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EPA Waste Analysis Guidance for Facilities That Burn Hazardous Wastes

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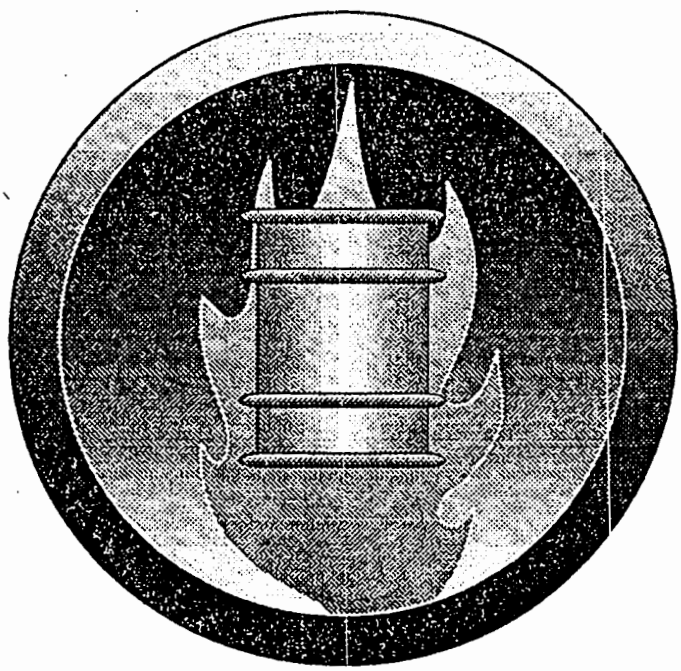

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WASTE ANALYSIS GUIDANCE FOR FACILITIES THAT BURN HAZARDOUS WASTES

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1.0 INTRODUCTION

1.1 BACKGROUND

On January 23, 1981, the United States Environmental Protection Agency (EPA), pursuant to requirements of the Resource Conservation and Recovery Act of 1976 (RCRA), promulgated regulations governing the combustion of hazardous waste (HW) in incinerators (HWI). On February 21, 1991, EPA promulgated regulations governing the burning of hazardous wastes in boilers and industrial furnaces (BIF). The regulations are intended to protect human health and the environment from exposure to emissions from the combustion of hazardous wastes. Regulations governing such activities are codified at 40 Code of Federal Regulations (CFR) Section (§) 264 Subpart O and §265 Subpart O for permitted and interim status HWIs, respectively, and at 40 CFR §266 Subpart H for BIFs.

1.2 PURPOSE

The purpose of this document is to provide guidance to facilities and EPA Regional and state personnel regarding appropriate approaches to sampling and analyzing feed streams to ensure compliance with EPA requirements for waste analysis for hazardous waste combustion devices. This document describes three alternatives for demonstrating compliance. The alternatives provide a uniform approach to documenting compliance with limits on constituent feed rates established during compliance testing or a trial burn. The three alternatives are batch analysis, qualification of a feed stream, and statistical analysis.

The concepts presented in the following sections meet the intent of the regulations and can be implemented in a way that is consistent with daily operations of the facility. Guidance also is provided in this document for analysis of residues generated from the combustion of hazardous wastes. This document does not cover specific methods of sampling and analysis for units regulated under RCRA and does not preclude EPA or state personnel from taking enforcement actions related to waste analysis.

1.3 REGULATORY REQUIREMENTS[1]

To ensure proper combustion of hazardous wastes, the HWI and BIF regulations and individual operating permits establish limits on operating parameters for combustion units. The limits ensure that the maximum levels of emissions of the constituents of concern from the combustion units are low enough to ensure acceptable levels of constituents in ambient air, as specified in EPA regulations or the facility's permit (levels protective of human health and the environment). To demonstrate this, air dispersion modeling and/or emissions testing is used to establish operating limits for the facility that ensure that a facility's emissions do not exceed the regulatory levels. Emissions tests are conducted during the trial burn for HWIs and BIFs attempting to obtain operating permits or during the compliance test for BIFs operating under interim status.

Some examples of operating parameters contained in the BIF regulation and some HWI permits that generally are established through air dispersion modeling and/or emissions testing are:

- Continuous monitoring and recording of the flow rates and composition of hazardous waste, other fuels, and feed stocks for industrial furnaces to yield the feed rates of 10 metals (mercury, lead, cadmium, chromium, barium, beryllium, arsenic, thallium, silver, and antimony), chlorine and chlorides, and ash
- Maximum and minimum temperature limits for the burning zone
- Maximum production rate (for example, steam)
- Continuous emissions monitoring for oxygen, carbon monoxide, and hydrocarbons
- Appropriate operating parameters for air pollution control equipment

Operating permits and regulations require that combustion facilities maintain, monitor, and record established operating parameters while burning HW to document compliance (for example, 40 CFR §266.102(e)(10), §266.103(k), §264/265.73). Of the various operating parameters, feed rate limits for metals, chlorine and chlorides, and ash are key elements for which facilities must maintain records to demonstrate compliance. For example, the BIF

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[1]This guidance document discusses requirements that are generally included in the regulations and/or individual permits for combustion facilities. Because these requirements may vary by type of status of a combustion unit, it is necessary to consult the regulations and/or permit for requirements specific to a particular unit.

regulations specify that the feed rate limits for metals, total chlorine and chloride, and ash are to be "established and monitored by knowing the concentration of the substance in each feed stream and the flow rate of the feed stream" (for example, 40 CFR §266.103(c)(4)(iv)(D)). The flow rate must be monitored under the continuous monitoring requirements specified in a permit or the regulations (for example, 40 CFR §266.103(c)(4)(iv)(D) of the BIF regulations or 40 CFR §264.347 of the incinerator regulations). In other words, the feed rate for each metal, chlorine and chloride, and ash in the total feed streams must be established and monitored continuously (for example, 40 CFR §266.103(c)(3)). The term "total feed streams" includes anything that is fed to the unit (for example, liquid and solid hazardous wastes, raw materials, fuels, nonhazardous wastes, and off-gas streams from production processes, see 56FR7176).

In addition, compliance with all the other limits on operating parameters (for example, operating limits on air pollution control devices and temperature) may not be adequate to establish compliance with emission limits, if the feed streams fed into the combustion unit are not characterized and monitored properly. It is easy to conclude, then, that analysis of constituents of concern in the feed streams is the starting point in demonstrating compliance with many requirements governing combustion of hazardous waste. However, the regulations do not require that specific methods be used in sampling and monitoring the concentrations of each substance. Various interpretations therefore have been put forth of what constitutes compliance with requirements for waste analysis at such facilities.

