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# APPENDIX H

## QUALITY ASSURANCE/QUALITY CONTROL EVALUATION RESULTS

### H.1. ENVIRONMENTAL DATA

#### H.1.1 ANALYTICAL METHODS

During the analytical program for the Depleted Uranium Hexafluoride (DUF6) Conversion Facility Site Characterization Study at the Paducah Gaseous Diffusion Plant (PGDP), the following laboratories were used:

- United States Enrichment Corporation (USEC) C-710 PGDP laboratory was the fixed-base laboratory for all environmental soil, groundwater, sediment, and surface water samples.
- International Technology Corporation, Oak Ridge, Tenn., was the fixed-base laboratory for geotechnical samples.

Chemicals of potential concern for the DUF6 site were selected based on historical and future use of the site. There have been no previous samplings at the site. The site characterization included a wetland delineation study; collecting geotechnical, chemical, and radiological properties of the underlying soils and groundwater; determining hydrogeological characteristics of the site; identifying utility availability and capacity; identifying site topography and definition; and collecting surface water and sediment data. Environmental sampling included analyses of volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), metals, alpha spectroscopy, gamma spectroscopy, gross alpha/beta, and <sup>99</sup>Tc.

The USEC C-710 PGDP laboratory performed fixed-base laboratory analyses of soil and water samples. This laboratory was contracted through the U.S. Department of Energy (DOE) Oak Ridge Operations (ORO) Sample Management Office (SMO) and is a DOE-approved, Nuclear Regulatory Commission-licensed laboratory. U.S. Environmental Protection Agency (EPA) SW-846 methods were used for all samples, except those parameters for which other methods are necessary. The analysis followed SW-846 protocols, and “Forms Only” data packages were provided along with electronic data deliverables (EDDs). Table G.1 summarizes the analytical methods and sample requirements of the fixed-base laboratory. Fixed-base laboratory data qualifiers are defined here:

#### A. Inorganic Analysis

- B This flag is used when the analyte is found in the associated blank as well as in the sample.
- U The analyte was analyzed for but not detected.
- J Indicates an estimated value.
- E The reported value is estimated because of the presence of interference. An explanatory note must be included under comments on the cover page (if the problem applies to all samples) or on the specific form I-in (if it is an isolated problem).

- M Duplicate injection precision was not met.
- N Spiked sample recovery was not within control limits.
- S The reported value was determined by the method of standard additions (MSA).
- W Postdigestion spike for furnace atomic absorption analysis is out of control limits (85% – 115%, while sample absorbance is less than 50% of spike absorbance).
- X Other specific flags may be required to properly define the results.
  - \* Duplicate analysis was not within control limits.
  - + Correlation coefficient for the MSA is less than 0.995.

## B. Organic Analysis

- U Indicates the compound was analyzed for but not detected.
- J Indicates an estimated value. This flag is used under the following circumstances: (1) when estimating a concentration for tentatively identified compounds where a 1:1 response is assumed and (2) when the mass spectral and retention time data indicate the presence of a compound that meets the pesticide/Aroclor identification criteria, and the result is less than the contract-required quantitation limit but greater than zero.
- P This flag is used for pesticide/Aroclor target analyte when there is greater than 25% difference for detected concentrations between the two gas chromatography (GC) columns.
- C This flag applies to pesticide results where the identification has been confirmed by GC/mass spectrometry (MS).
- B This flag is used when the compound is found in the associated blank as well as in the sample.
- E This flag identifies compounds whose concentrations exceed the calibration range of the GC/MC instrument for that specific analysis.
- D This flag identifies all compounds identified in an analysis at a secondary dilution factor.
- X Other specific flags may be required to properly define the results.
- Y Indicates matrix spike and matrix spike duplicate (MS/MSD) recovery and/or relative percent difference (RPD) failed to meet acceptable criteria.

