FINAL

AMENDMENT TO

FINAL BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT) BACKGROUND DOCUMENT FOR ORGANOPHOSPHORUS WASTES

(K036 NONWASTEWATERS)

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1.0 INTRODUCTION

The United States Environmental Protection Agency (EPA or Agency) is amending the "Final Best Demonstrated Available Technology (BDAT) Background Document for Organophosphorus Wastes" (Reference 1) and promulgating as proposed, revised treatment standards for nonwastewater forms of the listed organophosphorus waste stream, K036, promulgated on August 8, 1988 as part of the land disposal restrictions for the "First Third" list of hazardous wastes.[1] No comments were received on the proposed K036 nonwastewater treatment standards (see 54 FR 48454, November 22, 1989). K036 is listed in Title 40, Code of Federal Regulations, Section 261.32 (40 CFR 261.32) as "still bottoms from toluene reclamation distillation in the production of disulfoton." The previous standard of "No Land Disposal" was based on an assumption of "No Generation" for K036 nonwastewaters (Reference 1). Because information received subsequent to promulgation of the standard indicates that K036 indeed may be generated, EPA is now promulgating numerical standards for nonwastewater forms of K036.[2] BDAT treatment standards for K036 nonwastewaters will be effective no later than May 8, 1990, as part of the "Third Third" rulemaking. On and after the effective date, compliance with BDAT treatment standards is required under 40 CFR Part 268 for placement of K036 in land disposal units.

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[1]These standards were originally promulgated in accordance with the amendments to the Resource Conservation and Recovery Act (RCRA) of 1976, under the Hazardous and Solid Waste Amendments (HSWA) of November 8, 1984. With this authority, the EPA established best demonstrated available technology (BDAT) treatment standards for the wastes identified in Title 40, Code of Federal Regulations, Section 261.32 (40 CRF 261.32) as K036. Compliance with these BDAT treatment standards is a prerequisite under 40 CFR Part 268 for placement of K036 in land disposal units.

[2]For wastewater forms of K036, a treatment standard of 0.025 mg/l for disulfoton is based on biological treatment. This numerical standard was developed from treatment performance data transferred from wastestreams containing the similar organophosphorous compound, parathion (Reference 1). The Agency is not revising the treatment standard for K036 wastewater.

This amendment to the background document for organophosphorus wastes provides the Agency's rationale and technical support for selecting the regulated constituent, disulfoton, and for developing the treatment standard for this constituent.

The numerical standard for nonwastewater forms of K036 is based on treatment performance data for incineration of K037, presented in the "Final Best Demonstrated Available Technology (BDAT) Background Document for K037" (Reference 2). K037 is listed in 40 CFR 261.32 as "wastewater treatment sludges from the production of disulfoton" and its primary constituents are disulfoton, an organophosphorus insecticide, and toluene. Because of the similar origins and composition of K037 and K036, treatment performance data are being transferred from incineration of K037 to K036 nonwastewaters for the purpose of developing BDAT treatment standards. Incineration treatment data for K037 are presented in Section 3 of this document and indicate substantial treatment of the K037 nonwastewater constituent, disulfoton.

The Agency's legal authority and promulgated methodology for establishing treatment standards and the petition process necessary for requesting a variance from the treatment standards are summarized in EPA's Methodology for Developing BDAT Treatment Standards (Reference 3).

This amendment to the Final Best Demonstrated Available Technology (BDAT) Background Document for Organophosphorus Wastes presents: 1) a discussion of incineration as an additional applicable and demonstrated technology for treating disulfoton, the proposed constituent of concern in K036 nonwastewaters, 2) EPA's determination of incineration as the best demonstrated available technology for K036 nonwastewaters, and 3) EPA's rationale for transferring treatment performance data from incineration of K037 to K036 nonwastewater streams. More specifically, Section 2 of this document amends Section 3 of the Final BDAT Background Document for Organophosphorus Wastes by adding incineration as an applicable and demonstrated technology for treating nonwastewater forms of K036. Section 3 of this document amends Section 4 of the Final BDAT Background Document for Organophosphorus Wastes by adding treatment performance data for incineration of K037 to develop treatment standards for K036 nonwastewaters. Section 4 amends Section 5.1, identifying incineration as BDAT for K036 nonwastewaters. Finally, Section 6 amends Section 7, presenting numerical standards for disulfoton based on treatment performance data for incineration transferred from K037 to K036 nonwastewaters.

To determine the applicability of a treatment standard, wastewaters are defined as wastes containing less than 1% (weight basis) total suspended solids[3] (TSS) and less than 1% (weight basis) total organic carbon (TOC). Wastes not meeting this definition are classified as nonwastewaters and must comply with nonwastewater treatment standards. The numerical treatment standard for disulfoton in K036 nonwastewater is shown in Table 1-1. This treatment standard is based on the total concentration of disulfoton in the waste for any single grab sample. The units used for the constituent concentration are mg/kg (parts per million on a weight-by-weight basis).

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[3]The term "total suspended solids" (TSS) clarifies EPA's previously used terminology of "total solids" and "filterable solids." Specifically, total suspended solids are measured by Method 209C (total suspended solids dried at 103-105°C) in Standard Methods for the Examination of Water and Wastewater, Sixteenth Edition (Reference 4).

TABLE 1-1

BDAT TREATMENT STANDARDS FOR K036

NONWASTEWATERS

(REVISED FROM NO LAND DISPOSAL)

BDAT No.	Regulated Constituent	Maximum for Any Single Grab Sample Total Concentration (mg/kg)
195	Disulfoton	0.10

2.0 AMENDMENT TO SECTION 3 ("APPLICABLE/DEMONSTRATED TREATMENT TECHNOLOGIES") OF THE FINAL BACKGROUND DOCUMENT FOR ORGANOPHOSPHORUS WASTES (K036)

This section discusses incineration as an applicable and demonstrated technology for the treatment of K036 nonwastewaters. Other technologies already identified as applicable and demonstrated are discussed in the Organophosphorus Wastes Background Document (Reference 1). These technologies (for wastewater forms of organophosphorus wastes) are biological treatment and carbon absorption. They are not discussed further here.

2.1 Applicable Treatment Technologies

In addition to those technologies already described in the BDAT Background Document for Organophosphorus Wastes (including K036), the Agency has identified incineration as an applicable treatment technology for K036 nonwastewaters (Reference 1). Incineration destroys organic constituents present in untreated wastes with high filterable solids. Because K036 nonwastewaters contain high concentrations of organics and filterable solids, incineration is applicable for treatment of these wastes. The selection of the treatment technologies applicable for treating BDAT list organic constituents in K036 nonwastewaters is based on data submitted by industry, current literature sources, and field testing.

2.2 Demonstrated Treatment Technologies

Incineration is considered to be demonstrated for treatment of K036 nonwastewaters or similar wastes (i.e., high organic content, low water content, and high filterable solids content). Of the various types of incineration, EPA believes fluidized bed incineration is demonstrated for K036 nonwastewaters because it has been used to treat wastes with similar characteristics. The

Agency knows of at least one facility using fluidized bed incineration for treatment of wastes similar to K036 nonwastewaters. However, EPA is not aware of any generator or TSD facility currently using this technology for treatment of wastes containing K036.

