SITEWIDE CERCLA QUALITY ASSURANCE PROJECT PLAN

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
FERNALD, OHIO

SEPTEMBER 1998

U.S. DEPARTMENT OF ENERGY
FERNALD AREA OFFICE

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June 1998

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RECORD OF ISSUE/REVISION

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ISSUE AUTHORIZATION DATE	EFFECTIVE DATE	PCN No.	REV. No.	DESCRIPTION
9-22-92	10-23-92		0	In accordance with the requirements of the Federal Facilities Compliance Agreement between the U.S. Department of Energy and the U.S. Environmental Protection Agency, the Sitewide CERCLA Quality Assurance Plan (SCQ) was developed to integrate CERCLA and RCRA requirements into applicable sampling activities at the FEMP. This document superseded the RI/FS Quality Assurance Project Plan.
4-27-93	5-24-93		0.1	Revised to reflect change in DOE prime contractor and to address U.S. EPA comments concerning sample custody and data validation. Attachment I, "FEMP Analytical Laboratory Methods Manual" (Volumes III, IV, and V) was removed.
5-04-94	7-22-94		0.2	Major revision of SCQ to incorporate multiple DCRs and comments from U.S. EPA and Ohio EPA.
5-10-95	5-10-95		0.3	Revision of requirements for groundwater sampling and monitoring well installation.
8-14-98	9-01-98		1	Major revision of SCQ to reflect change in site activities from RI/FS to Remedial Action. Numerous DCRs concerning sampling methods, analytical procedures, and data validation processes were incorporated. Validation and verification requirements for computer software and hardware were added. Numerous changes were made in accordance with U.S. EPA and Ohio EPA review comments.

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GLOSSARY

ACRONYMS AND ABBREVIATIONS

- A -

AA	Atomic Absorption
ACBM	Asbestos-Containing Building Materials
AEC	Atomic Energy Commission
AEDE	Annual Effective Dose Equivalent
Ag	Silver
ALARA	As Low As Reasonably Achievable
ANSI	American National Standards Institute
APM	Analytical Project Manager
ARAR	Applicable or Relevant and Appropriate Requirement
As	Arsenic
ASL	Analytical Support Level
ASME	American Society of Mechanical Engineers
ASQC	American Society of Quality Control
ASTM	American Society for Testing and Materials
AVGRRF	Average Relative Response Factor

- B -

Ba	Barium
BDN	BioDeNitrification
BFB	p-BromoFluoroBenzene
BNA	Base Neutrals Analysis

- C -

CAA	Clean Air Act
CADD	Computer Aided Design and Drafting
CAM	Continuous Air Monitor
CAR	Corrective Action Report
CCB	Continuing Calibration Blank
cc	Cubic Centimeter(s)
CCV	Continuing Calibration Verification
CCVS	Continuing Calibration Verification Sample
Cd	Cadmium
CDROM	Compact Disk Read Only Memory
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CIT	Colorimetric Indicator Tubes
CLP	Contract Laboratory Program (U.S. Environmental Protection Agency)
cm	Centimeter(s)

CN	Cyanide
Co	Cobalt
COC/RFA	Chain of Custody/Request for Analysis
COLIWASA	Composite Liquid Waste Sampler
cpm	Counts per Minute
Cr	Chromium
CRDL	Contract-Required Detection Limit (in the CLP)
CRQL	Contract-Required Quantitation Limit (in the CLP)
CRU	CERCLA/RCRA Unit
Cu	Copper
CVAA	Cold Vapor Atomic Absorption methods for mercury analysis
CWA	Clean Water Act

- D -

DBC	DiButylChlorendate
DCR	Document Change Request
D&D	Decontamination and Decommissioning
DFTPP	Decafluorotriphenylphosphine
DI	De-Ionized (water)
DOE	U.S. Department of Energy
DOE-FEMP	U.S. Department of Energy-Fernald Environmental Management Project
DOT	U.S. Department of Transportation
dpm	Disintegrations per Minute
DQO	Data Quality Objective

- E -

ECD	Electron Capture Detector
EDP	Electronic Data Processing
EG&G	EG&G, Inc.
Eh	Redox Potential
EPA	U.S. Environmental Protection Agency
EPDM	Ethylene-Propylene-Diene Monomer
EP Tox	Extraction Procedure Toxicity

- F -

F	Fluoride
FACTS	Fernald Analytical Computerized Tracking System
FEMP	Fernald Environmental Management Project
FERMCO	Fernald Environmental Restoration Management Company
FFCA	Federal Facility Compliance Agreement
FID	Flame-Ionization Detector
FMPC	Feed Materials Production Center
FR	Federal Register
FRL	Final Remediation Level