**Table H.1. Analytical methods, preservation, and container type for all samples analyzed by fixed-base laboratory**

<b>Analysis</b>	<b>Analytical method</b>	<b>Container type</b>	<b>Preservation</b>
<i>Soil</i>			
TCL VOCs	SW-846 8260	2-oz. glass with septa	Cool to 4°C
TCL SVOCs	SW-846 8270	4-oz. amber glass	Cool to 4°C
TCL Metals	SW-846 6010A	8-oz. glass	Cool to 4°C
	SW-846 7060		
	SW-846 7471A		
	SW-846 7740		
PCBs	SW-846 8082	2-oz. amber glass	Cool to 4°C
Radionuclides	SW-846 RL-7120	500-mL	Cool to 4°C
	SW-846 RL-7124		Cool to 4°C
Gross Alpha/Gross Beta	SW-846 RL-7111	4-oz. plastic	Cool to 4°C
<i>Groundwater</i>			
TCL VOCs	SW-846 8260	(3) 40-mL amber glass	HCl, pH<2; cool to 4°C
TCL SVOCs	SW-846 8270	(1) 1-L amber glass	Cool to 4°C
TCL Metals	SW-846 6010A	(2) 1-L plastic,	(2) HNO <sub>3</sub> , pH<2,
	SW-846 7060	1 filtered, 1 unfiltered	1 filtered, 1 unfiltered
	SW-846 7471A	(1) 1-L amber glass, filtered	(1) None
	SW-846 7740		Cool to 4°C
PCBs	SW-846 8082	(1) 1-L amber glass	Cool to 4°C
Rad-Gamma	SW-846 RL-7124	500-mL Boston Round, unfiltered	HNO <sub>3</sub> , pH<2,
		(2) 1-L plastic, filtered	(1) HNO <sub>3</sub> , pH<2,
			(1) None
Rad-Alpha	SW-846 RL-7120	(2) 1-L plastic,	(2) HNO <sub>3</sub> , pH<2,
Gross Alpha/Gross Beta	SW-846 RL-7111	1 filtered, 1 unfiltered	1 filtered, 1 unfiltered
Technetium-99	SW-846 RL-7116	(1) 1-L amber glass, filtered	(1) None; cool to 4°C
<i>Surface Water</i>			
TCL VOCs	SW-846 8260	(3) 40-mL amber glass	NA <sub>2</sub> S <sub>2</sub> O <sub>3</sub> , pH<2; cool to 4°C
PCBs	SW-846 608	1-L amber glass	Cool to 4°C
TCL SVOCs	SW-846 8270	1-L amber glass	Cool to 4°C
TCL Metals	SW-846 200.7	1-L plastic	HNO <sub>3</sub> , pH<2; cool to 4°C
Gross Alpha/ Gross Beta	SW-846 RL-7111	1-L plastic	HNO <sub>3</sub> , pH<2; cool to 4°C
Technetium-99	SW-846 RL-7116		

## H.1.2 ANALYTICAL DATA QUALITY

### H.1.2.1 Precision, Accuracy, Representativeness, Completeness, and Comparability

Precision, accuracy, and completeness objectives for the fixed-base laboratory measurements during the DUF6 Conversion Facility Site Characterization are presented in Bechtel Jacobs Company LLC's (BJC's) Analytical Services Master Specifications. An assessment of the precision, accuracy, representativeness, completeness, and comparability of fixed-base laboratory analytical data was performed and the results are discussed in the following paragraphs.

### H.1.2.1.1 Precision

Precision is a measure of the agreement or repeatability of a set of replicate results (RPD) obtained from duplicate laboratory analyses of one property using the same method or technique. Precision for analytical data collected during the sampling event was evaluated using results of field duplicate samples, laboratory duplicate samples, MS/MSD samples, and/or consecutive laboratory control samples (LCS). The RPD is calculated and compared to the appropriate quality assurance (QA) objective. RPDs, which are typically expressed as percentages, are used to evaluate both field and laboratory duplicate precision and are calculated as follows:

$$RPD = \frac{|V1 - V2|}{(V1 + V2)/2} \times 100$$

where

RPD = relative percent difference,

V1, V2 = two results obtained by analyzing duplicate samples.