The Agency believes that rotary kiln incineration is also demonstrated to treat K036 nonwastewaters since it has been shown to effectively treat wastes that are similar in parameters affecting treatment selection, including low water content, high organic content, and high solids concentration. EPA tested rotary kiln incineration to demonstrate treatment of the closely related wastestream, K037. K037 is defined as "wastewater treatment sludges from the production of disulfoton" (40 CFR 261.32). K036 and K037 both are derived from the production of disulfoton and contain this organophosphorus compound as their primary constituent. The Agency conducted a rotory kiln incineration test on K037 and treatment performance data collected by EPA from this test are presented and discussed more fully in Section 3.

The remainder of this section provides information regarding the applicability of incineration technologies, the underlying principles of operation, a technology description, waste characteristics that affect performance, and finally, important design and operating parameters. As appropriate, the subsections are divided by type of incineration unit.

2.2.1 Applicability and use of this technology

Liquid Injection - Liquid injection is applicable to wastes that have viscosity values low enough that the waste can be atomized in the combustion chamber. A range of maximum viscosity values are reported in the scientific literature, with the lowest being 100 Seybolt Univeral Seconds (SUS) (@100°F) and the highest being 10,000 SUS. It is important to note that viscosity is temperature dependent so that while liquid injection may not be applicable to a waste at ambient conditions, it may be applicable when the waste is heated. Other factors that affect the use of liquid injection are particle size and the presence of suspended solids. Both of these waste parameters can cause plugging of the burner nozzle.

Rotary kiln/fluidized bed/fixed hearth - These incineration technologies are applicable to a wide range of hazardous wastes. They can be used on wastes that contain high or low total organic content, high or low suspended solids, various viscosity ranges, and a range of other waste parameters. EPA has not found these technologies to be demonstrated on wastes that are composed essentially of metals with low organic concentrations. In addition, the Agency expects that some of the high metal content wastes may not be compatible with existing and future air emission limits without emission controls far more extensive than currently practiced.

2.2.2 Underlying principles of operation

Liquid injection - The basic operating principle of this incineration technology is that incoming liquid wastes are volatilized and then additional heat is supplied to the waste to destabilize the chemical bonds. Once the chemical bonds are broken, these constituents react with oxygen to form carbon dioxide and water vapor. The energy needed to destabilize the bonds is referred to as the energy of activation.

Rotary kiln and fixed hearth - There are two distinct principles of operation for these incineration technologies, one for each of the chambers involved. In the primary chamber, energy in the form of heat is transferred to the waste to achieve volatilization of the various organic waste constituents. During this volatilization process, some of the organic constituents will oxidize to carbon dioxide and water vapor. In the secondary chamber, additional heat is supplied to overcome the energy requirements needed to destabilize the chemical bonds and allow the constituents to react with excess oxygen to form carbon dioxide and water vapor. The principle of operation for the secondary chamber is similar to that of liquid injection.

Fluidized bed - The principle of operation for this incineration technology is somewhat different from that for rotary kiln and fixed hearth incineration in that the fluidized bed incinerator contains fluidizing sand and a freeboard section above the sand. The purpose of the fluidized bed is to both volatilize the waste and combust the waste. Destruction of the waste organics can be accomplished to a better degree in the primary chamber of a fluidized bed incinerator than that of a rotary kiln or fixed hearth incinerator because of; 1) improved heat transfer from fluidization of the waste using forced air and, 2) the fact that the fluidization process provides sufficient oxygen and turbulence to convert the organics to carbon dioxide and water vapor. The freeboard generally does not have an afterburner; however, additional time is provided for conversion of the organic constituents to carbon dioxide, water vapor, and hydrochloric acid if chlorine is present in the waste.

2.2.3 Description of incineration technologies

Liquid injection - The liquid injection system is capable of incinerating a wide range of gases and liquids. The combustion system has a simple design with virtually no moving parts. A burner or nozzle atomizes the liquid wastes and injects it into the combustion chamber where it burns in the presence of air or oxygen. A forced draft system supplies the combustion chamber with air to provide oxygen for combustion and turbulence for mixing. The combustion chamber is usually a cylinder lined with refractory (i.e., heat resistant) brick and can be fired horizontally, vertically upward, or vertically downward. Figure 2-1 illustrates a liquid injection incineration system.

Rotary kiln - A rotary kiln is a slowly rotating, refractory lined cylinder that is mounted at a slight incline from the horizontal (see Figure 2-2). Solid wastes enter at the high end of the kiln, and liquid or gaseous wastes enter through atomizing nozzles in the kiln or after burner section. Rotation of the kiln exposes the solids to the heat, vaporizes them, and allows them to combust by mixing with air. The rotation also causes the ash to move to the lower end of the kiln where it can be removed. Rotary kiln systems usually have a secondary combustion chamber or afterburner following the kiln for further combustion of the volatilized components of solid wastes.

Fluidized bed - A fluidized bed incinerator consists of a column containing inert particles such as sand, which is referred to as the bed. Air, driven by a blower, enters the bottom of the bed to fluidize the sand. Air passage through the bed promotes rapid and uniform mixing of the injected waste material within the fluidized bed. The fluidized bed has an extremely high heat capacity (approximately three times that of flue gas at the same temperature), thereby providing a large heat reservoir. The injected waste reaches ignition temperature quickly and transfers the heat of combustion back to the bed. Continued bed agitation by the fluidizing air allows larger particles to remain suspended in the combustion zone. (See Figure 2-3)

Fixed hearth - Fixed hearth incinerators, also called controlled air or starved air incinerators, are another major technology used for hazardous waste incineration. Fixed hearth incineration is a two-stage combustion process (see Figure 2-4). Waste is ram-fed into the first stage, or primary chamber,