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FS	Feasibility Study
ft	Foot or Feet
FTAAS	Flame Technique Atomic Absorption Spectroscopy
FWHM	Full Width Half Maximum

- G -

g	Gram
GC	Gas Chromatography (or Chromatograph)
GC/ECD	Gas Chromatography/Electron Capture Detector
GC/FID	Gas Chromatography/Flame Ionization Detector
GC/MS	Gas Chromatography/Mass Spectrophotometer
GFAA	Graphite Furnace Atomic Absorption
GIS	Geographical Information System
GUI	Graphical User Interface

- H -

H	Hydrogen
HAMDC	Highest Allowable Minimum Detectable Concentration
Hg	Mercury
HMT	Hazardous Materials Table
HSL	Hazardous Substance List
HWMU	Hazardous Waste Management Unit

- I -

ICB	Initial Calibration Blank
ICP	Inductively Coupled Plasma (spectroscopy)
ICS	Interference Check Sample
ICV	Initial Calibration Verification
ICVS	Initial Calibration Verification Sample
ID	Identification
IDL	Instrument Detection Limit
IDLC	Instrument Detection Limit Concentration
IEMP	Integrated Environmental Monitoring Plan
in.	Inch or Inches
IR	Infrared
IS	Internal Standards

- K -

K	Hydraulic Conductivity
kg	Kilogram(s)

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- L -

L	Liter
LAACC	Large-Area, Activated-Charcoal Collector
LCS	Laboratory Control Sample
LIMS	Laboratory Information Management System
LLD	Lower Limit of Detection
LSA	Low Specific Activity

- M -

m	Meter(s)
mA	Milliampere(s)
MCA	Multi-Channel Analyzer
MCL	Maximum Contaminant Level
MDC	Minimum Detectable Concentration
MDA	Minimum Detectable Activity
MDL	Method Detection Limit
Mg	Magnesium
mg	Milligram(s)
mg/L	Milligram(s) per Liter
min	Minute(s)
mL	Milliliter(s)
m/min	Meters per Minute
mrem	Millirem(s)
mrem/h	Millirem per Hour
MS	Mass Spectroscopy (or Spectrometer)
MSA	Method of Standard Additions
MS/MSD	Matrix Spike/Matrix Spike Duplicate
MSND	Matrix Spike Normalized Difference
msl	(Feet Above) Mean Sea Level
mV	Millivolt(s)
m/z	Ion Mass (m) to Charge (z) Ratio

- μ -

μg	Microgram(s)
μg/g	Microgram(s) per Gram
μg/L	Microgram(s) per Liter
μmhos/cm	Micromhos per Centimeter

- N -

N/A	Not Applicable
nCi	Nanocuries
NCP	National Contingency Plan for Oil and Hazardous Substances Pollution
NEPA	National Environmental Policy Act

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NESHAP	National Emissions Standards for Hazardous Air Pollutants
ng	Nanogram
ng/μL	Nanogram(s) per Microliter
NIST	National Institute of Standards and Technology
N/K	Not Known
NLO	National Lead of Ohio Incorporated
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NR	Nonconformance Report
NRC	Nuclear Regulatory Commission
NTU	Nephelometric Turbidity Units
NVO-325	Nevada Test Site Defense Waste Acceptance Criteria, Certification, and Transfer Requirements

- O -

O	Oxygen
OAC	Ohio Administrative Code
OEPA	Ohio Environmental Protection Agency
OJT	On-the-Job Training
OSHA	Occupational Safety and Health Administration (or Act)
OU	Operable Unit

- P -

PAH	Polynuclear Aromatic Hydrocarbons
Pb	Lead
PCB	PolyChlorinated Biphenyls
pCi/g	Picocuries per Gram
pCi/L	Picocuries per Liter
PE	Performance Evaluation
pH	Hydrogen Ion Concentration
PIC	Pressurized Ionization Chamber
PID	Photo-Ionization Detector
Po	Polonium
ppb	Parts per Billion
ppm	Parts per Million
ppt	Parts per Trillion
PQL	Practical Quantitation Limit
PSP	Project-Specific Plan
PVC	PolyVinyl Chloride