Since waste analysis is the basis for knowing the concentrations of constituents and demonstrating compliance with requirements governing feed rates, a waste analysis plan describing the specific procedures that will be followed to obtain accurate, representative results is necessary to support the analysis. EPA's waste analysis regulations at 40 CFR §264.13, 265.13 state that before a waste is treated, stored or disposed, the facility must obtain a detailed analysis of the waste, which, at a minimum, "must contain all the information which must be known to treat store or dispose of the waste" in compliance with relevant standards. In addition, the regulations governing permitted incinerators and BIFs, set forth under 40 CFR §264.341 and §266.102, require detailed analysis for concentrations of constituents as necessary to ensure that the waste feed is "within the physical and chemical composition limits specified" in the permit. Because of the uncertainty associated with most production processes, the Agency has found that process knowledge alone does not generally give the type of precise information necessary to establish and monitor feed rate limits. Therefore, any facility choosing to rely on process knowledge alone will be intensely scrutinized and runs the risk that the Agency's

own sampling will demonstrate that the facility's waste analysis method did not produce the information required to demonstrate knowledge of the constituent concentrations in the feed streams. Further, the requirements for waste analysis at 40 CFR §264.13(a)(3) and (b)(4) and at §265.13(a)(3) and (b)(4) state that analysis must be repeated at a frequency sufficient to ensure that it is accurate and up-to-date. The following sections of this document provide facilities guidance on demonstrating compliance with the waste analysis requirements for monitoring feed rates through:

- Development of a waste analysis plan
- Selection of the appropriate frequency for sampling and analysis
- Quality assurance and quality control of data from analysis
- Documentation that demonstrates compliance

Included is a discussion of the requirements for analysis of residues generated from combustion of hazardous wastes. Because some of those residues have the potential to be hazardous to human health and the environment, proper sampling and analysis is also necessary to make this determination.

2.0 WASTE ANALYSIS PLANS

Waste analysis is the backbone of the RCRA program and the hazardous waste combustion regulations discussed above. Therefore, every facility that treats, stores, or disposes of hazardous wastes is required to develop a waste analysis plan (WAP) (40 CFR §264.13 and §265.13). Elements of the WAP that are particularly applicable to combustion facilities are discussed here. General contents and development of a WAP will not be covered; for such general information the reader should refer to the EPA guidance *Waste Analysis At Facilities That Generate, Treat, and Dispose of Hazardous Waste*, (OSWER [Office of Solid Waste and Emergency Response] # 9938.4-03, April 1994). The document is available from the National Technical Information Services (NTIS), publication # PB94-963-603.

In this document, the term *waste analysis plan* refers to a written document, prepared by each regulated facility, that defines the sampling and analysis protocols and frequency through which the facility determines the concentration of regulated constituents in each feed stream at all times. The WAP is not limited to hazardous waste feed streams, but includes all feed streams, such as

nonhazardous wastes, fossil fuels, and raw materials when they (the nonhazardous feed streams) are cofired with hazardous waste. The waste analysis plan should be amended with the appropriate information when new units are added, processes change, new regulations are promulgated, or permit modifications are issued that affect analysis of feed streams before treatment, storage, or disposal of those feed streams.

Some items that may be contained in the WAP are: a description of treatment activities conducted at the facility; identification and classification of HW generated, treated or managed at the facility and of their quantities; and descriptions of HW units and operating procedures (for example, use of safety equipment); and other pertinent information. Some specific items that treatment facilities such as BIFs and HWIs must include in the WAP, per 40 CFR §264.13, §265.13, and §268.7 are discussed below:

2.1 SAMPLING METHODS FOR EACH FEED STREAM

Sampling methods may be included in the WAP either by reference to sampling methods described in 40 CFR §261 Appendix I (for example, specific methods set forth in EPA publication SW-846 or specific American Society for Testing and Materials (ASTM) methods) or by specifying an equivalent standard sampling procedure for the selected analytical method. The WAP must describe measures used to ensure that the analytical sample(s) is representative of the entire feed stream (40 CFR §264.13 and §265.13). Representative samples may be grab samples or composite samples. In general, compositing of samples should be used only to account for spatial variations within a single sample lot (for example, a rail car load of coal or a truck load of limestone). Compositing should not be used to reflect the concentrations of constituents in a group of waste containers that originate at any one of several sources. If a facility's regulatory limits on feed rates are specified on a time-average basis (that is, hourly rolling average), compositing also may be used to account for temporal variations in the sample lot. In such cases, the compositing period should not exceed the regulatory averaging period for that sample lot (that is, compositing of several sample lots being burned at different times is not appropriate). If the facility is subject to an instantaneous constituent feed rate limit, temporal compositing should not be used. Test methods in SW-846 provide more detailed information on sampling methods.

2.2 METHODS OF PREPARATION AND ANALYSIS OF SAMPLES

Methods of preparation and analysis of samples must be specified in the WAP for each regulated constituent in each feed stream (40 CFR §264.13 and §265.13). This requirement can be met either by reference to standard methods of preparation and analysis of

samples (specific methods in EPA publication SW-846 or specific ASTM methods) or by specifying a step-by-step procedure for preparation and analysis of samples. An SW-846 method must be used when required by regulation. If an SW-846 method is not specified in the regulations, it is recommended that SW-846 methods be used whenever the methods are both available and appropriate for the sample matrix; however, other equivalent methods generally may be used. In addition, any laboratory that is to conduct the analysis and meet requirements for quality assurance and quality control (QA/QC) procedures (testing methods, laboratory procedures for handling of the sample, and others) should be specified in the WAP.

2.3 SAMPLING AND ANALYSIS STRATEGY

An acceptable strategy is one that, in combination with the data from continuous monitoring of the feed rate, provides reasonable assurance that all constituent feeds are within allowable limits before they are fed and that the limits on feed rates will not be exceeded at any time while waste is being burned. After-the-fact knowledge of feed rates of constituents is not an acceptable way to determine compliance with the regulations. The strategy should outline the frequency at which the feed streams will be sampled and analyzed. Supporting documentation should be kept on record to justify the selection of the frequency of sampling and analysis.

2.4 SAMPLING LOCATION

The location from which a sample is to be collected is important in determining the appropriate sampling method and assessing the ability to obtain a representative sample. The location also may influence the results of the analysis, thereby affecting the feed rates, as well as the choice of an appropriate frequency of sampling and analysis. Examples of appropriate sampling locations include:

- For an on-site, continuous process that generates one waste stream, a sample may be obtained from the pipeline that feeds hazardous waste to the combustion unit. However, such sampling should be implemented only at facilities at which it is known, through a statistical profile, that none of the concentrations of constituents in the feed streams is above the maximum allowable limits.

- For a batch process, such as a tank filled with hazardous wastes, a representative sample of the entire batch in the tank should be obtained and analyzed before the contents of the tank are fed. Potential for stratification of the wastes should be considered during the sampling procedure. Continuous mixing or

recirculating of the contents of a tank reduces the significance of the degree of heterogeneity of the waste.

- For a lot of containerized wastes from the same waste stream, a representative sample may be obtained by compositing samples from the containers. ASTM Method D140-70 may be used to estimate the number of containers within the lot to be sampled. Each sample should be considered acceptable only if the particular waste sample closely resembles all other samples (for example, in color). The composite or representative sample should be analyzed before the wastes are fed to the combustion unit.

Whatever sampling location is selected, the location should be identified clearly and its selection justified in the WAP.

2.5 QUALITY ASSURANCE AND QUALITY CONTROL

The facility's QA/QC procedures for sampling and analysis should be stated in the WAP. Sources of information on developing a QA/QC procedure include: 1) Chapter One of SW-846, "Quality Control"; 2) *Guidance on Setting Permit Conditions and Reporting Trial Burn Results* (EPA/625/6-89/019); and 3) *Handbook - QA/QC Procedures for Hazardous Waste Incineration* (EPA/625/6-89/023).