For the DUF6 Conversion Facility Site Characterization, field duplicate samples were collected for all media at a frequency of 5%. Exceedances of the acceptable duplicate RPD ( $\pm 20\%$  for aqueous samples,  $\pm 35\%$  for soil samples) were noted for cadmium and antimony in water sample UFSB01W025; for barium and calcium in all soil samples from UF-SB05 and for all sediment samples; and for pyridine in water samples UFSB05W027 and -W027D, in all surface water samples, in field blank UFQC0014E, and in equipment rinsate blank UFQC0014F. In UFSB01W025, an exceedance of the acceptable RPD for MS/MSD was noted for 2,4,6-trichlorophenol, 2,4,5-trichlorophenol, and pentachlorophenol. An MS/MSD exceedance for RPD was also noted for 2,4,5-trichlorophenol, 2,4,6-trichlorophenol, and pentachlorophenol in soil samples UFSB01S001, -005, -010, -013, -018, and -023.

### H.1.2.1.2 Accuracy

Accuracy is a measure of the agreement between the true value and the value measured using an analytical method (percent recovery). Accuracy also is evaluated during data validation by assessing initial and continuing calibration data for the analytical instrument. Accuracy for analytical data collected during the DUF6 Site Characterization was assessed by evaluating percentage recoveries for MS/MSD samples, surrogate spikes, and blank spikes.

The recovery of each spiked analyte was calculated and compared to the appropriate QA objective, between 75% and 125%. The percent recovery (%R) for MS/MSD analysis did not meet the objective for several analytes in water, soil, sediment, and in samples UFQC0014E and UFQC0014F. The surrogate %R did not meet the objective for some semivolatiles in water and some organics in soil. The %R for the LCS analysis did not meet the objective for some organics in soil, water, sediment, surface water, and in the trip blanks UFQC001T and UFQC009T. In addition, the %R for the LCS analysis did not meet the objective for lead in sample UFSB05W027 and all sediment samples and did not meet the objective for some semivolatiles in surface water, sample UFQC0014E, sample UFQC0014F, and sample UFSB05W027. No detected concentrations were rejected for these reasons. The initial calibration or continuing calibration did not meet QA objectives for several semivolatiles in water and surface water and for several organics in soil, water, sediment, and surface water including acetone and 2-butanone in soil and sediment.

### **H.1.2.1.3 Representativeness**

Representativeness is the degree to which the data obtained from an environmental sample accurately reflect the nature and extent of contamination at a site. The data collected during the DUF6 Site Characterization were both accurate and precise. The samples required in the DUF6 Site Characterization were collected using standardized procedures designed to provide a true representation of the location sampled. Standardized, accepted analytical methods or modified standard methods, using National Institute of Standards and Technology traceable standards, were used to ensure that accurate, reproducible data were generated. Based on these criteria, the data from the DUF6 Site Characterization were deemed representative.

### **H.1.2.1.4 Completeness**

Completeness is the percentage of usable data reported and validated compared with the total number of data expected. “Overall completeness” refers to the percentage of valid measurements versus the total measurements planned where “laboratory completeness” refers to the percentage of usable data reported by the laboratory versus the total number of data samples collected. Usable data are those measurements that were not rejected (qualified with an "R") during the validation process. The fractions and media analyzed and their corresponding data completeness as determined by the validation process were the following:

- All radiological data – 100%
- Inorganic data from SB01 – 97.0%
- Inorganic data from SB05, surface water, and sediments– 100%
- All PCB data – 100%
- Semivolatile data in UFSB01W025 – 81.4%
- Semivolatile data in UFSB05W027, soil, surface water, and sediment – 100%
- Organic data in trip blank UFQC001T – 97.2%
- Organic data in water sample UFSB01W025 and surface water – 100%
- Organic data in water sample UFSB05W027 and trip blank UFQC009T – 98.4%
- Organic data in sediment samples – 94.4%
- Organic data in trip blank UFQC0033T, field blank UFQC0014F, and rinsate blank UFQC0014E – 97.5%
- Organic data in soil samples UFSB01001, -018 and -023 – 95.4%
- Organic data in soil samples UFSB01050 and -010 – 98.6%
- Organic data in soil sample UFSB01013 – 94.4%
- Organic soil samples from SB05 – 95.4%

The goal for analytical completeness for the DUF6 Site Characterization was 90% usable data. The completeness goal of 90% was met for all matrices and all parameters except for semivolatile data in UFSB01W025 (81.4%). Of the overall analytical data, 59 data points were rejected.