- Q -

QA	Quality Assurance
QAPP	Quality Assurance Program Plan

QA/QC	Quality Assurance/Quality Control
QC	Quality Control

- R -

r	Radius
Ra	Radium
RA	Remedial Action
RAM	RadioActive Material
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RDL	Required Detection Limit
RER	Relative Error Ratio
RF	Response Factor
RGC	Reactivity Group Code
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RIR	Request for Additional Information/Resubmittal
RIS	Relational Interface System
Rn	Radon
ROD	Record of Decision
ROI	Region of Interest
RPD	Relative Percent Difference
RPM	Remedial Project Manager
RQL	Required Quantitation Limit
RRF	Relative Response Factor
RRT	Relative Retention Time
RSD	Relative Standard Deviation
RSE	Removal Site Evaluation
RvA	Removal Action

- S -

S	Coefficient of Storage or Storativity
SA	Spike Added
SARA	Superfund Amendments and Reauthorization Act
SAS	Sample Analysis Selection (or Summary)
SCQ	Sitewide CERCLA Quality Assurance Project Plan
SDG	Sample Delivery Group
SDWA	Safe Drinking Water Act
SOP	Standard Operating Procedure
SOW	Statement of Work
SPCC	System Performance Check Compound
SQL	Structure Query Language
SRPD	Self-Reading Pocket Dosimeter
SSOD	Storm Sewer Outfall Ditch
SSR	Spike Sample Result

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STR	Subcontract Technical Representative
SVOA	Semivolatile Organic Analysis (or Analytes)

- T -

T	Transmissivity
TAL	Target Analyte List
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
Th	Thorium
TIC	Tentatively Identified Compound
TLD	ThermoLuminescent Dosimeter
TOC	Total Organic Carbon
TOX	Total Organic Halogens (or Halides)
TPU	Total Propagated Uncertainty
TQM	Total Quality Management
TSCA	Toxic Substance Control Act

- U -

U	Uranium
USEPA	United States Environmental Protection Agency
UST	Underground Storage Tank
UV/VIS	UltraViolet/Visible Spectrum

- V -

V	Vanadium
VOA	Volatile Organic Analysis (or Analytes)
VOC	Volatile Organic Compound

- W -

WEMCO	Westinghouse Environmental Management Company of Ohio
WISDM	Windows Integrated Sample and Data Management
WTP	Water Treatment Plant

- X -

XRF	X-Ray Fluorescence

- Z -

Zn	Zinc

- % -

%D	Percent Difference
%R	Percent Recovery
%RSD	Percent Relative Standard Deviation

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Accuracy. Accuracy refers to the closeness of a measured value to the accepted true value.

Administrative Record. This is the official repository for CERCLA related information documenting progress of programs and projects aimed at remediation of the FEMP. Contents of the Administrative Record are determined by the DOE. Copies of the Administrative Record contents are accessible by the public.

Administrative Record Coordinator. The AR Coordinator is the FDF representative responsible for maintaining, updating, and tracking the contents of the CERCLA Administrative Record, Post Record of Decisions Files, and associated files. The AR Coordinator holds the position with approval from the DOE.

Analytical Batch. An analytical batch is a group of twenty or fewer FEMP samples analyzed as a group, relative to instrument calibration checks, quality control samples, etc.

Analytical Laboratory Services (ALS) Group. The ALS group provides data to FDF project from the analysis of samples in the on-site laboratory.

Analytical Project Manager. The analytical project manager is a member of the FEMP sample management organization who is responsible for the management and tracking of analytical samples for a FEMP project from the initial planning and scheduling until the final data package is verified and validated, if necessary. The analytical project manager is also the single point of contact between the project contact and the analytical laboratory.

Analytical Support Level (ASL). The ASL is the defined quality assurance/quality control parameter to assure data are satisfactory for their intended use.

Applicable Relevant and Appropriate Requirements. ARARs are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal or state environmental laws or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial actions, location or other circumstance found at a CERCLA site. If a requirement is not applicable, it may be relevant and appropriate in that its use is well suited to the particular site.

Aquifer. An aquifer is a geological formation, group of formations, or part of a formation that is sufficiently permeable to conduct groundwater and yield a significant quantity of water to wells and springs.

Associated Data/Results. Data or results are related to a particular QC check or analysis. Association may be: (1) sample specific holding time, (2) method specific for samples with the sample delivery group (calibrations), (3) constituent specific for samples of the same matrix in the SDG, or (4) a combination of (2) and (3).

Associated Samples. Samples are associated with a particular QC analysis methodology (e.g., for an initial calibration, all samples run under the same calibration curve).

Audit. An audit is an in-depth review of an entire program, including an evaluation of the associated quality assurance program and procedures, effectiveness of its implementation, and review of associated documentation (synonymous with system audit).