All the factors discussed above can influence the quality of the analytical results. Therefore, they should be addressed in a site-specific WAP as part of a facility's demonstration that the waste streams will be sampled and analyzed in a manner that complies with requirements for monitoring of feed rates of constituents. In their WAPs, facilities also should set forth procedures for evaluating analytical data with respect to outliers, completeness, and detection limits, as discussed in greater detail in Section IV of this document.

3.0 SAMPLING AND ANALYSIS STRATEGIES

This section presents options for sampling and analysis programs to ensure compliance with either the permit or the regulatory requirements discussed above.

The BIF rule and some permits for hazardous waste incinerators require combustion facilities to continuously monitor the feed rates of selected metals, chlorine and chlorides, ash, and wastes (40 CFR §266.103 (c)(iv)(D) and §264 and 265.347). As discussed above, to satisfy this requirement, the feed rate of each feed stream must be monitored continuously and the facility operator must "know" the concentration of each regulated constituent in each

feed stream. The requirements for a continuous monitor are provided in 40 CFR 266.103(c)(4)(iv)(B)(i). A logical and coherent sampling and analysis program for regulated constituents, and continuous monitoring of feed rates of feed streams, are fundamental aspects of a compliance strategy that ensures that limits on maximum feed rates of regulated constituents are not exceeded. Knowledge of the concentrations of regulated constituents in each feed stream should be based on an ongoing sampling and analysis program. Fundamentally, the "knowing" of concentrations of regulated constituents allows the calculation of feed rates for those constituents for any point in time at which hazardous waste is being burned. That calculation then can be compared with regulatory limits.

When a sampling and analysis program is established, several factors should be considered, including: variability of the feed stream, sampling location, and proximity of levels of regulated constituents to established limits. The following discussion describes three generally acceptable approaches to sampling and analysis. Other strategies may also be acceptable and will be considered on a case-by-case basis.

3.1 SAMPLING AND ANALYSIS BY BATCH

Sampling and analysis by batch is a strategy most appropriate for facilities that have multiple feed streams in which concentrations of regulated constituents vary greatly and for facilities that receive wastes from off-site. Multiple storage and feed tank systems may be necessary to properly execute this compliance strategy. The batch methodology requires that once a representative sample has been taken from a tank and analyzed, no other material can be added to the tank. Results of laboratory analysis must be known before wastes are burned; therefore, laboratory turnaround time may be a consideration. The measured concentrations of the regulated constituents establish a maximum feed rate that is at or below the regulatory limit. For tanks that do not have agitation systems, stratification of the contents is possible. Therefore, care should be taken to ensure that a representative sample is obtained. The objective of a batch strategy is to enable a facility to calculate a maximum feed stream rate based on measured concentrations of regulated constituents. The facility also can calculate the actual feed rate of regulated constituents at actual feed rates of feed streams and actual concentrations of constituents in any given instance. Batch sampling and analysis is a relatively simple and straightforward methodology for ensuring compliance. Examples that illustrate generally acceptable and unacceptable ways of complying with this strategy are given below:

- A simple example of a case in which sampling and analysis by batch is generally appropriate is a facility that receives hazardous waste from many off-site sources and blends the wastes on site. Such a facility may conduct some preliminary analysis on each waste stream before it is accepted and discharged to the storage tank system. Wastes are accumulated in one of three continuously agitated mixing and storage tanks. When a tank is full, a representative sample of the waste in the tank is obtained and analyzed. After the facility receives the results of the analysis, the waste is fed as a batch to the combustion unit. Once characterized, no other material (for example, hazardous wastes, used oil, or fuels) is added to the tank being fed, and incoming wastes are accumulated in the remaining two tanks. Calculations of feed rates are based on the results of analysis of that batch.

- A facility generates several waste streams from relatively consistent production processes. One or all of the streams may be piped to a storage tank at any given time and in quantities determined by production. A sample to determine the concentrations of metals, ash, and chlorine and chlorides is taken once from the storage tank for preparation of the certification of compliance, and again six months later in preparation for emissions testing to revise the certification of compliance. The two samples show variations in concentrations of constituents; as shown however, concentrations in both samples are below limits on feed rates.

In the second example, the facility performed analytical determinations but did not consider how the results would be used to document compliance. For example, to calculate a feed rate at a given point in time, which of the two results (if either) should be used to determine compliance? How can the facility prove that the two samples include the variations in concentrations of constituents, considering that the various process streams exist in different ratios in the burn tank at any given time? The facility should consider several options that are more reliable compliance protocols. One option may be a batch feed operation, in which the three streams would be collected in the tank and an analytical determination made after preparation of the batch and before feeding. Under this option, a given set of analytical results correlates directly with the period when a particular batch is fed. Drawbacks are associated with the approach: frequent analysis is necessary (every tank) and installation of several new tanks may be appropriate.

3.2 QUALIFICATION OF A FEED STREAM

As long as a facility can ensure that the feed rates for regulated constituents are at or below regulatory limits, it is not necessary to know the exact or actual constituent feed rate. This alternative is a variation of the batch sampling and analysis strategy and may be appropriate for facilities that have complex feed management systems and those that have a continuous demand for steam or production rate requirements (this does not imply a constant feed rate of hazardous waste, since such wastes often are cofired with other fuels). The qualification strategy is similar to a batch strategy in that all feed streams are sampled and analyzed for all constituents identified in the permit or regulations at some point in the feed stream management system before they are fed into the combustion device. After-the-fact knowledge of constituent concentrations or feed rates of constituents is not acceptable. The qualification strategy also can be an appropriate approach for facilities that generate multiple waste streams in various quantities and at various times. This strategy can be implemented in two ways. There are two variables for the calculation of constituent feed rates: The concentration of the regulated constituent in the feed stream and the feed rate of the stream. If one variable is fixed, the other variable can be adjusted to ensure that the regulatory limit is not exceeded. This approach is illustrated below as:

$$FR = (C)\ (Q)$$

where:

FR = The regulatory feed rate limit of a constituent for the feed stream (unit weight/time)

C = The concentration of the constituent in the feed stream

Q = The feed rate of the feed stream

The feed rate limit, FR, has a maximum value that cannot be exceeded. (It should be noted that the sum of all Qs must be at or below the allowable hazardous waste feed rate for the Qs that represent hazardous waste feed streams (40 CFR §266.103(c)(1)(i)). It follows that both C, the concentration of the constituent, and Q, the feed rate of the feed stream, can vary, as long as their product does not exceed FR. Two options using this approach are:

- Qualification based on predetermined feed rate of the total feed system

  This option can be used by a facility that requires a relatively constant feed rate, Q, to meet production needs or demand for steam. The fixed feed rate also fixes the maximum acceptable concentration, C, that can be present without exceeding the maximum regulatory limit FR. In other words, the concentration, C, can vary below its maximum limit. Thus, when using this compliance strategy, a facility would analyze each batch of waste or feed material for regulated constituents before acceptance of the waste into the feed management systems. If each regulated constituent is determined to be at or below its maximum allowable concentration (determined by the fixed feed rate Q so that the product of the concentration, C, and Q does not exceed FR, the regulatory limit), that batch is qualified for combustion. For determination of compliance, the "known" concentration of a regulated constituent is the maximum concentration at which the material may be "qualified." The qualified material then may be blended without restriction with other qualified feed streams without further analysis, since FR is at or below limits for the fixed Q.