The Sampling and Analysis Plan (SAP) for the DUF6 Site Characterization called for subsurface soil sampling at 20 locations and for 10 of those to be advanced to the water table estimated at approximately 70 ft below ground surface (bgs). The water table was encountered at a much more shallow depth (approximately 20 ft bgs); therefore, the “planned” subsurface soil samples (at 5-ft intervals) were not collected from the water table to 70 ft bgs. Because the SAP directed subsurface soil samples to be collected to the water table, these uncollected samples below the water table do not affect the completeness of the project.

### **H.1.2.1.5 Comparability**

Comparability is defined as the degree of confidence with which one data set can be compared to another. Data collected for this investigation were generally collected according to the DUF6 Work Plan and the Quality Assurance Project Plan (QAPP), and all field changes were approved. The overall comparability of the data collected in the DUF6 Site Characterization to historical data is good.

### **H.1.2.2 Surveillances**

Tetra Tech, Inc., conducted surveillances of the field activities. Surveillances covered the following: sample management activities, log keeping and chain-of-custody documentation, equipment decontamination, waste management activities, sampling activities, implementation of QA data policies, and boring abandonment activities. The ORO-SMO conducted laboratory surveillances of the fixed-base laboratory.

### **H.1.2.3 Data Quality Objectives**

Data Quality Objectives (DQOs) are qualitative and quantitative criteria used to establish requirements for sample collection and analysis and are based on the intended uses of the data. The overall intent of the DQOs is to generate data of appropriate quality to support the characterization of the site for use as an uranium conversion facility. DQOs were documented in the approved DUF6 Work Plan and were implemented as documented in the SAP and the QAPP.

### **H.1.2.4 Fixed-Base Laboratory Performance**

Fixed-base laboratory performance was based on the results of the laboratory quality control (QC) samples, MS/MSD analysis, and adherence to the laboratory procedures through data validation. The laboratory is audited annually by ORO-SMO and is contracted to follow the Analytical Master Specification document for various analytical chemistry protocols mandated by ORO-SMO.

Some continuing calibration deficiencies led to laboratory qualification of some data during data validation. Specific laboratory problems with the data were addressed and resolved during the data assessment phase.

### **H.1.2.5 Data Validation**

Data validation is a process performed for a data set by a qualified individual independent from sampling, laboratory, project management, and other decision-making personnel for the project. In the data validation process, the laboratory adherence to analytical method requirements is evaluated. Tetra Tech's subcontractor, NFT, Inc., with oversight provided by the BJC Sample Manager, validated definitive data collected for this DUF6 Site Characterization in accordance with TT-ERWM/ER-P2213, "Data Validation Plans for ER Projects," and the following BJC validation procedures:

- EMEF Intersite Procedure Environmental Restoration and Waste Management (ERWM)/Environmental Restoration (ER)-P2209, "Radiochemical Data Verification and Validation," Rev. 0.
- EMEF Intersite Procedure ERMW/ER-P2210, "Volatile and Semivolatile Data Verification and Validation," Rev. 0.
- EMEF Intersite Procedure ERMW/ER-P2211, "Pesticide and PCB Data Verification and Validation," Rev. 0.

- EMEF Intersite Procedure ERMW/ER-P2212, “Inorganic Data Verification and Validation,” Rev. 0.

As part of the data review process, findings were qualified as necessary to reflect data validation results. The following qualifiers were assigned by the data validators:

- U The material was analyzed for, but was not detected. The associated numerical value is the quantitation limit.
- J Estimated value, either because QC criteria were not met or because the amount detected is below the documented quantitation limit.
- UJ Undetected but the number reported as the quantitation limit is an estimated value.
- NJ Presumptively present at an estimated quantity.
- R Rejected, so data are of “information only” quality and should be supplemented with additional data for decision making.
- = Data were validated; however, no qualifier was added.
- X Data were not validated.