Calibration. The establishment of a relationship between instrument response and the concentration of an analyte by performing measurements on materials with analyte concentrations certified by NIST or another equivalent agency or organization. This frequently results in the preparation of a graph or a mathematical function which describes instrument response as a function of analyte concentration.

Capillary Water. Water is held as a film around soil particles and in tiny spaces between particles in the unsaturated zone. Capillary water is held in the soil by surface tension, which acts as an adhesive force.

Carrier. To minimize the loss of a radioactive species during sample processing, a carrier, a quantity of nonradioactive material with similar behavior to the analyte(s) of interest, is added to the sample.

CERCLA-Covered. Those programs or projects at the FEMP that generate data or perform functions required by the CERCLA program are referred to as CERCLA-covered. The programs or projects fulfill requirements of the NCP or the Consent Agreement.

CERCLA-Driven. CERCLA-driven items or activities are required by the NCP or the Consent Agreement.

Channel. A channel is a long gutter, groove, furrow or any bed where a natural stream of water runs.

Chemical Yield. The yield is the amount of carrier recovered compared to amount added (used to correct the final analytical result).

Comparability. A qualitative expression of the confidence with which one data set can be compared to another.

Composite Sample. A composite is a mixture of a number of samples to represent the average properties of the parameters of concern over the extent of the area sampled.

Condition Adverse to Quality - An all inclusive term used in reference to any of the following: failures, malfunctions, deficiencies, defective items, and nonconformances.

Condition Significantly Adverse to Quality - A condition which, if left uncorrected, could have a serious effect on safety or operability. **Significant** conditions adverse to quality found in a program or a system shall be documented on the Corrective Action Report (CAR) form and processed as such by the designated FEMP QA organization.

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Confined Aquifer. A confined aquifer is one that is overlain by a confining bed. The confining bed has a significantly lower hydraulic conductivity than the aquifer.

Consent Agreement. The U.S. Department of Energy and the U.S. Environmental Protection Agency entered into the Consent Agreement in April 1990; it was amended in September 1991. The Consent Agreement, which specifies actions to be taken at the FEMP, includes defining Operable Units (OU); conducting Removal Actions (RA), Remedial Investigations (RI), and Feasibility Studies (FS); preparing Records of Decision (ROD); and implementing Remedial Design (RD) and Remedial Actions (RA). The goal of the Consent Agreement is remediation of the FEMP with oversight from the EPA.

Contaminant. A contaminant is any physical, chemical, biological, or radiological substance or matter that has an adverse effect on air, soil, or water.

Contractor. The contractor is the organization that the DOE has appointed to function in a specific capacity at the FEMP and reports to the DOE or its designee. At the FEMP, the contractor is the Fluor Daniel Fernald, a wholly-owned subsidiary of Fluor-Daniel Incorporated.

Controlled-Document Coordinator. The controlled document coordinator is a FDF representative responsible for issuing, tracking, and distributing revisions to controlled documents at the FEMP.

Data Package. See Sample Delivery Group.

Data Qualifiers. Data qualifiers are specifically defined letters, groups of letters, and symbols used by data validators to qualify the useability of data.

Data Quality Organization. The FEMP data quality organization is the group that is responsible for the management of activities necessary to verify and assure compliance of data generation functions with the appropriate site and regulatory requirements.

Dedicated Equipment. Dedicated equipment are systems exclusive to a location or purpose.

Designated FEMP Quality Assurance Organization. The quality assurance group of Fluor Daniel Fernald is designated by DOE to be responsible for oversight of QA functions of contractors and subcontractors onsite. The designated FEMP Quality Assurance Organization may utilize Quality Assurance resources of other contractor and subcontractor organizations to fulfill its duties.

Designee. A designee is an individual designated to perform a function in place of the defined responsible individual. The delegation of authority to a designee must be documented in the project record and must include the scope and length of time the delegation is in effect.

Deviation. A deviation is any departure from a specified requirement; it is used interchangeably with nonconformance. It can be a condition in which a characteristic of an

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item does not conform to prescribed limits, a required document is not available or is inadequate, a regulatory requirement was violated, or a procedure does not yield desired results.

DQO Coordinator. The DQO coordinator is responsible for overall control of the DQO process at the FEMP. This includes assigning DQO numbers, ensuring that all required approvals have been received, distributing the approved controlled documents, and storing the DQO files.

Duplicate. A duplicate may be a second analysis (or count) of the same sample (duplicate analysis) or identical analyses of two samples that were obtained from a single sample (duplicate sample).

