Chapter 5
Assessment of Environmental Data for Useability in Baseline Risk Assessments

This chapter provides guidance for the assessment and interpretation of environmental radioanalytical data for use in baseline human health risk assessments. Data assessment is accomplished by examining two general sets of data. One set of data consists of the data supporting the individual analysis. Questions often asked of these data include:

- Were all the correct parameters used?
- Were the specified methods used?
- Were all controlled parameters maintained within specified limits?
- Were the calculations performed correctly?
- Do the final analytical results make sense in light of the site history and results obtained for other samples?
- Are the analytical results legally defensible if enforcement activity or cost recovery activity is to be pursued by EPA?

The second set of data supports the validity of the method and proper operation and calibration of measurement equipment. This set of data comprises instrument calibration, operational checks, method demonstration and cross-check programs, and routine QC samples. Both sets of data need to be examined to judge the validity of individual analyses.

To evaluate radioanalytical data, it is necessary to understand the normal methods of calculating radiochemical values for activity concentration, error, minimum detectable concentration (MDC), and lower limit of detection (LLD). Generalized equations for these calculations are given in Exhibits 9 and 10. These equations contain the parameters used to calculate the radioactivity in a given sample. Although not all parameters will be used in every radioanalysis, these equations will serve as the basis for the following discussion of individual parameters. This discussion assumes the user has specified, received, or can obtain access to the data shown in Exhibit 11.

Activity, error, and detection limits are the parameters generally reported by radioanalytical laboratories. Activity, which is the estimate of radioactivity in a sample, may be a screening parameter (e.g., gross alpha) or isotope specific (e.g., Sr-90). Activity must always be calculated from a net count-rate because all radioactivity measurement systems are subject to background count-rates from cosmic radiation, the laboratory environment, and their own construction materials, among other sources.

Error terms are usually reported based on counting statistics only. While Equation 2 in Exhibit 9 calculates a single standard deviation, it is common practice to report radiochemical data to two standard deviations. To determine whether two analytical results are significantly different, it is important to know the number of standard deviations to which the reported errors correspond.

A standard radiochemical data report should include values for the activity concentration and the associated error, or the MDC. The data user must ensure that the MDC value is in fact sample specific, and not a generalized value. Some laboratories report the activity concentration and associated error only when the sample is above the sample-specific MDC. Others will report the activity concentration and associated error even when the results are less than zero (negative). The reporting conventions should be decided prospectively and the requirements communicated to the analytical laboratory.

The risk assessor must evaluate the radioanalytical data for completeness and appropriateness and to determine if any changes were made to the work plan or the sampling and analysis plan (SAP) during the course of the work. The risk assessor will assess the radioanalytical data for completeness, comparability, representativeness, precision, and accuracy as described in Part A, Chapter 5.

Acronyms

EPA	U.S. Environmental Protection Agency
LLD	lower limit of detection
MDC	minimum detectable concentration
QC	quality control
SAP	sampling and analysis plan

EXHIBIT 9. GENERALIZED EQUATIONS FOR RADIOACTIVITY CALCULATIONS

$$ACT = \frac{\frac{SC}{ST} - \frac{BC}{BT}}{2.22x10^6 \times EFF \times CY \times ALI \times RY \times DIFs} \quad (1)$$

$$ERR = \frac{\sqrt{\frac{SC}{ST^2} + \frac{BC}{BT^2}}}{2.22x10^6 \times EFF \times CY \times ALI \times RY \times DIFs} \quad (2)$$

$$MDC = \frac{4.65 \times \sqrt{\frac{BC}{BT \times ST}}}{2.22x10^6 \times EFF \times CY \times ALI \times RY \times DIFs} \quad (3)$$

$$LLD = \frac{4.65 \times \sqrt{\frac{BC}{BT \times ST}}}{2.22x10^6 \times EFF \times RY} \quad (4)$$

Where:

ACT	=	Activity in units of microCuries per units of ALI
ERR	=	One standard deviation counting error (Same units as ACT)
MDC	=	Minimum detectable concentration (Same units as ACT)
LLD	=	Lower limit of detection in units of microCuries at time of counting
SC	=	Total sample counts
ST	=	Elapsed time for which sample was counted (minutes)
BC	=	Total background counts
BT	=	Elapsed time for which background was counted (minutes)
$2.22x10^6$	=	Number of disintegrations per minute (dpm) per microCurie
EFF	=	Counting efficiency for radiation being measured (counts per minute detected for each disintegration per minute actually occurring in sample)
ALI	=	Aliquot of sample actually analyzed (units of volume or mass)
CY	=	Yield of the radiochemical separation procedure (fractional unit of recovery)
RY	=	Radiation yield (number of radiations of the type being measured which are produced per each disintegration which occurs. For gamma spectrometry this is commonly called gamma abundance.)
DIFs	=	Product of various decay and ingrowth factors. The most commonly used DIFs are shown in Exhibit 10.

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EXHIBIT 10. GENERALIZED EQUATIONS FOR RADIOACTIVITY DECAY AND INGROWTH CORRECTION FACTORS

$$DFA = e^{-\frac{0.693}{HLA} \times T_1} \quad (5)$$

$$DFC = \frac{\frac{0.693}{HLA} \times T_2}{1 - e^{-\frac{0.693}{HLA} \times T_2}} \quad (6)$$

$$IDF = 1 - e^{-\frac{0.693}{HLD} \times T_3} \quad (7)$$

$$DFD = e^{-\frac{0.693}{HLD} \times T_4} \quad (8)$$

Where:

DFA	=	Decay correction to obtain activity at the end of the sampling period (continuous collection) or at the time of collection (grab sample)
DFC	=	Corrects average count rate during acquisition to count rate at beginning of counting
IDF	=	Calculates fraction of the decay product ingrowth for radiochemical methods where the decay product is the entity actually counted
DFD	=	Corrects for decay of the decay product between the end of ingrowth and beginning of counting
HLA	=	Half-life for isotope of interest
HLD	=	Half-life of the decay product (if the decay product is isotope counted)
T_1	=	Time interval between end of sampling and beginning of counting
T_2	=	Elapsed time for acquisition of sampling counts
T_3	=	Time permitted for ingrowth of the decay product activity
T_4	=	Time interval between last separation of parent and the decay product isotopes and the beginning of counting of the decay product.

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EXHIBIT 11. DATA REPORT REQUIREMENTS FOR TYPICAL RADIOCHEMICAL ANALYSIS

The following are the minimum parameters required on a radiochemical analytical report to recreate and verify the analytical report.

- Lab Sample ID
- Field Sample ID
- Start Collection Time/Date
- Stop Collection Time/Date
- Flow Rate
- Volume/Weight Adjustment Factors
- Aliquot Analyzed (Vol/Wgt)
- Chemical Yields
- Start and Stop Times and Dates for the Sample Count
- Total Sample Acquisition Time
- Start and Stop Times and Dates for the Background Count
- Total Background Acquisition Time
- Energy Regions of Interest
- Uncorrected Gross Sample Counts
- Gross Background Counts
- Gamma Abundance Values
- Counter Efficiency
- Sample Specific Correction Factors
- Start and Stop Times & Dates for Decay Product Ingrowth
- Start and Stop Times & Dates for Radioactive Decay

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