

**Attachment Q**

**Statistics for Release Determination**



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## **Attachment Q. Statistics for Release Determination**

### **1 OVERVIEW**

Statistical analysis procedures approved in the original 2002 permit for the Triassic Park Waste Disposal Facility will be used to determine whether monitoring results show that a release has occurred from the facility. In accordance with Permit Condition 4.6.1.a., Release Determination, these procedures shall be used to perform release determinations for metals and radionuclides in water (i.e., fluid) samples obtained in the vadose zone monitoring system (VZMS) wells. These procedures shall be applicable to the following analytes obtained under Permit Conditions 4.4.1 and 4.4.2: dissolved and total metals (Sb, As, Ba, Be, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Ti, Zn) and radionuclides (gross alpha, gross beta, gamma emitters, total uranium, radium 226/228, radon).

As indicated in Permit Condition 4.6.1.a, statistical release determination procedures do not apply to general water chemistry parameters (bicarbonate, chloride, dissolved major cations) or to organic parameters. Release determinations for general water chemistry parameters will be made through a trilinear diagram comparison between VZMS well fluid samples and baseline non-leachate fluid samples (i.e., fluid obtained by extracting non-leachate source water through representative soil samples obtained from the installation of the VZMS wells). The release determinations for organics shall be made by the detection of any anthropogenic organic in a VZMS well sample.

The overall statistical procedure for making release determinations for metals and radionuclides in VZMS well samples is as follows:

- i. an upper tolerance limit shall be constructed for non-leachate analytes in water samples extracted under the Synthetic Precipitation Leaching Procedure (SPLP; U.S. EPA method 1312) (see Permit Attachment I, Vadose Zone Monitoring System Work Plan, Appendix A, Synthetic Precipitation Leaching Procedure) for baseline soil boring samples (or baseline soil cutting samples) obtained under Permit Condition 4.4.1. This non-leachate SPLP-extract analyte tolerance limit will be constructed for each individual metal analyte and for each individual radionuclide analyte in the non-leachate SPLP-extracted samples. These non-leachate SPLP-extract analyte tolerance limits shall be reported as required by Permit Condition 4.4.1.b; and
- ii. analyte concentrations of dissolved/total metals and radionuclides from VZMS well samples, as obtained under Permit Condition 4.4.2, shall be compared to each individual non-leachate SPLP-extract analyte tolerance limit. The results of this comparison shall be reported according to VZMS well sample reporting requirements established under Permit Conditions 4.5.2 and 4.6.2.

The construction of the non-leachate SPLP-extract analyte tolerance limits shall adhere to the following guidelines:

- i. a minimum of 20 non-leachate SPLP-extract analyte concentrations (e.g., total lead) from baseline SPLP-extract samples are required to construct an adequate upper tolerance limit for each non-leachate analyte in the SPLP-extract data sets;
- ii. each set of non-leachate SPLP-extract analyte concentrations shall be evaluated for the occurrence of values reported below the achievable detection limits (i.e., non-detects). The procedure for performing this evaluation, and the methods to manage non-detects, is provided below; and
- iii. each set of non-leachate SPLP-extract analyte concentrations shall be evaluated for normality using the procedure described below. If a data set of non-leachate SPLP-extract analyte concentrations exhibits a normal distribution, the non-leachate SPLP-extract analyte tolerance limits shall be constructed on the original (i.e., raw) data set using the parametric tolerance limit procedure described below. If a data set of non-leachate SPLP-extract analyte concentrations exhibits a log-normal distribution instead, the non-leachate SPLP-extract analyte tolerance limit shall be constructed on the log-transformed baseline data set using the parametric tolerance limit procedure, with the respective log-transformed VZMS well sample concentration for that analyte being used in the comparison of the VZMS well sample to the log-transformed non-leachate SPLP-extract analyte tolerance limit.

These procedures are based upon the following guidance developed by the U.S. Environmental Protection Agency (EPA): Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Interim Final Guidance, (U.S. EPA, 1989); Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Draft Addendum to Interim Final Guidance, (U.S. EPA, 1992); and Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance (U.S. EPA, 2009). Requirements set forth in Use of Tolerance Intervals for Determining Inorganic Background Concentrations (NMED, 2000) shall also be adhered to, including the following:

- i. each parametric and non-parametric analyte tolerance limit shall be constructed with a minimum of 20 SPLP-extract samples; and
- ii. each parametric analyte tolerance limit shall be constructed with a minimum coverage of 95% and a minimum tolerance coefficient of 95%.

## **2 MANAGING NON-DETECTS IN NON-LEACHATE SPLP-EXTRACT DATA SETS**

If concentrations of any non-leachate SPLP-extract analyte are reported below the achievable detection limits in a data set (i.e., minimum of 20 samples), the following procedure must be followed before the tolerance limit is calculated for the data set.

If the non-leachate SPLP-extract analyte data set has no more than 15% non-detects, use one-half of the detection limit for that particular measurement. Subsequently, proceed to the normality test procedures described in Section 3.

If the non-leachate SPLP-extract analyte data set has more than 15% non-detects, but less than or equal to 50% non-detects, use Cohen's approximation to approximate the mean and standard deviation of the data set. However, before calculating Cohen's approximation, it must be decided whether the analyte data are more closely approximate to a normal or a log-normal distribution. To make this determination, censored probability plots, as described in EPA's guidance (U.S. EPA, 1992), should be constructed on both the raw measurements and the log-transformed measurements.