Data generated by the fixed-base laboratory were independently validated on a frequency of 10%. Data packages from the DUF6 conversion site were validated for parameters including VOCs, metals, PCBs, SVOCs, and radiological analyses. A review of the data validation summary reports indicates that the majority of data quality parameters, including MS/MDS recovery and RPD criteria, for the validated data packages were within established method-specific limits. Quality problems for individual samples and/or analytes were identified in each of the validated packages; in particular, there were instances of laboratory blank contamination affecting analytes, such as pentachlorophenol, copper, lead, and di-n-butylphthalate, and problems with continuing and initial calibrations for some of the VOC and SVOC analytes. Results for <sup>134</sup>Cs were rejected by the project because activity would be underestimated due to short half-life and would exclude any previous site-induced <sup>134</sup>Cs. Since the data were not rejected due to routine validation, the completeness of the total package was not affected. Of the overall analytical data, 59 data points were rejected.

### H.1.3 DATA MANAGEMENT

Project Environmental Measurement System (PEMS) was used to manage field-generated data; import laboratory-generated data; add data qualifiers based on data verification, validation, and assessment; and transfer data to Paducah’s Oak Ridge Environmental Information System (OREIS). PEMS included a tracking system to identify, track, and monitor each sample and associated data from point of collection through final data reporting. The system included field measurements, chain-of-custody information, and a tracking system for tracking hard-copy data packages and EDDs. PEMS also included information for field planning and data evaluation.

All data packages and EDDs received from the laboratory were tracked, reviewed, and maintained in a secure environment. When first received, data packages were assigned a document control number and then logged into the tracking system. The following information was tracked: sample delivery group numbers, date received, document control number, number of samples, sample analyses, receipt of EDDs, and comments.

The data verification processes for laboratory data were implemented for both hard-copy data and EDDs. The data packages were reviewed to confirm that all samples had been analyzed for the requested parameters. Discrepancies were reported to the laboratory and the data validators. As part of a series of internal integrity checks within PEMS, a check was run to identify which of the requested samples and analyses were not received in EDDs. Hard-copy data packages were checked to confirm agreement with the associated EDD. Integrity checks in PEMS were also used to check the list of compounds generated

by the laboratory to confirm the data were provided for all requested analytes. Discrepancies were reported to the laboratory for responses and/or correction and to the data validators.

Data verification within PEMS included standardization of analytical methods, chemical names and units, as well as checks for holding time violations and detections above background values. Validation qualifiers from the NFT, Inc., data validators were manually input into PEMS. PEMS system requirements included backups, security, change control, and interfacing with other data management systems. PEMS was housed on the Paducah Environmental Management and Enrichment Facilities (EMEF) network. System backups were performed nightly following standard Paducah EMEF network protocol. Updates made to files were copied to a computer backup tape each night, and an entire backup was performed each week.

Security of PEMS and data used for the data management effort was considered essential to the success of the project. The security protocol followed by the data management team was consistent with that of the Paducah EMEF network. Access to the network is password-protected. Access to PEMS was limited, on an as-needed basis, to the data management personnel. Read-write, graded access to PEMS was limited to the data management team, which consisted of the PEMS Coordinator and the supporting data entry staff. The data management staff assisted other project members with data needs from PEMS by running requested queries.

Each sampling location and sample collected during the DUF6 Site Characterization was assigned a discrete sample identification (ID) number, which consisted of the site identification, the sample borehole number, and the depth at which the sample was collected. According to the requirements of the PEMS database, sample nomenclature cannot exceed 12 characters in length. Table G.2 illustrates the sample nomenclature used at the DUF6 site.

**Table H.2. DUF6 Conversion Facility sample number scheme**

Sample category	Project ID No.	SOW No.	Sample ID No.
Soil boring	UFSB00-01 through -20	UFSB00-01 and -02	UFSBXX <sup>a</sup> SXXX <sup>b</sup> UFSBXX <sup>a</sup> WXXX <sup>b</sup>
Surface water	UFSW00-01	UFSW00-01	UFSWXX <sup>c</sup> W000
Sediment	UFSS00-01	UFSS00-01	UFSSXX <sup>c</sup> S000
Rigs	UFRIGS00-01	UFRIGS00-01	UFRIGSPXXX <sup>d</sup>
Decon water	UFDW00-01	UFDW00-01	UFDWXXXXXXXX <sup>e</sup>
Waste (soil)	UFW00-01	UFW00-01	UFSWXXXXXXXX <sup>e</sup>
Refrigerator blanks	UFREF00-01	UFREF00-01	UFREFWXX <sup>d</sup>
Quality control			UFQC00XX <sup>d</sup> Y <sup>f</sup>
HP monitoring	UFHP00-01	UFHP00-01	UFHPPXXX <sup>d</sup>