Electro-Fishing. This refers to a fresh-water fish sampling method that uses a pulsating direct current electro-shocker between 300 and 30,000 ohms to stun fish for collection.

Environmental Safety and Health Organization (ES&H). ES&H is the Fluor Daniel Fernald group responsible for the radiological and industrial safety of FEMP workers. ES&H may utilize expertise and resources of other contractor and subcontractor organizations to fulfill its duties.

Feasibility Study. See Remedial Investigation/Feasibility Study.

FEMP. The DOE Fernald Environmental Management Project, formerly a uranium processing plant named Feed Materials Production Center. Consists of a 1050 acre site and potentially affected off-site areas.

Field Blank. Field blanks are used to determine whether the sample collection process or conditions at the collection point have affected sample quality. A field blank is prepared using analyte-free/organic-free reagent water and appropriate containers and equipment.

Fluid. A fluid is not necessarily a pure liquid; it can refer to any material or substance that flows or moves, whether in a semisolid, liquid, sludge, gas, or any other form or state.

Formation. A formation is a body of consolidated or unconsolidated rock, characterized by a degree of lithologic homogeneity that is prevailingly, but not necessarily, tabular and is mappable on the earth surface or traceable in the subsurface.

Formation Fluid. Formation fluid is present in a formation under natural conditions, as opposed to introduced fluids (such as drilling mud).

Fully Penetrating Well. A fully penetrating well is drilled to the bottom of an aquifer and constructed in such a way that it withdraws water from the entire thickness of the aquifer.

Gaining Stream. A gaining stream is one in which the flow is being increased by inflow of groundwater (that is, effluent with respect to groundwater). The hydraulic head of the stream surface has a lower potential than the surrounding groundwater environment, so groundwater is discharged to the stream.

Glacial Overburden. The glacial overburden is a relatively impermeable mix of clay, silt, sand, gravel and cobbles which overlies bedrock and the Great Miami Aquifer.

Grab Sample. A grab sample is a discrete sample representative of a specific location at a specific point in time.

Groundwater. Groundwater is water under the earth's surface that forms a natural reservoir, water at or above atmospheric pressure which is below the land surface in the zone of saturation, or water in a saturated zone or stratum beneath the surface of land or water.

Gully or Rill. This is a miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage. A rill is of lesser depth and can be smoothed over by ordinary tillage.

Hazardous Substance. As defined under RCRA (42 USC 6903, section 1004), a hazardous substance is (A) any substance designated pursuant to section 311(b)(2)(A) of the Federal Water Pollution Control Act, (B) any element, compound, mixture, solution, or substance designated pursuant to section 102 of this Act, (C) any hazardous waste having the characteristics identified under, or listed pursuant to, section 3001 of the Solid Waste Disposal Act (but not including any waste the regulation of which, under the Solid Waste Disposal Act, has been suspended by Act of Congress), (D) any toxic pollutant listed under section 307(a) of the Federal Water Pollution Control Act, (E) any hazardous air pollutant listed under section 112 of the Clean Air Act, and (F) any immediately hazardous chemical substance or mixture with respect to section 7 of the Toxic Substances Control Act. The term does not include petroleum, including crude oil or any fraction thereof which is not specifically listed or designated as a hazardous substance under subparagraphs (A) through (F) of this paragraph, and the term does not include natural gas or synthetic gas useable for fuel (or mixtures of such synthetic and natural gas).

Hazardous Waste. As defined under RCRA (42 USC 6903, section 1004), a hazardous waste is a solid waste or combination of solid wastes which, because of its quantity, concentration, or physical, chemical or infectious characteristics may (A) cause or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or (B) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed. Disposal, treatment or storage of hazardous wastes can only take place in a site or facility which holds a permit from the state or federal EPA.

Holding Time. For validation purposes, the holding time is the time from sample collection to laboratory analysis.

Hydraulic Conductivity. This is a coefficient of proportionality describing the rate at which water can move through a permeable medium. The density and kinematic viscosity of the water must be considered in determining hydraulic conductivity.

Instrument Detection Limit. This is three times the standard deviation obtained from the analysis of a standard solution (in reagent water) at a concentration of three to five times the IDL on three non-consecutive days with seven consecutive measurements per day. The IDL is estimated sequentially until subsequent estimates do not change.

Laboratory Control Sample. The LCS is a control sample of known composition that is analyzed using the same sample preparation, reagents, and analytical methods used in the analysis of characterization samples.