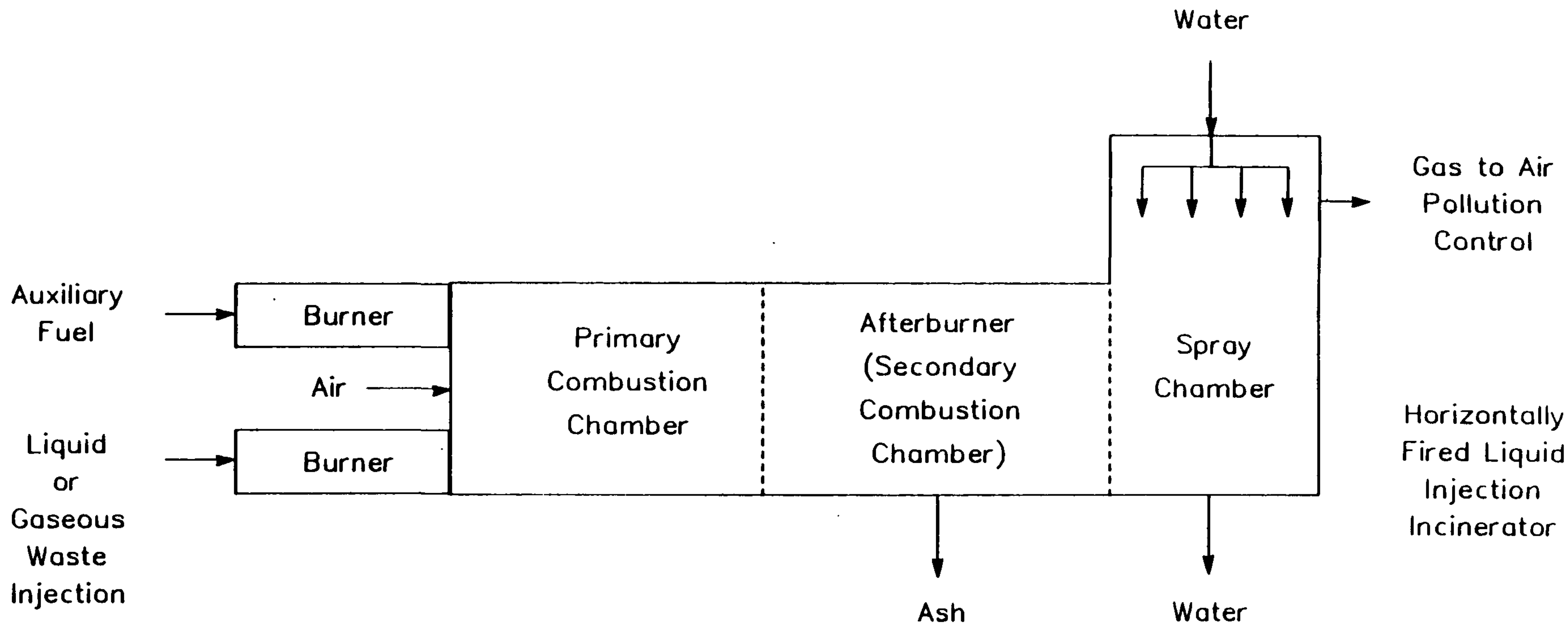

Figure 2-1. Liquid Injection Incinerator

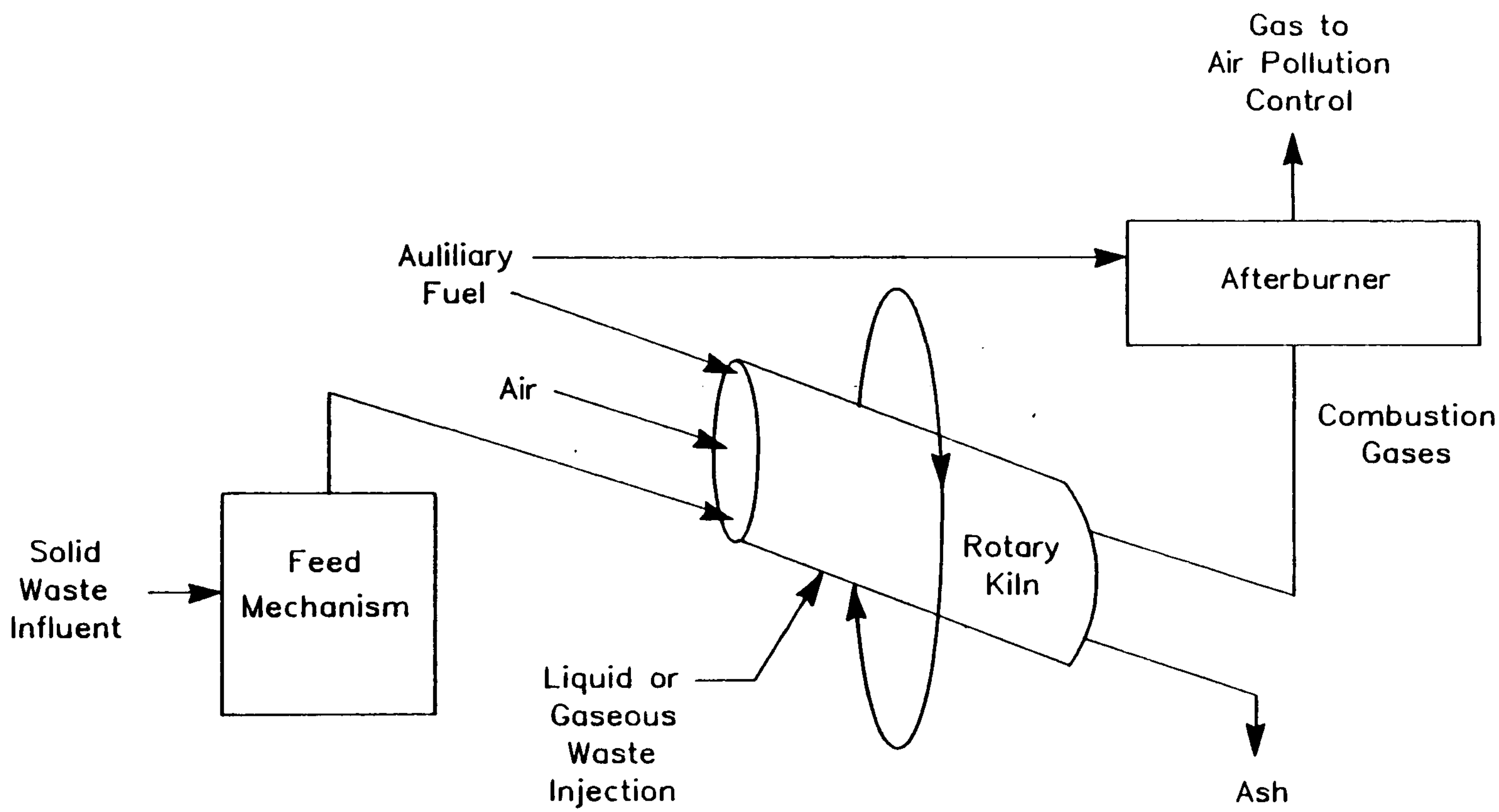

Figure 2-2. Rotary Kiln Incinerator

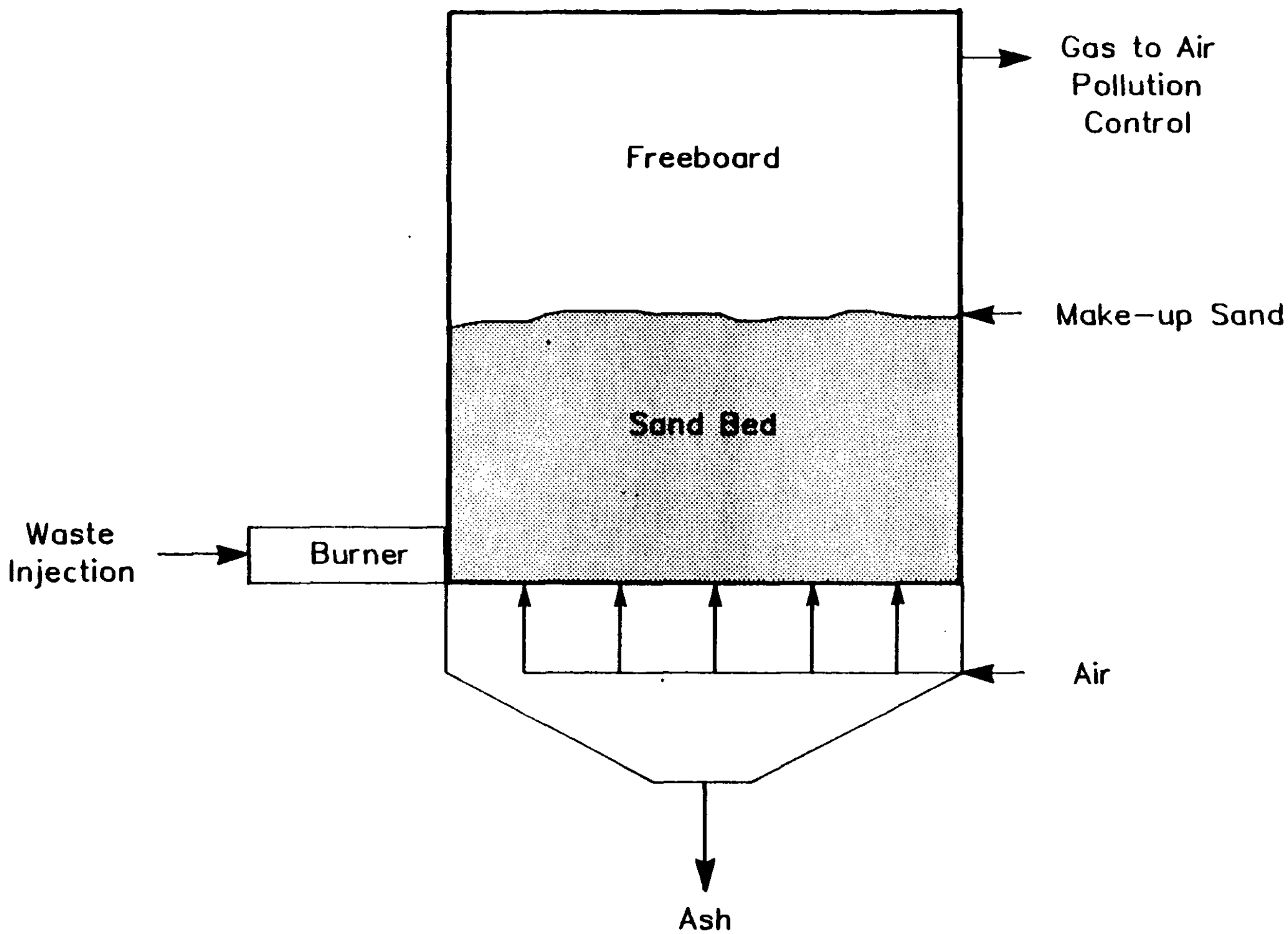

Figure 2-3. Fluidized Bed Incinerator

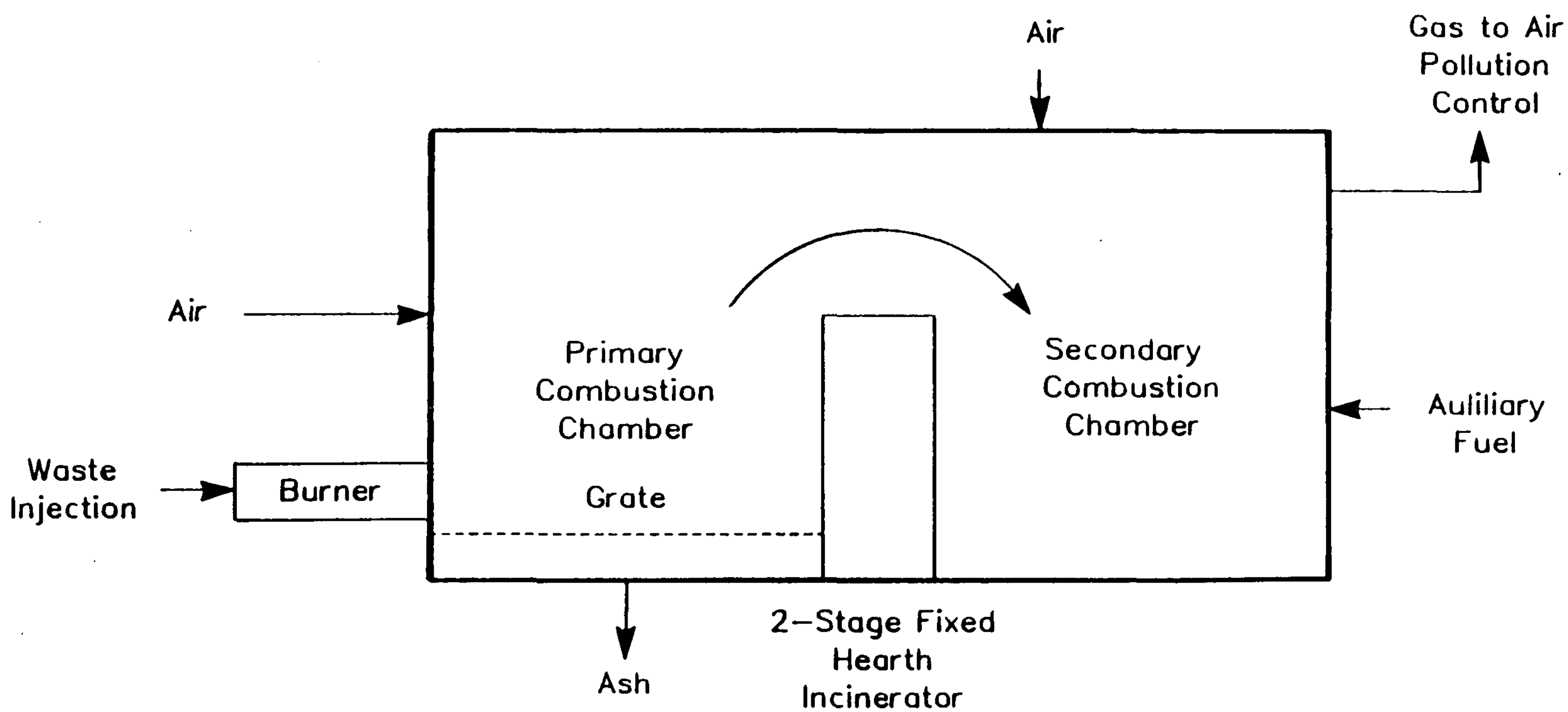

Figure 2–4. Fixed Hearth Incinerator

and burned at less than stoichiometric conditions. The resultant smoke and pyrolysis products, consisting primarily of volatile hydrocarbons and carbon monoxide, along with the additional air is injected to complete the combustion. This two-stage process generally yields low stack particulate and carbon monoxide (CO) emissions. The primary chamber combustion reactions and combustion gas are maintained at low levels by the starved air conditions so that particulate entrainment and carryover are minimized.

Air pollution controls - Following incineration of hazardous wastes, combustion gases are generally further treated in an air pollution control system. The presence of chlorine or other halogens in the waste requires a scrubbing or absorption step to remove HCl and other halo-acids from the combustion gases. Ash in the waste is not destroyed in the combustion process. Depending on its composition, ash will either exit as bottom ash, at the discharge end of a kiln or hearth for example, or as particulate matter (fly ash) suspended in the combustion gas stream. Particulate emissions from most hazardous waste combustion systems generally have particle diameters less than one micron and require high efficiency collection devices to minimize air emissions. Scrubber systems provide an additional buffer against accidental releases of incompletely destroyed waste products due to poor combustion efficiency or combustion upsets, such as flame outs.