<sup>a</sup>XX – boring number (i.e., 01 for boring No. 1)

<sup>b</sup>XXX – bottom depth of sampling interval (i.e., 005 for 5 ft)

<sup>c</sup>XX – location number (i.e. 01 for location No. 1)

<sup>d</sup>XX – sequential number

<sup>e</sup>XXXXXX – RFD number assigned to tank or roll-off bin

<sup>f</sup>Y – designation for type of QC sample: E = equipment rinsate, T = trip blank, F = field blank

#### **H.1.4 DATA ASSESSMENT/VALIDATION**

To confirm the data set could be used by prospective bidders to complete their proposal/bid for designing, constructing, and operating the uranium conversion facility, the Site Characterization team performed various checks and reviews during and after fieldwork to maintain data consistency and to identify problems. Tetra Tech completed data assessment to fulfill the requirements defined in TT-PMSA-1001, “Quality Assured Data.” BJC used the site-specific OREIS transition tables to print data assessment packages for the Tetra Tech project team. Upon completion of the data assessment process, the Tetra Tech project team provided the BJC Sample Manager with any assessment qualifiers to be input into the site-specific OREIS transition tables.

#### **H.1.5 FIELD QUALITY CONTROL**

EPA, DOE, the Commonwealth of Kentucky, and PGDP procedures require that field QC samples be collected to assess data quality. The QC samples collected and analyzed included:

- Equipment rinsates
- Trip blanks
- Field blanks
- Duplicate blanks
- Refrigerator blanks

##### **H.1.5.1 Equipment Rinsates**

Equipment rinsates were scheduled to be collected at a frequency of 1 in 20 samples. Appendix A provides the data from equipment rinsate samples. A total of 14 equipment rinsates was collected during the project. Equipment rinsate samples were designated UFQCXXXE samples in Appendix G.

##### **H.1.5.2 Trip Blanks**

Trip blanks were collected at a frequency established by the direction of BJC. A total of 30 trip blanks was collected during the project. Appendix A provides the results from trip blank samples. Trip blank samples were designated UFQCXXXT samples in Appendix G.

##### **H.1.5.3 Field Blanks**

Field blanks were scheduled to be collected at a frequency of 1 in 20 samples. Appendix A provides the data from field blank samples. A total of 14 field blanks was collected during the project. Field blank samples were designated UFQCXXXF samples in Appendix G.

##### **H.1.5.4 Duplicate Blanks**

Field duplicates were collected and sent to the fixed-base laboratory for analysis. Field duplicates were scheduled to be collected at a frequency of 1 in 20 samples by matrix. Appendix A provides the data from field duplicate samples. A total of 7 soil and 1 groundwater field duplicates was collected during the project. Field blank samples were designated with a “D” at the end of the sample number in Appendix G.

### **H.1.5.5 Refrigerator Blanks**

Once a week a 40-mL volatile organic analyte (VOA) vial filled with organic-free water in the laboratory was placed in the sample storage refrigerator and analyzed to detect contamination by VOAs during sample storage in a refrigerator. Two refrigerator blanks were collected during the project. Refrigerator blank samples are designated UFREFWXXX in Appendix G.

## **H.2. GEOTECHNICAL DATA**

Tetra Tech collected geotechnical soil samples from three boreholes. Spacing of borings was based on the assumption that uniform, regular soil conditions prevail at the site. Soil samples were collected from the first 23 ft at shallow, midboring, and deep locations.

The initial boring (SB03) installed to groundwater was used to compile the depth, thickness, and composition of each stratum to determine depths to collect geotechnical samples at subsequent borings. Two soil units were found within the first 20 ft. At the 3-ft depth, four 3-gal buckets were collected for analysis by American Society for Testing and Materials (ASTM) methods D1883 and D698-91. For subsequent depths, a Shelby tube sample was collected for each analysis using undisturbed sample material. The Shelby tube was analyzed using ASTM methods D2216-92, D2435, D2487-90, D2850, D422-63, D4318-95, and D4767. The SAP contains a summary of ASTM analysis methods for each collected sample.