Laboratory Project Manager. This individual is employed by a laboratory and is responsible for overseeing the analysis and reporting of all samples from FEMP for a particular program or project. The laboratory project manager is also responsible for day-to-day liaison with the FEMP project contact.

Leachate. Natural leachate is liquid that has percolated through solid waste and dissolved soluble components, and any liquid, including any suspended components in the liquid, that has percolated through or drained from waste materials. In a laboratory setting, leachate refers to the result of TCLP extraction.

Losing Stream. A losing stream is influent with respect to groundwater (i.e., there is a net loss of stream water to the groundwater system). The hydraulic head of the stream surface has a greater potential than the surrounding groundwater environment, so the stream water contributes recharge to the aquifer.

Lower Limit of Detection. The LLD is the minimum count rate that can be routinely detected (radionuclide analyses).

Matrix Spike. The matrix spike is a known concentration of a spiking substance that is introduced into a sample to provide information about the effect of the sample matrix on the digestion and measurement method and on the accuracy of the result.

Method Blank. A method blank is prepared with the same reagents and put through the same processing as the samples.

Micro-Purge. Micro-purge is a method for low flow, low volume representative groundwater sampling.

Minimum Detectable Activity. The MDA is the smallest quantity of a radionuclide that can be detected in a sample with a 95 percent confidence level.

Monitoring Well. This is a well installed in a selected location and screened at a specific depth to allow monitoring of chemical and hydraulic parameters of the groundwater and aquifer. Wells are sequentially numbered and designated by the first digit in the well number according to the hydrogeologic zone in which they are screened. Type 1 wells are screened in the glacial till. Type 2 wells are screened across the top of the Great Miami Aquifer. Type 3 wells are screened in the general middle of the aquifer. Type 4 wells are screened ten feet above underlying bedrock.

National Priorities List. The EPA's list of the most serious uncontrolled or abandoned hazardous waste sites identified for possible long-term remedial response using Superfund. The list is based primarily on the site's Hazardous Ranking System score. The FEMP was added to the NPL in 1989.

Open-Channel Flow. Open channel flow has a free surface within definable, continuous-channel boundaries, such as a stream, river, or unconfined flow in a conduit.

Overland Flow. Overland flow commonly refers to the flow resulting when rainfall rates exceed surface infiltration rates. It is defined as water flowing over the land surface without the ordinary constraint of definable, continuous channel boundaries, and may also include flood flows, also termed channel-excess flows. One characteristic of overland flow is that it is ephemeral.

Partially Penetrating Well. A partially penetrating well is constructed in such a way that it draws water directly from a fractional part of the total thickness of the aquifer. The fractional part may be located at the top or the bottom of the aquifer or anywhere in between.

pH. The pH of a solution is defined as the negative logarithm of hydrogen ion activity in moles per liter, and is a measure of effective hydrogen ion concentration. The pH value determines the basic or acidic nature of a sample.

Piezometer. A piezometer is a bored, drilled, or driven shaft or a dug hole with a depth greater than the largest surface width; a shaft or pit dug or bored into the earth, generally cylindrical, and often walled with bricks or tubing to prevent earth from caving in with its main purpose being to monitor groundwater elevation or pressure; or a nonpumping well used to measure the elevation of the water table or potentiometric surface.

Ponding. Ponding refers to standing water on soils in closed depressions. The water can be removed only through percolation or evapotranspiration.

Practical Quantitation Limit. The PQL is the lowest quantity of analyte in a sample that can be reliably detected within specified limits of precision and accuracy during routine laboratory operating conditions. For radiochemical measurements, this is interpreted to mean the minimum quantity of analyte in a sample which results in a total propagated uncertainty (at the 95% confidence level) which is 20% of the measured value.

Precision. Precision refers to the measure of the repeatability of an analysis or measurement. Measurements that are repeatable within small limits are said to be precise.

Process Wastewater. Process wastewater is any water that, during manufacturing or processing, comes into direct contact with, or results from, the production or use of any raw material, intermediate product, finished product, byproduct, or waste product.

Program. In the context of this SCQ, a program is a defined set of ongoing activities, such as routine monitoring, that will be continued in basically the same format for an indeterminate length of time (e.g., the CERCLA Program, Environmental Compliance Monitoring Groundwater Program, and Environmental Monitoring Program). Programs are

subject to the same substantive requirements regarding sampling and analysis as projects. Because projects may be subsets of programs, all SCQ requirements for projects also apply to programs conducting similar activities.