- Qualification based on predetermined concentrations

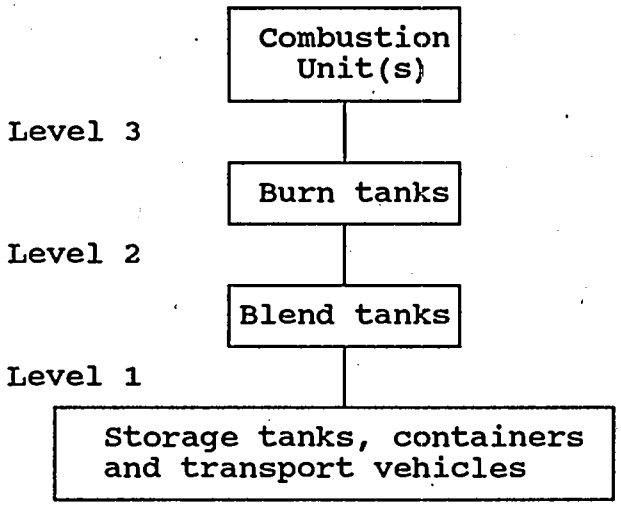
  This approach sets a maximum limit on C (that is, fixes this variable), the concentration of a regulated constituent, and allows Q to vary below a maximum value determined in such a way that the product of C and Q does not exceed FR. To use this compliance strategy, a facility performs the required waste analysis on incoming batches of waste before the batches are mixed. Rather than doing another analysis of the blended wastes, the waste stream is considered to have the concentration of regulated constituents found in the batch having the highest concentrations. The facility then calculates a maximum feed rate, Q. Compliance with the regulatory limits on feed rates will be ensured as long as Q remains at or below its maximum value.

Implementation of the qualification strategy can vary widely depending on the complexity of a facility's feed stream and waste management system (for example, presence of an interconnection and isolation system for storage tanks). It is also possible for a facility to reestablish a predetermined maximum concentration, C, that could be lower than a previously established level and thus allow an increased feed rate, Q. In any event, as is true of the

original limits, a change in limits on concentrations should be well documented, justified, and specifically associated with a particular time period during which the waste is burned.

Application of the compliance strategy based on use of predetermined concentrations is illustrated by the following example:

- A facility that receives liquid hazardous wastes from off-site has a series of storage, blend, and burn tanks, as shown below:



All incoming shipments are received, sampled, and analyzed at Level 1 and determined to be below the maximum concentration limits, C, which are based on a fixed feed stream feed rate limit, Q. Thus, constituents past level 1 in the system will have concentrations less than the limits, because the operator does not allow transfers into the system of waste having concentrations above the maximum concentration limits. This sampling and analysis strategy also can be applied effectively at Level 2. When monitoring concentrations at Level 2, for example, it is not necessary that the actual concentrations of the individual loads delivered to the Level 1 tanks be below the maximum limits, C, since all concentrations that pass through levels 2 and 3 to be fed to the combustion unit must be at or below maximum concentrations C. However, the facility may not be able to apply this strategy at Level 3 since after-the-fact knowledge of constituent concentrations or feed rates of constituents is not acceptable. Weighted averages should not be used to determine levels of concentrations. Compositing of samples from different levels and tanks is not acceptable. If a concentration, C, anywhere in the system before the level being monitored exceeds a predetermined maximum concentration limit, the

contents of the tank can be reblended with other fuels until the concentrations are lowered (and resampled and analyzed before transfer to the next level), or a new maximum C can be established and applied in future calculations of feed rates. Under certain circumstances, blending of wastes (for the batch or qualification strategies) may require a permit.

3.3 STATISTICAL ANALYSIS

A statistical approach can characterize concentrations of constituents in fossil fuels, raw materials, or wastes generated on-site. It is appropriate for "consistent" feed streams (for example, hazardous waste generated by a specific on-site production process, coal produced from a specific mine or seam, or limestone ore produced from a specific quarry), for which there is reasonable expectation that each constituent will be normally distributed about a mean. It should not be used at facilities that receive wastes from off site. The approach demands that the operator of the facility have sufficient knowledge of the source of the feed material to be aware of any change that is likely to affect the sample distribution. When such a change is known to have occurred, the facility operator should not rely on this approach until a statistical profile of the "new" feed stream has been developed. Through statistical analysis, the owner or operator ultimately will develop a program that specifies a frequency at which sampling and analysis are to be conducted to ensure, with an appropriate degree of confidence, that feed rates are not exceeded. It also should be understood that, with the use of a statistical approach, there is a finite probability that a facility can be found to be out of compliance based on sampling and analysis. If such a circumstance occurs, use of a statistical sampling and analysis strategy is not a shield against enforcement action and the adequacy of the analysis may be considered in penalty calculations.

Because this approach should be used to characterize waste streams only as-generated. It should not be used after the waste has been blended with any other waste, fuel, or raw material. It is therefore generally not appropriate in any case in which the hazardous waste is generated at a facility that is not under the same ownership and control as the facility that burns the waste. (This approach may be appropriate however, in cases in which raw materials and fossil fuels are produced by entities other than the facility that burns the waste, provided that there is a contractual requirement that the burner be notified of changes that could have significant effect on concentrations of constituents in those feeds.)

When using any statistical approach, facilities should be guided by the following principles:

- The statistical analysis should be based on actual analytical results. As discussed above, Process knowledge alone is not generally sufficient.

- The operator of the facility should demonstrate at least a 95 percent probability and confidence that the maximum concentration of any sample will not exceed an allowable limit.

- A continuing sampling and analysis program should be established to demonstrate that the statistical distribution does not change over time.

Of the several approaches to conducting a statistical analysis, the use of an upper tolerance limit is discussed here. This is the same method described in 40 CFR §266 Appendix IX Section 7.2 of the BIF regulations for Statistical Methodology for Bevill Residue Determinations. There also is a useful discussion of the application and calculation of upper tolerance limits in *Statistical Intervals: A Guide for Practitioners*, by Gerald J. Hahn and William Q. Meeker (ISBN 0-471-88769-2). For reasons discussed below, this approach is a recommended approach to waste analysis at combustion facilities.

A general overview of statistical analysis is an appropriate starting point in understanding the approaches to be discussed. The underlying concept of statistical analysis is the development of a mathematical model for the expectation (or prediction) of a random variable within a given population. Such a model, commonly known as a probability distribution model, gives the probability that a random variable, x, lies between two values. Development of the model is simple and is illustrated below:

For a sample of random values for a given data set, one could find the average value for the sample, which is called the arithmetic mean, X. This is expressed as:

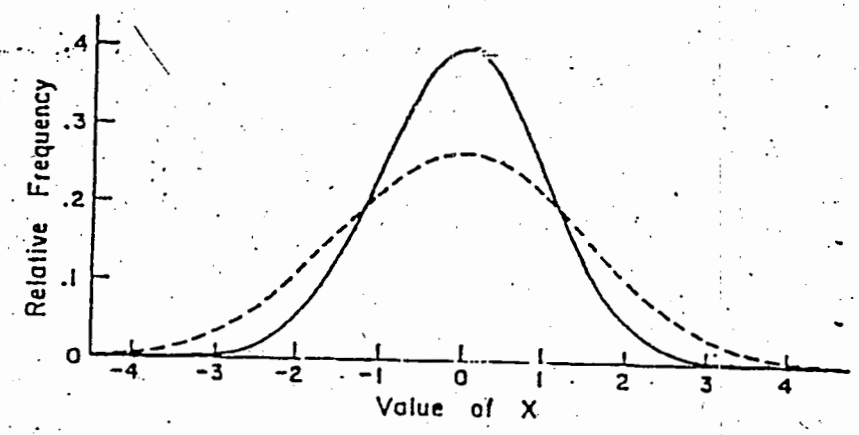
$$\overline{X} = \frac{X_1 + X_2 + \ldots + X_n}{n}$$

where:

X = Numerical value of sample point n

n = Number of samples
$\overline{X}$ = Mean of X

Next, the distribution of the sample values about the mean is desired. The most common distribution is called a "normal" or "Gaussian" distribution. Graphically, this distribution is represented by a bell-shaped curve, as shown below:



Solid curve: Normal distribution, with mean of 0 and standard deviation of 1.