2.2.4 Waste characteristics affecting performance (WCAP)

(a) Liquid injection - In determining whether liquid injection is likely to achieve the same level of performance on an untested waste as a previously tested waste, the Agency will compare dissociation bond energies of the constituents in the untested and tested wastes. This parameter is being used as a surrogate indicator of activation energy which, as discussed previously, destabilizes molecular bonds. In theory, the bond dissociation energy would be equal to the activation energy; however, in practice this is not always the case. Other energy effects (e.g., bond vibration, intermediate formation, and bond interaction) may have a significant influence on activation energy.

Because of the shortcomings of bond energies in estimating activation energy, EPA analyzed other waste characteristic parameters to determine whether these parameters would provide a better basis for transferring treatment standards from an untested waste to a tested waste. These parameters include heat of combustion, heat of formation, use of available kinetic data to predict activation energies, and general structural class. All of these were rejected for reasons provided below.

The heat of combustion measures only the difference in energy of the products and reactants, it does not provide information on the transition state (i.e., the energy input needed to initiate the reaction). Heat of formation is used as a tool to predict whether reactions are likely to proceed; however, there are a significant number of hazardous constituents for which these data are not available. Use of kinetic data were rejected because these data are limited and could not be used to calculate free energy values (delta G) for the wide range of hazardous constituents to be addressed by this rule. Finally, EPA decided not to use structural classes because the Agency believes that evaluation of bond dissociation energies allows for a more direct determination of whether a constituent will be destabilized.

(b) Rotary kiln/fluidized bed/fixed hearth - Unlike injection, these incineration technologies also generate a residual ash. Accordingly, in determining whether these technologies are likely to achieve the same level of performance on an untested waste as on a previously tested waste, EPA would need to examine the waste characteristics that affect volatilization of organics from the waste, as well as destruction of the organics, once volatilized. Relative to volatilization, EPA will examine thermal conductivity of the entire waste and boiling point of the various constituents. As with liquid injection, EPA will examine bond energies in determining whether treatment standards for scrubber water residuals can be transferred from a tested waste to an untested waste. Below is a discussion of how EPA arrived at thermal conductivity and boiling point as the best method to assess volatilization of organics from the waste; the discussion relative to bond energies is the same for these technologies as for liquid injection and will not be repeated here.

(i) Thermal conductivity. Consistent with the underlying principles of incineration, a major factor with regard to whether a particular constituent will volatilize is the transfer of heat through the waste. In the case of rotary kiln, fluidized bed, and fixed hearth incineration, heat is transferred through the waste by three mechanisms; radiation, convection, and conduction. For a given incinerator, heat transferred through various wastes by radiation is more a function of the design and type of incinerator than of the waste being treated. Accordingly, the type of waste treated will have a minimal impact on the amount of heat transferred by radiation. With regard to convection, EPA also believes that the type of heat transfer will generally be more a function of the type and design of the incinerator than of the waste itself. However, EPA is examining particle size as a waste characteristic that may significantly impact the amount of heat transferred to a waste by convection and thus impact volatilization of the various organic compounds. The final type of heat transfer, conduction, is the one that EPA believes will have the greatest impact on volatilization of organic constituents. To measure this characteristic, EPA will use thermal conductivity; an explanation of this parameter, as well as how it can be measured, is provided below.

Heat flow by conduction is proportional to the temperature gradient across the material. The proportionality constant is a property of the material and is referred to as the thermal conductivity. (Note: The analytical method that EPA has identified for measurement of thermal conductivity is named "Guarded, Comparative, Longitudinal Heat Flow Technique,"). In theory, thermal conductivity would always provide a good indication of whether a constituent in an untested waste would be treated to the same extent in the primary incinerator chamber as the same constituent in a previously tested waste.

In practice, thermal conductivity has some limitations in assessing the transferability of treatment standards; however, EPA has not identified a parameter that can provide a better indication of heat transfer characteristics of a waste. Below is a discussion of both the limitations associated with thermal conductivity and other parameters considered.

Thermal conductivity measurements, as part of a treatability comparison for two different wastes through a single incinerator, are most meaningful when applied to wastes that are homogeneous (i.e., major constituents are essentially the same). As wastes exhibit greater degrees of nonhomogeneity (e.g., significant concentrations of metals in soil), then thermal conductivity becomes less accurate in predicting treatability because the measurement essentially reflects heat flow through regions having the greatest conductivity (i.e., the path of least resistance) and not heat flow through all parts of the waste.

Btu value, specific heat, and ash content were also considered for predicting heat transfer characteristics. These parameters can no better account for nonhomogeneity than can thermal conductivity; additionally, they are not directly related to heat transfer characteristics. Therefore, these parameters do not provide a better indication of heat transfer that will occur in any specific waste.

(ii) Boiling point. Once heat is transferred to a constituent within a waste, removal of this constituent from the waste will depend on its volatility. EPA is using boiling point as a surrogate for the volatility of a constituent. Compounds with lower boiling points have higher vapor pressures and, therefore, would be more likely to vaporize. The Agency recognizes that this parameter does not take into consideration the impact of other compounds in the waste on the boiling point of a constituent in a mixture; however, the Agency is not aware of a better measure of volatility that can easily be determined.

2.2.5 Incineration design and operating parameters

(a) Liquid injection. For a liquid injection unit, EPA's analysis of whether the unit is well-designed will focus on (1) the likelihood that sufficient energy is provided to the waste to overcome the activation level for breaking molecular bonds and (2) whether sufficient oxygen is present to convert the waste constituents to carbon dioxide and water vapor. The specific design parameters that the Agency will evaluate to assess whether these conditions are met are temperature, excess oxygen, and residence time. Below is a discussion of why EPA believes these parameters to be important, as well as a discussion of how these parameters will be monitored during operation.

(i) Temperature. Temperature is important in that it provides an indirect measure of the energy available (i.e., Btu/hr) to overcome the activation energy of waste constituents. As the design temperature increases, it is more likely that the molecular bonds will be destabilized and the reaction completed.

The temperature is normally controlled automatically through the use of instrumentation which senses the temperature and automatically adjusts the amount of fuel and/or waste being fed. The temperature signal transmitted to the controller can be simultaneously transmitted to a recording device, referred to as a strip chart, and thereby continuously recorded. To fully assess the operation of the unit, it is important to know not only the exact location in the incinerator where the temperature is being monitored but also the location of the design temperature.

(ii) Excess oxygen. It is important that the incinerator contain oxygen in excess of the stoichiometric amount necessary to convert the organic compounds to carbon dioxide and water vapor. If insufficient oxygen is present, then destabilized waste constituents could recombine to the same or other BDAT list organic compounds and potentially cause the scrubber water to contain higher concentrations of BDAT list constituents than would be the case for a well-operated unit.

In practice, the amount of oxygen fed to the incinerator is controlled by continuous sampling and analysis of the stack gas. If the amount of oxygen drops below the design value, then the analyzer transmits a signal to the valve controlling the air supply and thereby increases the flow of oxygen to the afterburner. The analyzer simultaneously transmits a signal to a recording device so that the amount of excess oxygen can be continuously recorded. Again, as with temperature, it is important to know the location from which the combustion gas is being sampled.