Project. In the context of this SCQ, a project is a defined set of activities pursued towards a defined final conclusion. Examples of projects at the FEMP include the remedial investigation/ feasibility studies for each operable unit, removal site evaluations, and removal actions. A project may be included within a program.

Project Contact. The project contact serves as the project liaison with laboratory or other subcontractor personnel during the course of a project.

Project Manager. The project manager is responsible for the execution and completion of a project. This individual is usually a Fluor Daniel Fernald employee.

Project-Specific Plans. PSPs are scoping documents required for any program or project. Project-specific plans for FEMP sampling and analysis activities should include elements defined in Section 6 of the SCQ. Project-specific plans may include, but are not limited to, work plans, field sampling plans, health and safety plans, and standard operating procedures.

Raffinate. Raffinate is an aqueous solution and impurities (dissolved and suspended solids) resulting from the process of converting uranium ore and other source material to uranyl nitrate.

Reagent Blank. See Method Blank.

Recharge. A recharge is a natural or artificial process by which water is added to the saturated zone of an aquifer.

Recharge Area. The recharge area contains downward components of hydraulic head in the aquifer. Infiltration moves downward into deeper parts of an aquifer in a recharge area. A recharge area is where water reaches the groundwater by surface infiltration.

Record of Decision. The ROD is a public document that explains which cleanup alternatives will be used at a National Priorities List site. The ROD is based on information and technical analysis generated during the Remedial Investigation/Feasibility Study and consideration of public comments and community concerns.

Redox Potential. The redox potential is the expected level of oxidation and reduction of elements in water. A measure of aqueous electron concentration controlled by reactions involving elements present in more than one oxidation state.

Relative Percent Difference. The RPD is a measure of precision using results from duplicate analyses.

Remedial Action. Remedial Actions are consistent with permanent remedies taken instead of, or in addition to, removal actions in the event of a release or threatened release of a

hazardous substance into the environment to prevent or minimize the release of hazardous substances so that they do not migrate to cause substantial danger to present or future public health or welfare or the environment.

Remedial Design. The Remedial Design phase begins after the ROD is entered. This phase includes development of engineering drawings and specifications for a site cleanup.

Remedial Investigation/Feasibility Study. The RI/FS consists of two distinct but related studies that are usually performed concurrently. The Remedial Investigation is intended to gather data necessary to determine the types and extent of contamination at a Superfund site and assess risk to human health and the environment posed by identified contamination. The Feasibility Study identifies and screens cleanup alternatives and produces a detailed analysis of the technology and costs of remedial alternatives.

Removal Action. A removal action is a short term, immediate action that is taken to address releases of hazardous substances that require expedited response.

Removal Site Evaluation. The RSE is conducted to determine whether a site poses an imminent or potential hazard to human health and the environment requiring initiation of a removal action.

Representative Sample. A representative sample is taken as a typical example of a group, class or quality. For characterization purposes, representative samples may be extreme.

Rill. See Gully.

Runoff. Runoff is (1) precipitation discharged into stream channels from an area. Surface runoff is water that flows off the surface of the land without sinking into the soil. Water that enters the soil before reaching surface streams is called groundwater runoff or seepage flow from groundwater (U.S. Soil Conservation Service) or (2) any rain water, leachate, or other liquid that drains overland from any part of a facility.

Sample Delivery Group. This is a group of samples, usually fewer than 20, received over a period of up to 14 calendar days. Data from all samples in an SDG are contained in one data package. SDG is synonymous with data package in that the results from the samples in the SDG are (usually) reported in the one package.

Sample Management Organization. The sample management organization has overall coordination of sampling and analytical activities in support of the FEMP projects. It has responsibility for tracking samples through the analytical process, including the packaging and shipping of samples to offsite laboratories and the distribution of sample to onsite laboratories. It also has responsibility for management of laboratory subcontracts.

Sample Receiving Group. This is a subsection or group that receives samples directly from the sampling team. The sample receiving group then distributes the samples to an

onsite laboratory or packages and ships them to an offsite subcontract laboratory for the required analysis.

Sampling Activity. The sampling activity is the total of a number of steps required to be completed to collect a single sample.

Sampling Event. The sampling event refers to collection of a sample from a single location for a specific project.

Sampling Round. The sampling round refers to collection of samples from one or more locations for a specific project during a specified time period for a similar purpose.

Saturated Zone. The saturated zone is where the voids in the rock or soil are filled with water at a pressure greater than atmospheric. The water table is the top of the saturated zone in an unconfined aquifer.

