthene	NA	4030
			Bis(2-ethyl hexyl) phthalate	385	6465
			Di-n-octyl phthalate	385	6565
			Pentachlorodibenzo-p-dioxin	400-500	2490
4. Kora-thane	138-140	4911	Bis(2-ethylhexyl) phthalate	385	6465
			Di-n-octyl phthalate	385	6565

NA - Not available.
BDE - Bond dissociation energy.

*The listed constituents are more difficult to treat because they have higher boiling points and higher bond dissociation energies than the constituents of concern in K027, K113-K116, U221, and U223. The listed constituents are substantially treated by incineration and/or fuel substitute. Available treatment performance data for K015, K086, and F024 are included in Tables 4-2 through 4-4.

constituents of concern in K027, K113-K116, U221, or U223 since it has been shown in Step 4 that these treatment technologies provide substantial treatment for constituents that are more difficult to treat.

Step 6: In Table 4-5 of Section 4.0, design and operating data for incineration and/or fuel substitution systems currently treating K027, K113-K116, U221, and/or U223 are compared to design and operating data for treatment systems from the BDAT performance database for the waste codes selected in Step 3. As shown in the table, the operating ranges for BDAT incineration units (liquid injection for K015, rotary kiln for K086 and F024) on tested waste codes are similar to the operating ranges for the liquid injection and fluidized bed incineration units treating K027. EPA believes that the similarity in design and operation of incinerators and fuel substitution units treating these wastes provides additional support for the conclusion that incineration and/or fuel substitution provide substantial treatment for K027, K113-K116, U221, or U223 and therefore are appropriate as BDAT for these wastes.

5.2 Determination of BDAT for K027, K113-K116, U221, and U223 Wastewater Organics

The specific wastewaters of concern for organics treatment are contaminated surface and ground waters from RCRA corrective actions and CERCLA remedial actions and leachates from landfills containing K027, K113-K116, U221, or U223 wastes. Scrubber waters from incineration or fuel substitution of these wastes are not expected to contain treatable concentrations of organics, if any, and are not prohibited from land disposal.

As discussed in Section 3.2.1, carbon adsorption, solvent extraction, and biological treatment have been identified by the Agency as demonstrated treatment technologies for wastewater forms of the K027, K113-K116, U221, and U223 treatability group. The Agency is not aware of any facilities that treat K027, K113-K116, U221, or U223 wastewaters and does not have performance data for treatment of these wastes. However, the Agency does have data for solvent extraction and activated carbon adsorption treatment of wastewaters that contain aromatic organonitrogen compounds that are similar to the constituents of concern in K027, K113-K116, U221, and U223 (see the BDAT Background Document for K103/K104, reference 28). The Agency does not have data for biological treatment for these constituents. The available data for carbon adsorption presented in Table 4-6 show treatment of wastewaters containing aromatic organonitrogen compounds at concentrations similar to those expected for K027, K113-K116, U221, and U223 wastewaters, while the data for solvent extraction represent treatment of wastewaters containing high concentrations of organonitrogen compounds.

EPA believes that any of the organonitrogen compounds contained in wastewater forms of the K027, K113-K116, U221, and U223 treatability group can easily be adsorbed on carbon. Available characterization data suggest that the organonitrogen compounds comprising these wastes, as originally generated, are aromatic in nature and thus, their chemical structures and physical properties (e.g., high molecular weight) make them amenable to treatment by carbon adsorption. Therefore, based on a review of these data and a comparison of the expected waste concentrations, EPA has determined that carbon adsorption is best technology for K027, K113-K116, U221, and U223 wastewaters.