(iii) Carbon monoxide. Carbon monoxide is an important operating parameter because it provides an indication of the extent to which the waste organic constituents are being converted to carbon dioxide and water vapor. An increase in the carbon monoxide level indicates that greater amounts of organic waste constituents are unreacted or partially reacted. Increased carbon monoxide levels can result from insufficient excess oxygen, insufficient turbulence in the combustion zone, or insufficient residence time.

(iv) Waste feed rate. The waste feed rate is important to monitor because it is correlated to the residence time. The residence time is associated with a specific Btu energy value of the feed and a specific volume of combustion gas generated. Prior to incineration, the Btu value of the waste is determined through the use of a laboratory device known as a bomb calorimeter. The volume of combustion gas generated from the waste to be incinerated is determined from an analysis referred to as an ultimate analysis. This analysis determines the amount of elemental constituents present, which include carbon, hydrogen, sulfur, oxygen, nitrogen, and halogens. Using this analysis plus the total amount of air added, one can calculate the volume of combustion gas. After both the Btu content and the expected combustion gas volume have been determined, the feed rate can be fixed at the desired residence time. Continuous monitoring of the feed rate will determine whether the unit was operated at a rate corresponding to the designed residence time.

(b) Rotary kiln. For this incineration type, EPA will examine both the primary and secondary chamber when evaluating the design of a particular incinerator. Relative to the primary chamber, EPA's assessment of design will focus on whether sufficient energy is likely to be provided to the waste to volatilize the waste constituents. For the secondary chamber, analogous to the sole liquid injection incineration chamber, EPA will examine the same parameters discussed previously under liquid injection incineration. These parameters will not be discussed again here.

The particular design parameters to be evaluated for the primary chamber are kiln temperature, residence time, and revolutions per minute. Below is a discussion of why EPA believes these parameters to be important, as well as a discussion of how these parameters will be monitored during operation.

(i) Temperature. The primary chamber temperature is important, in that it provides an indirect measure of the energy input (i.e., Btu/hr) that is available for heating the waste. The higher the temperature is designed to be in a given kiln, the more likely it is that the constituents will volatilize. As discussed earlier under "Liquid injection," temperature should be continuously monitored and recorded. Additionally, it is important to know the location of the temperature sensing device in the kiln.

(ii) Residence time. This parameter is important in that it affects whether sufficient heat is transferred to a particular constituent in order for volatilization to occur. As the time that the waste is in the kiln is increased, a greater quantity of heat is transferred to the hazardous waste constituents. The residence time will be a function of the specific configuration of the rotary kiln including the length and diameter of the kiln, the waste feed rate, and the rate of rotation.

(iii) Revolutions per minute (RPM). This parameter provides an indication of the turbulence that occurs in the primary chamber of a rotary kiln. As the turbulence increases, the quantity of heat transferred to the waste would also be expected to increase. However, as the RPM value increases, the residence time decreases, resulting in a reduction of the quantity of heat transferred to the waste, This parameter needs to be carefully evaluated because it provides a balance between turbulence and residence time.

(c) Fluidized bed. As discussed previously, in the section on "Underlying principles of operation," the primary chamber accounts for almost all of the conversion of organic wastes to carbon dioxide, water vapor, and acid gas if halogens are present. The secondary chamber will generally provide additional residence time for thermal oxidation of the waste constituents. Relative to the primary chamber, the parameters that the Agency will examine in assessing the effectiveness of the design are temperature, residence time, and bed pressure differential. The first two were discussed under rotary kiln and will not be discussed here. The last, bed pressure differential, is important in that it provides an indication of the amount of turbulence and therefore, indirectly, the amount of heat supplied to the waste. In general, as the pressure drop increases, both the turbulence and heat supplied increase. The pressure drop through the bed should be continuously monitored and recorded to ensure that the design value is achieved.

(d) Fixed hearth. The design considerations for this incineration unit are similar to those for a rotary kiln except that rate of rotation (i.e., RPMs) is not an applicable design parameter. For the primary chamber of this unit, the parameters that the Agency will examine in assessing how well the unit is designed are the same as those discussed under rotary kiln; for the secondary chamber (i.e., afterburner), the design and operating parameters of concern are the same as those previously discussed under "Liquid injection."

3.0 AMENDMENT TO SECTION 4 ("PERFORMANCE DATA BASE") OF THE FINAL BACKGROUND DOCUMENT FOR ORGANOPHOSPHORUS WASTES (K036)

This section presents the data available on the performance of incineration in treating K037. K037 has been judged to be similar to the waste stream subject to this amendment, K036. The incineration data presented in this section are used later in this document in determining which technologies represent BDAT, in selecting constituents to be regulated, and in developing treatment standards for K036.

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

Where data are not available on treatment performance for the specific wastes of concern, the Agency may elect to transfer performance data from a demonstrated technology that treats a similar waste or wastes. To transfer data from another waste category, EPA must determine that the wastes covered by this (amended) background document are no more difficult to treat (based on the waste characteristics that affect performance of the demonstrated treatment technology) than the treated wastes from which performance data are being transferred.

Treatment standards for K037, based on incineration, were promulgated in the First Third Final Rule (53 FR 31174, August 17, 1988). K036 and K037 both have similar chemical composition and physical characteristics. Both derive from the same manufacturing process operated in the single U.S. facility producing disulfoton and, therefore, have the same primary constituent, disulfoton.

Consequently, treatment performance data for incineration of K037 nonwastewater are being transferred to K036 nonwastewater.

The Agency collected six data sets for untreated and treated K037 to characterize treatment of K037 nonwastewater using an EPA in-house rotary kiln treatment system. Treatment of K037 resulted in the generation of two treatment residuals: ash and scrubber water. Tables 3-1 through 3-6 present the six data sets of total waste concentration analyses for K037 nonwastewater samples, and the design and operating data for the treatment system. All six sets of incineration data indicate that concentrations of disulfoton may be reduced from greater than 10% to below detection levels in the ash and scrubber water treatment residuals. Furthermore, all the data sets also show treatment of the other organic BDAT list constituents detected in the untreated wastes to nondetectible concentrations in the treatment residuals, as shown by the operating data taken during collection of the samples. The Agency has no reason to believe that the treatment system was not well-designed and well-operated.

Table 3-1 Rotary Kiln Incineration
EPA-Collected Data
Sample Set #1

ANALYTICAL DATA:

BDAT Reference No.	BDAT list constituent	Untreated waste (mg/kg)	Treated waste (mg/kg)	Treated waste TCLP (mg/l)	Scrubber water (ug/l)
43	Toluene	640	<10	NA	<10
70	Bis(2-ethylhexyl)phthalate	<250	<2.0	NA	<50
155	Arsenic	3.1	10	<0.01	0.10
156	Barium	26	150	<0.045	0.91
157	Beryllium	<0.5	0.54	<0.005	<0.005
158	Cadmium	3.9	2.1	<0.015	0.059
159	Chromium	70	80	0.079	0.15
160	Copper	24	610	3.3	4.7
161	Lead	28	54	0.029	6.6
163	Nickel	130	110	0.20	0.10
166	Thallium	<2.5	<2.5	<0.015	<0.015
167	Vanadium	8	82	0.93	<0.1
168	Zinc	190	290	0.64	16
195	Disulfoton	171,000	<0.0335	NA	<1.00

DESIGN AND OPERATING DATA:

	Design value	Operating value
Kiln		
Temperature	1832°F	1778-1818°F
Revolutions per minute	0.2 rpm	0.2 rpm
Afterburner		
Temperature	2200°F	2043-2063°F
Excess oxygen	6-8%	8%
Carbon monoxide	<1000 ppm	<1 ppm

NA - Not Applicable.