Dotted curve: Normal distribution, with mean of 0 and standard deviation of 1.5.

As this curve shows, lower and upper values of the data set can be calculated with known probabilities. The shape of the curve depends upon the scatter or dispersion of the values about the mean and is often referred to as a "two-sided" distribution. Evaluating the dispersion or scatter about the mean can be done by calculating the standard deviation. The standard deviation, s, can be calculated as follows:

$$s = \sqrt{\frac{(x_i-\bar{x})^2+(x_2-\bar{x})^2+\ldots+(x_n-\bar{x})^2}{n-1}}$$

The objective is to describe a population represented by the samples, for which any given sample can be found to be between a set of upper and lower limits. From the samples, a confidence interval for the unknown population mean can be constructed. This interval consists of two values, the upper and lower limit. Given certain assumptions about the population, the chance that these values straddle the unknown mean is a certain percentage.

3.3.1 Upper Tolerance Limits

One approach that satisfies the criteria set forth above is based on upper tolerance limits. This approach is outlined in the paragraphs below. For a more detailed description, see Meeker and Hahn (1991).

If a variable is normally distributed and the sample mean, standard deviation, and number of samples are known, it is possible to estimate the probability that a fixed percentage of the sample population will not exceed a certain value. That value is known as an upper tolerance limit (UTL). For purposes of this guidance, the minimum UTL that should be used in lieu of continuous analysis of waste is the value of the one-sided upper 95 percent tolerance bound that exceeds at least 95 percent of the sample population. In other words, we can say with 95 percent confidence that 95 percent of all individual samples will not exceed the UTL. Therefore, if a facility generates a good initial database to establish the UTL for the constituents of concern, and subsequent sampling and analysis shows that the concentrations are below the UTL, the waste can be considered the type of waste for which the UTL was calculated. The UTL values then may be considered the "known" concentration for each constituent in that feed stream.

Although concentrations of constituents in any single sample are likely to be well below the UTL, feed rates always should be calculated as if each constituent were present at its UTL. The UTL is adjusted continually to reflect new information from analysis. The UTL for each constituent is calculated as follows:

Step 1: Using all valid analyses of the subject feed stream, calculate the mean concentration ($\bar{X}$) and the standard deviation (s) for the samples.

Step 2: Using the equation below, calculate the upper tolerance limit, $UTL_{(0.95;0.95)}$, so that there is at least 95 percent confidence that at least 95 percent of all samples will not exceed the UTL. Values for K are obtained from a table for calculating one-sided tolerance bounds for a normal distribution (see Appendix A).

$$UTL_{(1-\alpha;p)} = \bar{X} + (K_{(1-\alpha;p)})\ (s)$$

where:

$1-\alpha$ = The desired level of confidence that at least $100(p)$ percent of the individual samples will be below the UTL.

p = The decimal fraction of samples that will be predicted to fall below the UTL.

n = The number of samples.

Table 1 in Appendix A lists values of K for $1-\alpha=0.95$, with $p=0.95$. Statistical references may be consulted for other values of $1-\alpha$. Linear interpolation may be applied to obtain values of n that are not tabulated.

This guidance recommends that, if a UTL is to be used to demonstrate compliance, $1-\alpha$ must be ≥ 0.95 and p must be ≥ 0.95. A more conservative (that is, higher) UTL may be used to decrease the necessary frequency of sampling and analysis, as described in the following step.

Step 3. Determine the appropriate frequency of sampling and analysis according to the following equation.

$$\frac{\text{number of samples}}{\text{year}} = (\alpha_{calc})\ (Y)$$

where:

α_{calc} = One minus the level of confidence used to calculate the UTL; at a 95 percent confidence level, $\alpha_{calc} = (1-0.95) = 0.05$

Y = days per year on which waste is generated

For facilities that meet the minimum requirements of this methodology (estimating concentrations based on $\alpha_{calc} = 0.95$), the feed stream should be sampled and analyzed on at least 5 percent of the days on which it is generated. If the facility chooses to use a more conservative UTL, where $\alpha_{calc} > 0.95$, the burden of sampling and analysis will be reduced.

In qualitative terms, as the statistical confidence that an allowable feed limit on constituents will not be exceeded increases, the frequency with which sampling and analysis are necessary decreases. However, at a minimum, each feed stream should be analyzed at least once per year. Also, sampling dates should be spaced evenly throughout the year.

Most statistical tests assume that the data come from a normal distribution. The normal distribution is the assumed underlying model for such procedures as calculation of tolerance intervals. If the data are not distributed normally, false conclusions can result if the data follow a more skewed distribution like lognormal. Therefore, checking the data for normality is an important step in statistical calculations. EPA has available a useful discussion of evaluating data for normality in a document titled *Statistical Analysis of Ground-water Monitoring Data at RCRA Facilities, Addendum To Interim Final Guidance - Draft* (EPA/500/R-93/003, July 1992). The document is available for sale through the RCRA docket at (202) 260-9327. Copies cost $0.15 per page.

3.3.2 Statistical Approach: Compliance Issues

No statistical approach can guarantee true continuous compliance with short-term constituent feed rate limits. There is always a finite possibility that concentrations of constituents in any given sample will exceed the UTL. This fact is accepted in statistical characterization. If the sampling and analysis indicates that the UTL has been exceeded, then the following is recommended:

- continue to calculate constituent feed rates using the UTL
- immediately following receipt of an analysis that exceeds the UTL for any constituent, the facility should begin daily sampling and analysis of that feed stream. Daily analyses should continue until all regulated constituents are below their UTL for three consecutive days.
- if the feed stream exceeds the UTL for the same constituent 2 or more times while conducting the daily sampling, the facility should immediately cease using the statistical approach for that feed stream until a new feed profile is developed (using data obtained after the initial UTL exceedance).

It should be noted that, at facilities that have more than one waste stream, the maximum concentration of different regulated constituents can occur in different waste streams; thus, UTLs should be calculated for the different waste streams; and the UTLs are then composited for all waste streams.

The following example illustrates the calculations for the UTL and for determining sampling frequency.

- A facility generates one waste stream on site from a relatively constant production process. The stream has been analyzed several times for metals, ash, and chlorine and chlorides. The analyses revealed some variations in concentrations of constituents. The level of chromium (Cr) is near the allowable feed rate limit, but the levels of all other constituents are well below the limits. The facility would like to use the results in its WAP to demonstrate that the values are below the concentrations of constituents used in calculating feed rate calculations. The facility also would like to specify more frequent analysis for chromium than for the other constituents.