The Agency then evaluated the available data to determine whether carbon adsorption can be considered "available" for treatment of K027, K113-K116, U221, and U223 wastewaters, in terms of the commercial availability and treatment effectiveness of the technology. Carbon adsorption is a commercially available technology that is commonly used for wastewater treatment. The Agency's performance data for carbon adsorption treatment of K103 and K104 show that the technology provides substantial treatment for the constituents present in K103 and K104 wastes. Hazardous organic constituents that are expected to be present in K027, K113-K116, U221, and U223 wastewaters based on their demonstrated mobility in water (as discussed in the Listing Background Documents for these wastes and reference 37) are dinitrotoluenes, toluenediamines, aniline, tetrachloroethene, chloroform, carbon tetrachloride, o- and p-toluidine and phosgene.

The performance data that are available for K103 and K104 does not include treatment for any of these constituents with the exception of aniline. However, the Agency believes that since carbon adsorption provides substantial treatment for other organonitrogen compounds that are present in K103 and K104 such as 2,4-dinitrophenol and nitrobenzene, the technology will also provide substantial treatment for the organonitrogen compounds that are expected to be present in K027, K113-K116, U221, and U223 wastewaters. Furthermore, the molecular size and structure (complex, branched ring compounds) of the constituents in K027, K113-K116, U221, and U223 makes them amenable to removal by adsorption on activated carbon. Therefore, EPA has determined that carbon adsorption is an available technology for K027, K113-K116, U221, and U223 wastewaters.

Based on the above reasoning, the Agency is proposing carbon adsorption as BDAT for the wastewater forms of K027, K113-K116, U221, and U223.

5.3 Determination of BDAT for Nickel in K115

Characterization data for nickel are not available for treatment residuals generated from incineration or fuel substitution of K115. However, based on available characterization data for nickel for untreated K115 wastes and available treatment performance data for other nickel-bearing wastes previously tested by incineration, the Agency believes that treatment residuals generated from the incineration or fuel substitution of K115 contain treatable concentrations of nickel. Furthermore, transfer of treatment performance data from previously tested wastes for the purpose of developing treatment standards for nickel in K115 is technically feasible as discussed in Section 3.2.2. Treatment performance data for nickel, presented in Tables 4-7 and 4-8, are transferred from wastes determined by the Agency to be similar to nonwastewater and wastewater forms of K115 (F006 and K062, respectively) as discussed in Section 4.0. As discussed in the background documents for F006 and K062, references 22 and 23, these treatment performance data were reviewed and were determined to represent operation of well-designed and well-operated systems, that sufficient quality assurance/quality control measures were employed to ensure the accuracy of the data, and that the appropriate measures of performance were used to assess the performance of the treatment technologies.

The Agency has determined that stabilization of K115 nonwastewaters and chemical precipitation followed by sludge dewatering for K115 wastewaters are the best technologies for these wastes.

The Agency then evaluated the available data to determine whether these technologies are "available". Stabilization and chemical precipitation followed by sludge dewatering, are considered to be commercially available and provide substantial treatment for nickel. Therefore, stabilization and chemical precipitation followed by sludge dewatering are "available" for the purpose of establishing BDAT.

Based on the above discussion, EPA is proposing stabilization as BDAT for nickel in K115 nonwastewaters and chemical precipitation followed by sludge dewatering as BDAT for nickel in K115 wastewaters. The Agency is soliciting characterization data for K115 combustion residues to verify the assumption that these wastes contain treatable concentrations of nickel.

5.4 Summary of Proposed BDAT for the K027, K113-K116, U221, and U223 Treatability Group

As discussed in 5.1 above, EPA is proposing incineration and fuel substitution as BDAT for organics in K027, K113-K116, U221, and U223 nonwastewaters. As discussed in Section 5.2 above, EPA is proposing carbon adsorption as BDAT for the treatment of organic constituents in K027, K113-K116, U221, and U223 treatability group wastewaters other than scrubber waters. In addition, as discussed in Section 5.3 above, EPA is proposing stabilization as BDAT for nickel in K115 nonwastewaters and chemical precipitation followed by sludge dewatering as BDAT for nickel in K115 wastewaters. The proposed BDAT regulations do not preclude a facility from recycling operations provided that the terms of exclusion or exemption specified in 40 CFR Part 261.2 are met.