Reference: USEPA 1987. Onsite Engineering Report for K037 (Reference 5).

Table 3-2 Rotary Kiln Incineration
EPA-Collected Data
Sample Set #2

ANALYTICAL DATA:

BDAT Reference No.	BDAT list constituent	Untreated waste (mg/kg)	Treated waste (mg/kg)	Treated waste TCLP (mg/l)	Scrubber water (ug/l)
43	Toluene	530	<10	NA	<10
70	Bis(2-ethylhexyl)phthalate	<250	<2.0	NA	<50
155	Arsenic	2.4	5.0	<0.01	0.26
156	Barium	39	140	<0.045	0.19
157	Beryllium	<0.5	0.51	<0.005	<0.005
158	Cadmium	3.9	<2.0	<0.015	0.062
159	Chromium	73	93	0.22	0.21
160	Copper	12	940	10	4.7
161	Lead	12	66	0.013	11
163	Nickel	90	110	0.58	<0.1
166	Thallium	<2.5	<2.5	<0.015	<0.015
167	Vanadium	7	80	1.8	<0.1
168	Zinc	89	330	0.45	4.2
195	Disulfoton	104,000	<0.0335	NA	<1.00

DESIGN AND OPERATING DATA:

	Design value	Operating value
Kiln		
Temperature	1832°F	1778-1818°F
Revolutions per minute	0.2 rpm	0.2 rpm
Afterburner		
Temperature	2200°F	2043-2063°F
Excess oxygen	6-8%	8%
Carbon monoxide	<1000 ppm	<1 ppm

NA - Not Applicable.

Reference: USEPA 1987. Onsite Engineering Report for K037 (Reference 5).

Table 3-3 Rotary Kiln Incineration
EPA-Collected Data
Sample Set #3

ANALYTICAL DATA:

BDAT Reference No.	BDAT list constituent	Untreated waste (mg/kg)	Treated waste (mg/kg)	Treated waste TCLP (mg/l)	Scrubber water (ug/l)
43	Toluene	1,300	<10	NA	<10
70	Bis(2-ethylhexyl)phthalate	<250	<2.0	NA	<50
155	Arsenic	<2.0	25	0.022	0.22
156	Barium	18	130	0.049	0.22
157	Beryllium	<0.5	<0.5	<0.005	<0.005
158	Cadmium	3.8	<2.0	<0.015	0.073
159	Chromium	43	100	0.13	0.19
160	Copper	7.0	630	1.1	3.9
161	Lead	5.6	25	<0.01	9.6
163	Nickel	46	180	0.19	<0.1
166	Thallium	<2.5	<2.5	<0.015	<0.015
167	Vanadium	7	61	0.97	<0.1
168	Zinc	110	840	0.75	2.7
195	Disulfoton	246,000	<0.0335	NA	<1.00

DESIGN AND OPERATING DATA:

	Design value	Operating value
Kiln		
Temperature	1832°F	1778-1818°F
Revolutions per minute	0.2 rpm	0.2 rpm
Afterburner		
Temperature	2200p4op1F	2043-2063°F
Excess oxygen	6-8%	8%
Carbon monoxide	<1000 ppm	<1 ppm

NA - Not Applicable.

Reference: USEPA 1987. Onsite Engineering Report for K037 (Reference 5).

Table 3-4 Rotary Kiln Incineration
EPA-Collected Data
Sample Set #4

ANALYTICAL DATA:

BDAT Reference No.	BDAT list constituent	Untreated waste (mg/kg)	Treated waste (mg/kg)	Treated waste TCLP (mg/l)	Scrubber water (ug/l)
43	Toluene	630	<10	NA	<10
70	Bis(2-ethylhexyl)phthalate	<250	<2.0	NA	<50
155	Arsenic	<2.0	15	<0.01	0.23
156	Barium	28	150	0.075	0.18
157	Beryllium	<0.5	<0.5	<0.005	<0.005
158	Cadmium	5.3	<2.0	<0.015	0.063
159	Chromium	85	110	0.074	0.090
160	Copper	21	460	3.0	4.0
161	Lead	22	15	0.017	4.0
163	Nickel	120	160	0.24	<0.1
166	Thallium	<2.5	<2.5	<0.015	<0.015
167	Vanadium	9	78	1.1	<0.1
168	Zinc	180	620	2.7	0.97
195	Disulfoton	186,000	<0.0335	NA	<1.00

DESIGN AND OPERATING DATA:

	Design value	Operating value
Kiln		
Temperature	1832°F	1830-1897°F
Revolutions per minute	0.2 rpm	0.2 rpm
Afterburner		
Temperature	2200°F	2043-2063°F
Excess oxygen	6-8%	8%
Carbon monoxide	<1000 ppm	<1 ppm

NA - Not Applicable.

Reference: USEPA 1987. Onsite Engineering Report for K037 (Reference 5).

Table 3-5 Rotary Kiln Incineration
EPA-Collected Data
Sample Set #5

ANALYTICAL DATA:

BDAT Reference No.	BDAT list constituent	Untreated waste (mg/kg)	Treated waste (mg/kg)	Treated waste TCLP (mg/l)	Scrubber water (ug/l)
43	Toluene	201	<10	NA	<10
70	Bis(2-ethylhexyl)phthalate	<250	<2.0	NA	<50
155	Arsenic	<2.0	5.0	<0.01	0.29
156	Barium	22	140	1.1	0.30
157	Beryllium	<0.5	<0.5	<0.005	<0.005
158	Cadmium	3.3	<2.0	<0.015	0.11
159	Chromium	50	88	0.26	0.13
160	Copper	15	380	4.3	6.2
161	Lead	12	15	0.021	6.8
163	Nickel	61	110	0.41	<0.1
166	Thallium	<2.5	<2.5	<0.015	0.02
167	Vanadium	10	77	1.8	<0.1
168	Zinc	110	450	4.8	1.7
195	Disulfoton	181,000	<0.0335	NA	<1.00

DESIGN AND OPERATING DATA:

	Design value	Operating value
Kiln		
Temperature	1832°F	1830-1897°F
Revolutions per minute	0.2 rpm	0.2 rpm
Afterburner		
Temperature	2200°F	2043-2063°F
Excess oxygen	6-8%	8%
Carbon monoxide	<1000 ppm	<1 ppm

NA - Not Applicable.

Reference: USEPA 1987. Onsite Engineering Report for K037 (Reference 5).