  Because not all the constituents are well below the allowable limits, it is appropriate in a case such as this to specify different frequencies of analysis for different constituents. The UTL of the tolerance interval can be compared with the feed rate limit for each constituent. The WAP should specify that the upper limit of the tolerance interval is to be used in determining compliance, and, with future analyses at some reduced frequency, to verify that concentrations remain below the UTL.

Data from analysis for chromium used for statistical calculations and calculations of feed rate are:

- Ten samples were analyzed; n = 10.
- The mean of the data (average) is calculated; x = 2.39 mg/L.
- The standard deviation is calculated; s = 1.53.
- The facility established a maximum acceptable concentration of Cr of 8.47 mg/L for calculations of feed rate.

Using the procedures described earlier, UTL is calculated as follows:

$$UTL = \overline{X} + Ks$$

where:

$\overline{X}$ = Mean of the samples (Cr concentration - mg/L)

s = Standard deviation of samples

k = 2.911 for n = 10 (sample size)

$$UTL = 2.39 + (2.911)(1.53)$$

$$UTL = 6.84 \text{ mg/L}$$

The UTL of 6.84 mg/L then is compared with the maximum acceptable concentration of Cr of 8.47 mg/L. For a fixed feed stream feed rate at or near its maximum, use of the UTL provides a safety margin that ensures that the regulatory limit for Cr is not exceeded.

The facility also should determine the frequency of sampling and analysis for Cr as part of its sampling and analysis program. That program should be described in detail in the waste analysis plan. Assuming that the facility generates waste for 365 days per year, the frequency should be determined as follows:

$$\text{Number of samples/year} = [(\alpha_{calc})] \ (Y)$$

where:

$[(\alpha_{calc})] = 1 - 0.95 = 0.05$

$Y = 365$

$\text{Number of samples/year} = (0.05)(365) = 18.25$

Thus, the facility should sample the feed stream a minimum of 19 times per year (rounding up provides an extra degree of certainty). The minimum frequency of sampling should be once per year.

Site-specific factors can influence the choice of a statistical approach to compliance and its associated sampling and analysis strategies. Even if a facility follows the procedures outlined in its WAP, problems related to the results of analysis may arise. The issues that arise most often are incomplete data, outliers, and detection limits. These issues are discussed further in a later section of this document.

Summary:

Below are listed factors to be considered when selecting a sampling and analysis strategy for each methodology: sampling and analysis by batch, qualification of the feed stream, or the statistical approach. Such factors include, but are not limited to:

- Sampling and Analysis by batch
  - Appropriate for feed streams generated both on and off-site
  - Appropriate for multiple waste streams produced from on-site processes
  - Simplicity
  - Ease of documentation of compliance
  - Waste management system (burn tanks, blend tanks, and sample location)
  - Economic factors related to laboratory analysis
- Qualification of the Feed Stream
  - Appropriate for multiple feed streams generated on site
  - Flexibility with regard to feed rates or constituent concentrations
  - Possible complexity of documentation of compliance
  - More complex methodology to establish and execute than a batch system
  - More appropriate for situations in which a constant production rate to generate steam is necessary
- Statistical Approach
  - Appropriate for "as-generated" waste streams originating on-site
  - Fossil fuels
  - Raw materials
  - Requirements for maintenance of the database
  - Possible requirements for periodic reestablishment of statistical baselines for feed streams

- Measurable and finite probability that a facility might be out of compliance
- Minimum frequency of sampling of once per year

4.0 INCOMPLETE DATA, OUTLIERS, AND DETECTION LIMITS

Because it is important to have complete and accurate data on waste analysis, it is appropriate to discuss the issue in further detail. The facility's QA/QC procedures should be set forth in the WAP. The QA/QC procedure should outline a protocol for dealing with incomplete data, outlying data points, and detection limits. Such information may be requested during an inspection and will play an important role in determining compliance. Therefore, a facility should maintain it.

4.1 OUTLYING DATA POINTS

In waste analysis data, an outlying data point is one that does not appear to be within a reasonable or expected numerical range. Such an assumption most likely will be based on historical data with which a comparison can be made. When it is suspected that an outlier has occurred, the facility should determine why it has occurred. The quality assurance procedures submitted for the analytical test of the sample should include detailed and objective rejection criteria for all outlying data points. Those criteria could include procedures for documenting outliers and determining why outliers occur and what corrective action should be taken to prevent such events from occurring in the future. Several references are available for evaluating outliers. For example, a facility may evaluate the validity of its data using ASTM Method E 178-80, "Standard Practice for Dealing With Outlying Observations." In applying that and other methods, the underlying assumptions of the methodology should be kept in mind (for example, ASTM Method E 178-80 states that "the criteria for outliers are based on an assumed underlying normal (Gaussian) population or distribution"). Data that are suspected of being outliers, but in fact are the result of the character of the feed stream, or data that cannot be explained otherwise as an error in sampling or analysis, are not outliers and should be included in the data set. Outliers caused by an error in sampling should be corrected through immediate resampling and reanalysis of the feed stream. Outliers caused by errors in analysis often are corrected through reanalysis of the sample. If the holding time of a sample has expired, the facility should resample and perform the analysis again. However, it is recommended that the facility take two or three samples at the same time; if one sample exhibits an outlier, the remaining samples can be analyzed. If the facility is using statistical analysis and has an outlying data point above the calculated UTL, it is suggested the facility use the value of that data point in the calculations of feed rate until resampling or reanalysis shows different results. All procedures for identifying and discounting outliers should be documented in advance in the WAP.

4.2 INCOMPLETE ANALYTICAL DATA

Data from waste analysis are considered incomplete when results for one or more regulated constituents are missing from the analytical report. Incomplete analytical data is generally unacceptable in demonstrating compliance. A facility using sampling and analysis by batch or qualification of the feed stream should reanalyze. However, analyses conducted pursuant to a WAP that specifies different frequencies of analysis for different constituents would not be considered incomplete. Otherwise, for the statistical program, the facility should use the reported data and reanalyze to get results for all constituents. As discussed earlier, all quality assurance should be conducted, documentation gathered, and corrective measures taken to prevent recurrence of this problem in the future.

4.3 DETECTION LIMITS

The BIF regulations and some HWI permits specify the use of testing methods set forth in SW-846 for some constituents (for example, 40 CFR §266.106(a) for metals). Limitations associated with these methods, such as the detection limits, can present problems in the effort to use statistical analyses to determine sampling frequencies for some facilities that generate wastes on-site. When using these methods, such facilities may find that results of analysis are at or near the detection limit(s) for the constituent(s). Consequently, it may be difficult to develop a statistical distribution for the constituent because most of the distribution is below the detection limit. Therefore, the facility may not be able to use a statistical approach to determining an appropriate frequency of sampling and analysis. In such situations, it may be appropriate to specify that the facility sample and analyze more frequently (for example, every batch). Possible solutions to this problem include:

- The facility can use, when appropriate, the SW-846 Method 6020 (see 58FR46052) for analysis. (This method was promulgated in January 13, 1995 in the second update of the third edition, second update of SW-846.) This inductively coupled plasma-mass spectrometry (ICP-MS) method is a multielement, simultaneous method for the analysis of inorganic analytes. It is capable of testing for metals at much lower levels than other SW-846 test methods [parts-per-billion (ppb) instead of parts-per-million (ppm)]. Use of the method where allowed by the regulations or permit conditions may provide better analytical data upon which to base development of a statistical distribution, because the results of analysis would be less likely to fall below the lower detection limits.