6.0 SELECTION OF REGULATED CONSTITUENTS

This section presents the rationale for the selection of constituents being proposed for regulation in the K027, K113-K116, U221, and U223 treatability group. Since treatment standards for the K111 and K112 treatability group are not addressed in this proposed rule, this treatability group is not discussed in this section. Generally, constituents selected must satisfy the following criteria:

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

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

3. Where treatment performance data from another constituent are being transferred, the selected constituent(s) being proposed for regulation must be easier to treat than the constituent(s) from which performance data are transferred. Factors to assess

the ease of treatment vary according to the technology of concern. For instance, for incineration, factors include bond dissociation energies, thermal conductivities, and boiling points.

Section 2.0 presented waste characterization data for the K027 and K113-K116 waste codes. Major organic constituents of concern in these wastes such as karathane, TDI, TDA, and o- and p- toluidine would be considered for proposed regulation; however, as was discussed in Section 1.0, these constituents cannot be analyzed due to a lack of satisfactory analytical methods. Furthermore, as discussed in Section 4.0, no treatment performance data are available for these constituents. Therefore, EPA is proposing to set a treatment technology as BDAT for organics in the K027, K113-K116, U221, and U223 treatability group, rather than propose development of treatment performance levels for individual constituents.

A review of the inorganic waste characterization data identified spent nickel catalyst in untreated K115. Since metals are not treated in either incineration or fuel substitution processes, which are the proposed BDAT for organics in K115, the Agency is proposing to regulate nickel in nonwastewater and wastewater residuals of K115 based on treatment performance data from other waste codes as was discussed in Section 4.0.

7.0 DEVELOPMENT OF BDAT TREATMENT STANDARDS

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

BDAT treatment standards are determined for each constituent by multiplying the arithmetic mean of accuracy-adjusted constituent concentrations detected in treated waste by a "variability factor" specific to each constituent.

Constituent concentrations are adjusted to take into account analytical interferences associated with the chemical make-up of the sample. Generally, treatment performance data are corrected for accuracy as follows: (1) a matrix spike recovery is determined for each BDAT list constituent detected in the untreated or treated wastes; (2) an accuracy correction factor is determined for each constituent by dividing 100 by the matrix spike recovery (in percent) for that constituent; and (3) treatment performance data for each constituent are corrected by multiplying the reported concentration of the constituent by the corresponding accuracy correction factor.

Variability factors correct for normal variations in the performance of a particular technology over time and are designed to reflect the 99th percentile level of performance that the technology achieves in commercial operation. (For more information on the principles of calculating variability factors, see EPA's publication, Methodology for Developing BDAT Treatment Standards.) For details on accuracy adjustment of treatment performance data and the calculation of variability factors for nickel in K115, see the F006 and K062 background documents, references 22 and 23, from which treatment performance data and standards were transferred.

Where EPA has identified BDAT for a particular waste or waste treatability group, but because of analytical limitations cannot develop specific concentration-based treatment standards for that waste, the Agency can require the use of that treatment technology as the BDAT treatment standard. The Agency is proposing incineration or fuel substitution as the BDAT treatment technology standard for K027, K113-K116, U221, and U223 non-wastewaters, and carbon adsorption as the BDAT treatment technology standard for K027, K113-K116, U221, and U223 wastewaters other than scrubber waters.

For K115 nonwastewater and wastewater residuals, the Agency is proposing concentration-based treatment standards for nickel. These proposed standards are shown below.

Treatment standards for the K111 and K112 treatability group are being deferred as discussed in Section 8.0.