The censored probability plots shall be compared to determine whether the plot based on the raw measurements is more linear than the plot based on the log-transformed values. Cohen's approximation shall be computed using the raw measurements and then proceed with the normality test procedures described below. If the plot based on the log-transformed measurements is more linear, Cohen's approximation shall be computed using the log-transformed measurements and then proceed with the normality test procedures described in Section 3.

If the non-leachate SPLP-extract analyte data set contains more than 50% non-detects, then the procedure to calculate the non-parametric tolerance limit for the data set shall be used, as described in Section 5.

### **3 NORMALITY TEST OF NON-LEACHATE SPLP-EXTRACT DATA SETS**

Following the management of non-detects for each non-leachate SPLP-extract analyte data set, the normality or log-normality of each data set must be confirmed before constructing the analyte tolerance limit. If the non-leachate SPLP-extract analyte data set contains more than 50% non-detects, the data set is not tested for normality, and the method for calculating the non-parametric tolerance limit for the data set is used, as described in Section 5.

The normality or log-normality of each non-leachate SPLP-extract analyte data set will be tested by first constructing a probability plot on the compliance data, as described in EPA's guidance (U.S. EPA, 1992). In addition, because the probability plot is not a formal test of distribution, each compliance data set will be assessed using the Shapiro-Wilk test of normality at the 0.01 level of significance. Note that to test normality of each non-leachate SPLP-extract analyte data set, the raw measurements should be used in the construction of the probability plot and the calculation of the Shapiro-Wilk test. If normality of the data is confirmed, the non-leachate SPLP-extract analyte data set tolerance limit can be calculated on the raw measurements, as described in Section 4 in the discussion of parametric tolerance limit procedures.

If the probability plot and the results of the Shapiro-Wilk test indicate the non-leachate SPLP-extract analyte data set is not normally distributed, the data set should be log-transformed. Subsequently, the normality tests (i.e., probability plot and Shapiro-Wilk test) should be applied to the log-transformed data set to determine if the non-leachate SPLP-extract analyte data set is log-normally distributed. If log-normality of the data is confirmed,

the parametric tolerance limit can be calculated on the log-transformed data set, as described in Section 4 in the discussion of parametric tolerance limit procedures.

If both normality and log-normality of the non-leachate SPLP-extract analyte data set are rejected using the probability test and the Shapiro-Wilk test at the 0.01 level of significance, then the non-parametric tolerance limit shall be constructed as described in Section 5.

#### **4 PARAMETRIC TOLERANCE LIMIT FOR NON-LEACHATE SPLP-EXTRACT ANALYTE DATA SET**

For log-normally distributed or log-transformed data sets of SPLP-extract analyte data, the following procedure will be followed to establish the parametric tolerance limit:

- i. the mean ( $\bar{X}$ ) and standard deviation ( $S$ ) for the non-leachate SPLP-extract analyte data set shall be calculated;
- ii. the one-sided, upper tolerance limit for the non-leachate SPLP-extract analyte data set shall be constructed as:

$$\text{Tolerance Limit} = \bar{X} + K S$$

where  $K$  = the one-sided normal tolerance factor found in U.S. EPA (2009, Appendix D Table 17-3);

- iii. each dissolved/total metal analyte and radionuclide analyte obtained for each VZMS well sample, as obtained under Permit Condition 4.4.2, shall be compared to each respective non-leachate SPLP-extract analyte data set parametric tolerance limit constructed for the analyte under Step 2. If the non-leachate SPLP-extract analyte data set tolerance limit was constructed on the logarithm of the original data, the logarithm of the VZMS well sample analyte should be compared to the non-leachate SPLP-extract analyte data set tolerance limit for each analyte under Step 2; and
- iv. if the VZMS well sample analyte concentration exceeds the respective parametric non-leachate SPLP-extract analyte data set tolerance limit for that analyte, then there is statistically significant evidence that the VZMS well sample is composed of leachate from the landfill.

#### **5 NON-PARAMETRIC TOLERANCE LIMIT FOR NON-LEACHATE SPLP-EXTRACT ANALYTE DATA SET**

For data sets of SPLP-extract analyte data found to not be normally or log-normally distributed, the following procedure shall be followed to establish the non-parametric tolerance limit:

- i. Examine the non-leachate SPLP-extract analyte data set to observe and obtain the maximum value for the data set;

- ii. the non-parametric upper tolerance limit for the non-leachate SPLP-extract analyte data set shall be established as the maximum value obtained in Step 1;
- iii. each dissolved/total metal analyte and radionuclide analyte obtained for each VZMS well sample, as obtained under Permit Condition 4.4.2, shall be compared to the non-parametric non-leachate SPLP-extract analyte data set tolerance limit constructed for each analyte under Step 2; and
- iv. if the VZMS well sample analyte concentration exceeds the respective non-parametric non-leachate SPLP-extract analyte data set tolerance limit for that analyte, then there is statistically significant evidence that the VZMS well sample is composed of leachate from the landfill.

## 6 REFERENCES

U.S. Environmental Protection Agency (EPA). 1989. Statistical analysis of groundwater monitoring data at RCRA facilities, Interim final guidance. U.S. EPA Office of Solid Waste. April 1989.

U.S. EPA. 1992. Statistical analysis of ground-water monitoring data at RCRA facilities, Addendum to interim final guidance. U.S. EPA Office of Solid Waste. July 1992.

U.S. EPA. 2009. Statistical analysis of groundwater monitoring data at RCRA facilities, Unified guidance. EPA 530-R-09-007. March 2009.