Table 3-6 Rotary Kiln Incineration
EPA-Collected Data
Sample Set #6

ANALYTICAL DATA:

BDAT Reference No.	BDAT list constituent	Untreated waste (mg/kg)	Treated waste (mg/kg)	Treated waste TCLP (mg/l)	Scrubber water (ug/l)
43	Toluene	2000	<10	NA	<10
70	Bis(2-ethylhexyl)phthalate	500	<2.0	NA	<50
155	Arsenic	<2.0	20	<0.01	0.45
156	Barium	33	170	0.1	0.39
157	Beryllium	<0.5	0.71	<0.005	<0.005
158	Cadmium	10	<2.0	<0.015	0.16
159	Chromium	93	87	<0.045	0.17
160	Copper	16	240	0.15	6.3
161	Lead	8.2	20	<0.01	11
163	Nickel	120	110	0.59	0.11
166	Thallium	<2.5	<2.5	<0.015	0.02
167	Vanadium	8	88	0.25	<0.1
168	Zinc	120	330	0.16	2.3
195	Disulfoton	192,000	<0.0335	NA	<1.00

DESIGN AND OPERATING DATA:

	Design value	Operating value
Kiln		
Temperature	1832°F	1830-1897°F
Revolutions per minute	0.2 rpm	0.2 rpm
Afterburner		
Temperature	2200°F	2043-2063°F
Excess oxygen	6-8%	8%
Carbon monoxide	<1000 ppm	<1 ppm

NA - Not Applicable.

Reference: USEPA 1987. Onsite Engineering Report for K037 (Reference 5).

4.0 AMENDMENT TO SECTION 5.1 ("IDENTIFICATION OF BEST DEMONSTRATED AVAILABLE TECHNOLOGY FOR K036 NONWASTEWATER") OF THE FINAL BACKGROUND DOCUMENT FOR ORGANOPHOSPHORUS WASTES (K036)

This section presents the rationale for selecting incineration as the best, demonstrated, and available technology (BDAT) for K036 nonwastewater. For a treatment technology to be identified as BDAT, the treatment performance data are first screened to determine whether they represent a well-designed and well-operated treatment system, whether sufficient analytical quality assurance and quality control measures were employed to ensure the accuracy of the data, and whether the appropriate measures of performance were used to assess the performance of the particular treatment technology. If performance data are to be transferred from one wastestream to another (i.e., from K037 to K036 in this case), the wastestream upon which the performance data was derived is additionally evaluated for similarity to that of the subject wastestream. Preceding sections have already established the similar characteristics of K036 and K037, including a commonality of primary constituents and derivation from a single process.

The treatment performance data and the design and operating data collected during the test of rotary kiln incineration of K037 were reviewed for the points described above. The appropriate measure of performance (total constituent concentration) was used to assess the treatment system. Additionally, the Agency has no reason to believe that this treatment system is not well designed and well-operated, or that insufficient analytical quality assurance and quality control measures were employed in generating treatment performance data. The data collected during the incineration test show a reduction in concentrations of disulfoton, the primary constituent of K037 nonwastewaters, to below detection levels. Thus, incineration is considered demonstrated for K037 nonwastewaters.

An available treatment technology is one that (1) is not a proprietary or patented process that cannot be purchased or licensed from the proprietor (i.e., it must be commercially available), and (2) substantially diminishes the toxicity of the waste or substantially reduces the likelihood of migration of hazardous constituents from the waste. The technology that is demonstrated for treatment of K037, incineration, is considered to be commercially available and to provide substantial treatment of the waste. Therefore, incineration has been judged to be "available."

Incineration performance data for K037 are the only source of information currently available to the Agency for treatment of disulfoton or any other organophosphorus constituent in nonwastewaters. In the absence of performance data for treatment of disulfoton in similar wastes by technologies other than incineration, the Agency considers incineration to be best demonstrated available technology for the similar disulfoton-containing nonwastewater of K036.

5.0 AMENDMENT TO SECTION 7 ("DEVELOPMENT OF BDAT TREATMENT STANDARDS") OF THE FINAL BACKGROUND DOCUMENT FOR ORGANOPHOSPHORUS WASTES (K036)

Concentration-based treatment standards for disulfoton in K036 nonwastewaters were developed based on performance data transferred from incineration treatment of K037. Disulfoton was treated to concentrations below detection levels in K037 as shown in Section 3.0 of this document. The detection limit was 0.0335 mg/kg in K037 incinerator ash. A treatment standard for disulfoton in K036 nonwastewater was calculated by multiplying the accuracy-corrected detection limit by a variability factor, as described below.

First, the detection limit was corrected for accuracy as follows. (1) The lowest matrix spike recovery was determined for the waste constituent. The lowest matrix spike recovery for disulfoton in K037 incinerator ash was 91% (see Table 5-1). (2) An accuracy correction factor of 1.10 was determined for disulfoton by dividing 100 by the lowest matrix spike recovery for that constituent. (3) The disulfoton detection limit was corrected by multiplying the detection limit by the accuracy correction factor, yielding a value of 0.0368 mg/kg.

Second, a variability factor was derived. The variability factor accounts for the variability inherent in treatment system performance, treatment residual collection, and analysis of the samples of treated waste. A variability factor could not be calculated for disulfoton since it was not detected in the incinerator ash residual. Therefore, a variability factor of 2.8 was used to account for this inherent variability, as discussed in the <u>Methodology for Developing Treatment Standards</u> (Reference 3) (see Table 5-2).

To reiterate, when numerical standards are derived for BDAT List constituents that are regulated, they are calculated by multiplying the accuracy-corrected detection limit by the variability factor. Therefore, the accuracy-corrected detection limit (0.0368 mg/kg), multiplied by the variability factor (1.10), which yields the treatment standard of 0.10 mg disulfoton per kilogram of residual ash (0.10 mg/kg). The use of other technologies is not precluded to achieve this concentration-based treatment standard.

Table 5-1 Matrix Spike Recoveries for K037 Treated Solids - EPA-Collected Data

BDAT constituent	Original amount found (ug/l)	Sample Set #5 Spike Added (ug/g)	Sample Set #5 Spike result (ug/l)	Sample Set #5 Percent recovery	Sample Set #5 Duplicate Spike added (ug/l)	Sample Set #5 Duplicate Spike result (ug/l)	Sample Set #5 Duplicate Percent recovery(a)	Accuracy correction factor(b)
Disulfoton	<0.007	0.173	0.157	91	0.173	0.164	95	1.10

NC = Not calculable because the only values available were the spike amount and the percent recovery.
(a)Percent recovery = [(spike result - original amount)/spike added].
(b)Accuracy correction factor = 100/percent recovery (using the lowest percent recovery value).

Reference: USEPA 1987. Onsite Engineering Report for K037.

Table 5-2 Proposed Regulated Constituents and Proposed Calculated Treatment Standards for K037

Matrix	Constituent (units)	Accuracy-corrected concentration Sample set #1	Sample set #2	Sample set #3	Sample set #4	Sample set #5	Sample set #6	Average treated waste concentration	Variability factor (VF)	Treatment standard (average x VF)
Nonwaste-waters	Disulfoton (mg/kg)	0.0368	0.0368	0.0368	0.0368	0.0368	0.0368	0.0368	2.8	0.10

6.0 ACKNOWLEDGEMENTS

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The following personnel from Radian Corporation were involved in preparing this document: Mr. John Williams, Program Manager, Ms. Lori Stoll, Project Director, and the Radian engineering team, Ms. Debra Falatko and Mr. Steven Cragg.

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