K115 Nonwastewater Residual
BDAT: Stabilization

Constituent	Maximum for any Single Grab Sample Total Composition (mg/kg)	TCLP (mg/l)
Nickel	Not Applicable	0.32

K115 Wastewater Residual
BDAT: Chemical Precipitation followed by Sludge Dewatering

Constituent	Maximum for any Single Grab Sample Total Composition (mg/kg)	TCLP (mg/l)
Nickel	0.47	Not Applicable

8.0 DETERMINATION OF THE REGULATORY APPROACH FOR THE K111 AND K112 TREATABILITY GROUP

As described in Section 3.1.2, K111 and K112, as generated, are wastewaters and generally contain 0-1% organic compounds. Applicable technologies for treatment of K111 and K112 wastewaters include those that destroy or reduce the total amount of various organic compounds in the wastes. The following technologies were identified as potentially applicable for treatment of K111 and K112 wastewaters: (1) biological treatment, (2) carbon adsorption, and (3) solvent extraction. The technology identified as potentially applicable for treatment of K111 and K112 nonwastewaters was incineration.

Based on telephone contacts with the eight facilities producing DNT, TDA, and/or TDI, the Agency identified two demonstrated treatment technologies for K111 and K112 wastewaters: biological treatment and carbon adsorption. The Agency also identified fluidized bed incineration as a demonstrated technology for treatment of sludge, a nonwastewater form of K111 and K112, derived from wastewater treatment of K111 and K112.

To be considered an available technology for treatment of K111 and K112, the demonstrated technology must provide "substantial treatment" for constituents of concern in the wastes or similar wastes. As discussed previously, treatment performance data are not available for biological treatment or carbon adsorption followed by incineration of the spent carbon K111 and K112. The Agency has not determined whether these technologies provide substantial treatment for K111 and K112. This is because the Agency feels that further study should be made of all available treatment options and treatment performance data before proposing either a gross parameter indicator of performance, or BDAT as a method of treatment. These studies would compromise valuable resources and time the Agency is currently allocating to address other wastes that may be otherwise restricted from land disposal if EPA fails to develop standards by 1990. Finally, since these wastes were listed after the effective dates of the 1984 RCRA amendments and land disposal of these wastes is not subject to either "soft hammer" or "hard hammer" provisions. Therefore, the Agency has decided to address these waste codes at a later date.

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Appendix A

CBI WASTE CHARACTERIZATION DATA

Appendix B

APPLICATION OF THE SECTION 5.1.2 METHODOLOGY ON THE K027, K113-K116, U221, AND U223 TREATABILITY GROUP

The methodology outlined in Section 5.1 was applied to the K027 treatability group to show that incineration and/or fuel substitution will provide substantial treatment of the hazardous constituents in nonwastewater forms of K027, K113-K116, U221, and U223. Each step, shown in the flowchart of Figure 5-1 and described in Section 5.1, is repeated below along with results of its application to the K027 treatability group.

<u>Step 1</u>: Examine available waste characterization data for K027 and K113-K116 and identify major constituents of concern.

Characterization data for K027 and K111-K116 are presented in Table 2-2 of Section 2.0. Many of the constituents that characterize these waste codes are not on the BDAT List of hazardous constituents because of the difficulties associated with analyzing for the constituents in complex waste matrices (as discussed in Section 1.0). However, these constituents are major constituents of concern for the K027 waste treatability group as discussed below.

Major constituents of concern are those which demonstrate high toxicity, high concentrations in the untreated wastes, and/or a high degree of difficulty for treatment. EPA's BDAT methodology for determining the relative difficulty in incineration of different hazardous constituents includes a comparison of the boiling points and bond dissociation energies of the constituents. As shown in Table 2-2, karathane, TDI, TDA, and carbon tetrachloride are expected to be present in the untreated wastes at highest concentration.

In addition, karathane, TDI, and o- and p-toluidine have the highest bond dissociation energies of the constituents present in the untreated wastes (4,911 kcal/mole, 2,350 kcal/mole, and 2,480 kcal/mole, respectively). 2,4-TDA and 2,6-TDA also have the highest boiling points of 283-285°C. Therefore, based on the high toxicity, high concentrations in the untreated wastes, and high degree of difficulty to incinerate, the following constituents have been identified as the major constituents of concern for the K027 waste treatability group: karathane, TDI, 2,4- and 2,6-TDA, and o- and p-toluidine.