- The facility can, when appropriate, develop a mathematical model to estimate the statistical distribution of constituents below the detection limit. For example, EPA has recommended, in the guidance document on groundwater monitoring referred to above, the simple substitution method, under which nondetected results are replaced by one-half the detection limit. A mean and variance then can be

calculated by assuming all measurements were observable with the same precision. Another model that may be used, when appropriate, is the maximum likelihood estimator (MLE). Cohen (1959, 1961) developed the MLE for calculating the mean and variance of a distribution based on the mean and variance of the detected values, the difference between the mean of the detected values and the censoring point, and a factor that depends on the proportion of the data that are nondetected results. This approach has been found to work best for small, normally distributed results. A discussion this Cohen's method can be found in *Statistical Methods for Environmental Pollution Monitoring, R.O. Gilbert, Van Nostrand, 1987*. Also, detailed discussions of other approaches to handling nondetects can be found in *Statistical Analysis Of Groundwater Monitoring Data At RCRA Facilities, Addendum To Interim Final Guidance* (OSWER # EPA/500/R-93/003, July 1992).

- Facilities that are having difficulty implementing one of the approaches described above should establish a frequency of sampling and analysis for all constituents of at least once per year.

5.0 MANAGEMENT OF RESIDUES

Management of residues generated during combustion is an important element in the operations of facilities that burn nonexempt hazardous wastes. Because such residues may be considered hazardous, the relevant concepts are similar to those discussed in the previous sections of this guidance. For this document, the term "residue" includes bottom ash generated in the combustion unit and/or fly ash that is collected in an air pollution control device. As is the case in the generation of any solid waste, a determination must be made whether the residues are hazardous wastes. There are three regulatory requirements governing residues generated from the combustion of hazardous wastes:

- Listed Hazardous Wastes: All residues derived from the combustion of a listed hazardous wastes remain listed wastes (40 CFR §261.3(c)(2)) [until delisted] and are subject to the land disposal restrictions (LDR) requirements codified in 40 CFR §268 in disposing of such residues.

- Characteristic Wastes: Residues derived from the combustion of characteristic wastes remain hazardous unless they no longer exhibit any characteristic of a hazardous waste. The facility should sample and analyze the residue to determine whether it exhibits any of the characteristics. Further, if the waste was one classified in EPA waste code D002 or D012 through D043 at the point of generation, the residue must be analyzed for "underlying hazardous constituents," as defined at 40 CFR §268.2, that can be reasonably expected to have been present in the waste at the point of generation (40 CFR §268.7(a)). When managing such residues,

facilities also must comply with LDR requirements set forth at 40 CFR §268.9, "Special Rules Regarding Wastes That Exhibit a Characteristic."

- Bevill Exemption: Section 3001(b)(3)(A) of RCRA exempts certain types of residual materials (generally "high-volume, low-hazard" materials) from regulation under RCRA Subtitle C; this is commonly referred to as the Bevill exemption. Examples of Bevill exempt material include residues generated primarily from the combustion of coal or other fossil fuels and cement kiln dust. The BIF regulations define which BIF residues are subject to this exclusion from the definition of hazardous waste (40 CFR §266.112).

5.1 DETERMINATION OF THE BEVILL EXEMPTION

The promulgation of the BIF regulations specifically addressed the issue of continued applicability of the Bevill exemption when devices burn hazardous wastes (40 CFR §266.112). This regulation specifically states that "a residue derived from the burning or processing of hazardous waste in a boiler or industrial furnace is not excluded from the definition of a hazardous waste under §261.4(b)(4),(7), or (8) unless the device and the owner or operator meet the requirement (described below)." The first requirement states that the device must be a boiler that burns at least 50 percent coal or an ore or mineral furnace or cement kiln that processes at least 50 percent by weight normal, nonhazardous materials. The second requirement mandates testing to determine whether the residues have been affected significantly by the hazardous waste, thus causing them to no longer be the "high-volume, low-hazard" material that the Bevill exemption was intended to cover. That determination is achieved through either of two tests that show:

- Test One: The waste-derived residue does not contain toxic constituents at concentrations significantly higher than is exhibited by the residue generated when hazardous wastes are not burned.

- Test Two: The concentration of toxic constituents does not exceed health-based limits identified in the regulation.

The regulation at 40 CFR §266.112 requires that the waste-derived residue be sampled and analyzed "as often as necessary to determine whether the residue generated during each 24-hour period" meets requirements to qualify under the Bevill exclusion. However, no specified frequency is identified for making such a determination. Therefore, the discussions that follow will focus primarily on the issue of frequency of sampling and analysis as it affects facilities that attempt to claim the Bevill exemption.

5.2 FREQUENCY OF SAMPLING AND ANALYSIS

The first step a facility may take in determining the frequency of sampling and analysis is to develop a WAP that addresses the frequency of sampling and analysis of the residues and management practices for disposal of the residues or to include those subjects in its overall WAP for the facility. Two options a facility may consider when selecting a frequency, which are similar to the options described earlier, are sampling and analysis by batch and sampling at a reduced frequency, with statistical analysis. Both approaches may be appropriate for residues generated from the combustion of characteristic wastes.

- Sampling and analysis by batch: Since the regulation governing the Bevill exemption requires that sampling and analysis be representative of residues generated during a 24-hour period, daily sampling and analysis is acceptable for a batch frequency. The results of such analysis then should be compared with the limits established through either of the two tests described earlier.

- Statistical Analysis: If a facility chooses to sample and analyze less frequently than daily, the facility should be prepared to provide a technical justification of the appropriateness of the lesser frequency and an explanation of how the results of analysis represent the 24-hour periods during which residues were not sampled to determine eligibility for the Bevill exemption. Using the methods of statistical analysis described earlier, a facility might be able to establish that a less frequent sampling is adequate. The facility should consider that, when sampling at a reduced frequency based on statistical analysis, there is some chance that the facility will be out of compliance.

5.3 CONSIDERATIONS

When determining the frequency of sampling and analysis, several site-specific factors should be considered. Some of those factors are discussed below.

- Sampling: To obtain a representative sample for a 24-hour period, 40 CFR §266.112(b)(1)(ii) and (2)(iii) state that one or more samples may be taken, provided that the sampling does not exceed the 24-hour period. If more than one sample is taken, the samples may be composited or analyzed separately. The regulations do not specify the number of samples that may be taken within the 24-hour period. However, the facility should specify in the WAP a frequency that will account for any spatial or temporal variations in the residues. The location from which the sample is taken is another factor that should be considered in obtaining a representative sample. According to requirements set forth at 40 CFR §266.112, the residues must not contain toxic compounds at levels above the limits established in either of the tests

discussed earlier that could reasonably be attributed to the hazardous waste. Therefore, samples should be collected in a manner that minimizes any environmental contamination that is not attributable to the burning or processing of hazardous waste. Samples should be taken from a location as close to the residue outlet(s) as practicable; that location should be identified in the WAP. Any sampling conducted at a location other than that specified in the WAP may not be considered valid.