Step 2: Examine the BDAT performance database to identify all waste codes previously tested by incineration processes (i.e., incineration and/or fuel substitution).

As discussed in Section 5.0 (Step 2), the BDAT incineration database was chosen for examination in this methodology since it is best suited to the land disposal restriction regulations. Performance data obtained from 12 incineration treatment tests performed by the BDAT program presently constitute EPA's BDAT incineration performance database. The incineration database includes both treatment performance data (concentrations of hazardous constituents detected in the untreated and treated wastes) and corresponding design and operating data for the incineration systems.

For the BDAT program, incineration tests were performed only on incinerators operating under 40 CFR Part 264 Subpart O or Part 265 Subpart O, or on fuel substitution units operating under 40 CFR Part 266. Subsequent to each treatment test, EPA performed an engineering analysis of the treatment system's operation during the treatment test to determine whether the treatment system was well-designed and well-operated. The determination of whether a treatment system is well-designed and well-operated is based upon whether the treatment system was operating within design operating parameters during the treatment test. Additionally, EPA reviewed the performance data to determine whether the treatment system provided substantial treatment for the constituents of concern (i.e., regulated constituents) in the tested waste. If the treatment was determined to be well-designed and well-operated and substantial treatment was shown, the Agency included the data in the development of treatment standards for the tested waste. Where the treatment system was determined to be poorly-designed or operated, the Agency excluded that performance data from the incineration database precluding the use of that data in the development of treatment standards.

Based on a review of the existing BDAT performance database, the following waste codes previously tested by incineration, were identified:

Waste Codes	Definition in 40 CFR Part 261	Type of Incineration Test
K001	Bottom sediment sludge from the treatment of wastewaters from wood preserving processes that use creosote and/or pentachlorophenol.	Rotary kiln
K015	Still bottoms from the distillation of benzyl chloride.	Liquid injection
K019	Heavy ends from the distillation of ethylene dichloride in ethylene dichloride production.	Rotary kiln
K024	Distillation bottoms from the production of phthalic anhydride from naphthalene.	Rotary kiln
K037	Wastewater treatment sludge from the production of disulfoton.	Rotary kiln
K048	Dissolved air flotation (DAF) float from the petroleum refining industry.	Fluidized bed
K051	API separator sludge from the petroleum refining industry.	Fluidized bed
K086	Solvent washes and sludges, caustic washes and sludges, or water washes and sludges from cleaning tubs and equipment used in the formulation of ink from pigments, driers, soaps, and stabilizers containing chromium and lead.	Rotary kiln
K087	Decanter tank tar sludge from coking operations.	Rotary kiln
K101	Distillation tar residues from the distillation of aniline-based compounds in the production of veterinary pharmaceuticals from arsenic or organo-arsenic compounds.	Rotary kiln
K102	Residue from the use of activated carbon for decolorization in the production of veterinary pharmaceuticals from arsenic or organo-arsenic compounds.	Rotary kiln

Waste Codes	Definition in 40 CFR Part 261	Type of Incineration Test
F024	Wastes, including but not limited, distillation residues, heavy ends, tars, and reactor clean-out wastes, having carbon content from one to five, utilizing free radical catalyzed processes (this listing does not include light ends, spent filters, and filter aids, spent dessicant, wastewater, wastewater treatment sludges, spent catalysts, and wastes listed in Section 261.32).	Rotary kiln

Step 3: Screen the BDAT incineration database and identify waste codes that meet the criteria described below.

(a) Identify wastes that are generated from similar industries or similar processes, and/or have similar waste characteristics as K027, K113-K116, U221, and U223.

K027, K113-K116, U221, and U223 are generated from the production of organic chemicals; specifically, from the production of toluene diisocyanate and/or toluenediamine. Of the wastes previously tested by incineration, K015, K019, K024, K037, K086, and F024 were identified as waste codes that are generated from similar industries (production of organic chemicals) as K027, K113-K116, U221, and U223. However, none of these wastes are generated from similar processes as K027, K113-K116, U221, and U223.

(b) Identify wastes that have similar or lower thermal conductivities than the untested wastes of concern.

Analytical determinations of the thermal conductivities for these wastes are not currently available; however, the relative thermal conductivities of the wastes can be compared based on the chemical characteristics of these wastes. In general, organic constituents have similar thermal conductivities. Solids will tend to have higher thermal conductivities than liquids. Metals have a high thermal conductivity, whereas inorganics which are non-metallic are generally considered to act as insulators and have low thermal conductivities.

The wastes K015, K019, K024, K027, K037, K086, K113-K116, and F024, are generated from the production of organic chemicals; therefore, these wastes are expected to have high concentrations of organic constituents and very low concentrations, if any, of metals. The K086 wastes treated in EPA's incineration test are a mixture of solid and liquid wastes. All other waste streams are expected to be solid or semi-solid waste mixtures. Based on the discussion above, K086 as a solid and liquid mixture is therefore expected to have a lower thermal conductivity (i.e., is more difficult to incinerate) than K027, K113-K116, U221, and U223. The other waste streams, K015, K019, K024, K037, and F024, are expected to have similar thermal conductivities (i.e., similar incinerability) as K027, K113-K116, U221, and U223.

(c) Identify wastes that contain regulated BDAT List constituents that are equally or more difficult to incinerate than the constituents of concern.

The boiling points and bond dissociation energy (BDE) of the proposed regulated BDAT List constituents in K015, K019, K024, K037, K086, and F024 were examined. Of these wastes, K015, K086, and F024 were identified as the waste codes that contain proposed regulated BDAT List constituents that are more difficult to incinerate, i.e., have higher BDE's and boiling points, than K027, K113-K116, U221, and U223 constituents of concern. Characteristics of the proposed regulated constituents in K015, K086, and F024 along with the performance data, if available, are summarized in Tables 4-2 through 4-5 of Section 4.0.

Step 4: Select constituents from waste codes identified in Step 3 that meet the criteria delineated below.

The waste codes identified in Step 3 are K015, K086, and F024. Characteristics of the constituents of concern in the K027, K113-K116, U221, and U223 treatability group are summarized in Table 4-1 of Section 4.0. Characteristics of the regulated BDAT List constituents and performance data were examined to identify constituents that:

(a) Have higher boiling points and bond dissociation energies than the constituents of concern in K027 and K113-K116.

As mentioned in Step 1, the constituents of concern in K027 and K113-K116 are TDI, TDA, o- and p-toluidine, and karathane.

Based on the waste characterization and performance data presented in Tables 4-2 and 4-5 of Section 4.0, anthracene, phenanthrene, and benzo(b and/or k)fluoranthene in K015 were identified as constituents that have higher bond dissociation energies than TDI, TDA, and o- and p-toluidine. In addition, phenanthrene has a higher boiling point than TDI, TDA, and o- and p-toluidine. Anthracene has a higher boiling point than karathane, TDI, and o- and p-toluidine but a lower boiling point (bp 242°C) than TDA (bp 283-285°C). A boiling point is not available for benzo(b and/or k)fluoranthene. However, based on its structure, benzo(b and/or k)fluoranthene is expected to have a higher boiling point than phenanthrene. Therefore, benzo(b and/or k)fluoranthene is expected to have a higher boiling point than TDI, TDA, and o- and p-toluidine.

Based on waste characterization and performance data presented in Tables 4-3 and 4-5 of Section 4.0, bis(2-ethylhexyl)phthalate was identified as the only proposed regulated constituent in K086 that has a higher bond dissociation energy than either karathane, TDI, TDA, or o- and p-toluidine. In addition, the boiling point for bis(2-ethylhexyl)phthalate is also higher than the boiling points for the K027 treatability group constituents of concern.