- Management of Residues: Because of the potentially large volumes of residues generated in any 24-hour period, it is possible that a facility may have disposed of the residue after a sample of the residue had been taken but before the results of analysis had been received. The problem arises when results show that the residue is a hazardous waste and the residue is disposed of in a non-hazardous disposal area or unit. A similar problem becomes especially significant for facilities conducting sampling at reduced frequencies. As the preamble to the BIF regulations set forth in the August 27, 1991 BIF Federal Register states that "if the waste-derived residue is sampled and analyzed less often than on a daily basis, and subsequent analysis determines that the residue fails the test and is fully regulated hazardous waste, the Agency considers all residue generated since the previous successful analysis to be fully regulated hazardous waste absent documentation otherwise." In addition, residue generated after the failed test may also be considered a hazardous waste until the next passing test. Therefore, in all of these scenarios, the facility risks not only the residue becoming subject to the RCRA regulations, but also the disposal area or unit becoming subject to RCRA Subtitle C requirements. Resampling of the residue in the disposal area would not generally be acceptable, because the area would not normally be the appropriate sampling location and the residue found there may not be representative of the residue generated over a 24-hour period. To minimize the extent to which disposal areas are subject to RCRA regulations, a facility may want to implement certain disposal management practices. For example, management practices controlling disposal of residues into a quarry on-site may include:

  - Transfer by a dedicated truck for disposal
  - Disposal in specific segregated locations in the quarry
  - Documentation of disposal practices and locations

- Other Factors: Other factors to consider when selecting a frequency of sampling and analysis include:

  - Feed rate of wastes
  - Levels of volatility of metals in the waste
  - Physical form of the waste (for example, solid rather than liquid)
  - Waste feed system

- Levels and types of organic constituents in the waste (for example, difficulty of destruction or formation of by-products)
- Levels and types of metals regulated under RCRA, other than those regulated by the BIF regulations (for example, selenium)
- Changes in feed streams
- Changes in operating conditions or equipment
- Operating conditions when sampling compared with those when not sampling
- Trends in partitioning of metals in fly as compared with bottom ash

6.0 DOCUMENTATION TO DEMONSTRATE COMPLIANCE

Documentation of compliance consists of detailed and complete records of a facility's activities that are regulated by either permit conditions or regulatory requirements (e.g., 40 CFR 266.103(j)). Some conditions governed by permits can be measured and recorded directly, while others may require indirect measurement or calculation. For example, real time and continuous monitoring systems for such stack gases as CO, O_2, and SO_2 are in widespread use. However, no monitors are available for effective real-time measurement of metals or total chlorine in the stack gases. Therefore, compliance with those limits on emission rates are demonstrated indirectly by calculation of the feed rates of the constituents of interest.

Essentially, compliance with a permit or the regulations is demonstrated by showing that a facility burned wastes only under certain specified conditions. Those conditions usually are stated as maximum conditions, minimum conditions, or conditions over a specified range. Documentation and recording of those conditions provide the basis for determinations of compliance, not only by personnel of EPA or state agencies but also by the facility itself. The operators of a facility should have a detailed understanding of permit or conditions governed by permit or regulation that determine compliance or noncompliance. Since no two facilities are identical in permitted or regulatory operating conditions, no all-encompassing check list is feasible. However, the items listed below form a basis for a logical and coherent approach that will enable a facility to document combustion conditions and other parameters required by permit or regulation. The list is not all inclusive, and each facility should tailor it to that facility's own needs.

Facility operators should consider the following:

- Specific responsibility for compliance should be assigned. While owners and operators ultimately are responsible for compliance, they may not be involved in this issue daily. Therefore, a designated individual, with the necessary number of backups, should

be responsible for ensuring that activities necessary for compliance are carried out and documented. (This step is the basis of all subsequent actions).

- A written compliance methodology is recommended. It should identify the responsibilities of individuals associated with the combustion of hazardous waste. The document should be tailored to the specific facility, with emphasis on regular use by operators. In addition, it should be available to personnel of EPA or the appropriate state agency. Decision trees and actions to be taken in the event of failures or other situations should be a principal focus of the document. Conditions to be satisfied before hazardous wastes are burned should be set forth in the document.

- A WAP that contains the items required by permit or regulation is vital and mandatory (40 CFR §264/265.13). The plan, at a minimum, should cover sampling locations and frequency of sampling, statistical methodology (if applicable), procedures for handling outliers and nondetects, methods of preparation and analysis of samples, and QA/QC procedures and should identify the laboratories to be used. The foregoing list is not all-inclusive, since it may be necessary to meet other requirements. The result of application of procedures in a properly constructed WAP is that the facility will know what it burned and when. As an example, for any day on which waste is burned, corresponding data on waste analysis should be available that can be linked directly with that day's activity. The data should be available from whatever method of sampling and analysis is used. A facility's lack of this information can lead to determinations of noncompliance.

- Although not specifically required, computer hardware and software systems can be useful in providing a record of the most crucial data. The systems can be tailored to meet almost any permit condition or requirement. They enable the inspection of operating records with relative ease. Care should be taken to select a system that meets the needs of the facility, can accommodate upgrades of software, and facilitates compliance rather than merely reporting on compliance status.

- Recordkeeping that documents compliance is recommended. Records should include, but not be limited to: waste analysis data; records of continuous monitoring of feed stream rates; statistical data; data on permit or operating limits, such as temperatures; parameters for air pollution control devices; and any significant operating requirements or constraints. It is important to note that recordkeeping to support the sampling and analysis strategy used will provide data on operating conditions and limits that form the basis for enforcement actions -- for example, feed stream qualification values or UTLs. Finally, if the facility chooses to change from one compliance strategy to another (for example, from

sampling and analysis by batch to statistical analysis), complete and supportable records should be kept to document the change. It also is prudent to keep records of compliance in a single location, with a remote backup. This precaution applies not only to computer data storage but also to paper records.

Again, these items should be merely a starting point in the documentation effort and should be adjusted or expanded to meet the specific needs of the facility.

The objective of maintaining these items is that the facility will be able to demonstrate compliance to regulatory officials and the public. For example, if an inspector has a difficult time determining that a facility is in compliance with feed rates for various constituents, the inspector's underlying assumption may be that the facility is having the same difficulty. Such an assumption could lead inspectors to believe that the facility is out of compliance. Well-maintained documentation can prevent potentially unnecessary actions.

Appendix A
Table of K Factors for Calculation of Tolerance Limits

TABLE 1. K factors for Calculation of Tolerance Limits for 95 Percent Confidence and 95 Percent Proportion

Sample Size (n)	K Factor
2	26.260
3	7.656
4	5.144
5	4.203
6	3.708
7	3.398
8	3.187
9	3.031
10	2.911
11	2.815
12	2.736
13	2.670
14	2.614
15	2.566
16	2.524
17	2.486
18	2.458
19	2.423
20	2.396
21	2.371
22	2.349
23	2.328
24	2.303
25	2.292

From: Hahn, Gerald S. and William Q. Meeker. 1991. *Statistical Intervals: A Guide for Practitioners*. Wiley Interscience. (ISBN 0-471-88769-2).