Based on waste characterization and performance data presented in Tables 4-4 and 4-5 of Section 4.0, bis(2-ethylhexyl)phthalate, di-n-octyl phthalate, pentachloro-dibenzo-p-dioxin, and hexachloro-dibenzo-p-dioxin in F024 were identified as constituents that have higher bond dissociation energies (BDEs) than either TDI, TDA, o- and p-toluidine or karathane. (Bis(2-ethylhexyl)phthalate and di-n-octyl phthalate have higher BDEs than all four constituents of concern in the K027 treatability group; pentachloro-dibenzo-p-dioxin has a BDE higher than TDI, TDA, and o- and p-toluidine; and hexachloro-dibenzo-p-dioxin has a higher BDE than TDA.) In addition, the four constituents identified in F024 all have higher boiling points than karathane, TDI, TDA, and o- and p-toluidine in the K027 treatability group.

(b) The selected constituents are present in the untreated wastes at concentrations high enough to allow a determination that substantial treatment was achieved in the tested waste.

As shown in Tables 4-2 through 4-4, the selected constituents anthracene, phenanthrene, benzo(b and/or k)fluoranthene, bis(2-ethylhexyl)-phthalate, di-n-octyl phthalate, pentachloro-dibenzo-p-dioxin, and hexachloro-dibenzo-p-dioxin were all present in the untreated wastes at high enough concentrations to allow determination that substantial treatment was achieved in the tested waste.

Step 5: Summarize demonstration of substantial treatment.

Summarized below are the constituents identified in Step 4 along with their characteristics and the corresponding constituents of concern in the K027, K113-K116, U221, and U223 treatability group:

As discussed earlier, EPA's BDAT methodology for determining the relative difficulty of incineration of different hazardous constituents involves the comparison of boiling points and bond dissociation energies of the hazardous constituents. EPA's approach is based on the belief that the higher the boiling point, the harder it is to volatilize the constituent and the higher the bond dissociation energy, the harder it is to destabilize the constituent. Therefore, based on the above information, anthracene, phenanthrene, benzo(b and/or k)fluoranthene, bis(2-ethylhexyl)phthalate, di-n-octyl phthalate, and pentachlorodibenzo-p-dioxin are shown to be more difficult to combust than TDI and o- and p-toluidine. Phenanthrene, benzo(b and/or k)-fluoranthene, bis(2-ethylhexyl)phthalate, di-n-octyl phthalate, pentachlorodibenzo-p-dioxin, and hexachlorodibenzo-p-dioxin are shown to be more difficult to combust than TDA and bis(2-ethylhexyl)phthalate and di-n-octyl phthalate are shown to be more difficult to combust than karathane.

Furthermore, performance data from incineration of these constituents show that they are substantially treated by incineration. Therefore, since substantial treatment is demonstrated by incineration for constituents that are more difficult to incinerate than TDI, TDA, karathane, and o- and p-toluidine, combustion (as incineration and/or fuel substitution) is expected to provide substantial treatment for these major constituents of concern in the K027 treatability group.

In summary, the above analyses demonstrate that incineration provides substantial treatment for K027, K113-K116, U221, and U223 and, therefore, support the determination to identify incineration and fuel substitution as the BDAT method of treatment for K027, K113-K116, U221, and U223.

Step 6: Compare design and operating data for incineration systems treating K015, K086, K027, K113-K116, and F024.

To further support the determination of incineration as the BDAT method of treatment for K027, K113-K116, U221, and U223, EPA compared design and operating data for incineration systems treating K015, K086, F024, K027, and K113-K116. Table 4-5 in Section 4.0 summarizes available operating ranges for incineration systems treating K027, K015, K086, and F024. Although operating conditions vary from facility to facility and are waste-specific, the operating ranges for the incinerator treating K027 are very similar to the operating ranges for incinerators treating K015, K086, and F024 as indicated in Table 4-5. Therefore, based on the similarity in operating ranges of these incinerators, and since the incinerators treating K015, K086, and F024 have been shown to provide substantial treatment of hazardous organic constituents, EPA expects that incineration systems with similar operating conditions, also provide substantial treatment for K027, K113-K116, U221, and U223.