Seep. Seep refers to an area where water oozes from the earth, a surface expression of the water table, or a small spring with little or no discernable flow.

Site. The site "shall include all areas within the property boundary of FMPC [now FEMP] and any other areas that received or potentially received released hazardous substances, pollutants, contaminants, or hazardous constituents. The term shall have the same meaning as `facility' as defined by Section 101(9) of CERCLA, 42 U.S.C. §9601(9)." (Consent Agreement, April 9, 1990)

Slag. Slag, as defined at the FEMP, is a collection of waste solids derived from the molten processing of uranium metal.

Specific Conductance. Specific conductance is the ability of a solution to carry an electric current under specific conditions. This characteristic indicates concentration of dissolved solids in water.

Spring. A spring is a flow of water from the subsurface to the surface that occurs without artificial aid. It also refers to a surface expression of the water table.

Standard. (noun) In context of equipment calibration, a standard is something set up and established by authority as a rule for the measurement of a parameter (e.g. concentration, length, temperature, mass). (adj) A standard is a regularly and widely used method (e.g. standard operating procedure), material (e.g. standard gauge), or calculation (e.g. standard deviation).

Standard Purge. A standard purge is a high volume or high flow method for obtaining a representative groundwater sample.

Stream. A stream is any body of flowing water or other fluid.

Subcontractor. A subcontractor is an individual or organization that performs a service for the FEMP while contracted to Fluor Daniel Fernald.

Subcontract Technical Representative (STR). The STR is a FEMP employee assigned to work with a specific subcontractor (usually a laboratory) on contract and/or technical issues. This person serves as the Contracting Officer Technical Representative (COTR).

Surface Water. Surface water is open to the atmosphere and subject to surface runoff.

Surveillance. Equivalent to an EPA performance audit, a surveillance is a spot check of program implementation to determine conformance to specified requirements.

Teflon. Teflon is a fluorocarbon plastic manufactured by the DuPont Corporation. In this document, teflon refers to any fluorocarbon plastic.

Tracer. A tracer is a small quantity of a (usually) pure radionuclide, different than those of interest, but expected to behave similarly (i.e., is added to a sample to determine the effect of processing and to derive a correction factor if necessary).

Tremie Line Method of Grouting. The tremie line method involves inserting grout into a borehole to ensure that there are no void spaces. A hose or pipe is inserted into a borehole to within five feet of the bottom of the opening. Grout is pumped through the hose or pipe. As the borehole fills, the tremie line is retracted at approximately the same rate as the hole is filling.

Unconfined Aquifer. Also called water table aquifer, an unconfined aquifer has no confining beds between the zone of saturation and the surface.

Unsaturated Zone. The unsaturated zone is between the land surface and the water table. It includes the root zone, intermediate zone, and capillary fringe. The pore spaces contain water at less than atmospheric pressure, as well as air and other gases. Saturated bodies, such as perched groundwater, may exist in the unsaturated zone.

Validation (of software). The process of evaluation software at the end of the entire development process to ensure compliance with software requirements.

Verification Testing (of software). Confirmation by examination and provision of objective evidence that the hardware/software configuration, via the software programming, produces valid results for test problems that encompass the range of permitted usage defined by specified requirements.

Waste Stream. This is a term used to describe the total volume of waste leaving a facility or operation or specific segments thereof (e.g., "chlorinated solvent waste stream" or "recyclable waste stream").

Water Table. The water table is the surface in an unconfined aquifer or confining bed at which the pore water pressure is atmospheric. It can be measured by installing shallow wells extending a few feet into the zone of saturation and then measuring the water level in those wells.

Well. A well is a hydraulic structure which, when properly designed and constructed, permits the effective monitoring of chemical, radiological or hydraulic parameters, or the economic withdrawal of water from a water-bearing formation.

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Section 1

INTRODUCTION

The Fernald Environmental Management Project (FEMP) is a former uranium processing facility owned by the U.S. Department of Energy (DOE). The current mission of the FEMP is waste management and environmental restoration; as such, it is subject to a wide range of environmental statutes and regulations.

DOE entered into a Federal Facilities Compliance Agreement (FFCA) with the U.S. Environmental Protection Agency (USEPA) in 1986. The 1986 FFCA dealt with environmental issues regulated by the Clean Air Act (CAA), the Resource Conversation and Recovery Act (RCRA), and the Comprehensive Environmental Response Compensation and Liability Act (CERCLA).

Since then, the FEMP was added to the National Priorities List (NPL) for environmental cleanup as mandated by the CERCLA. This necessitated implementation of a new agreement between the DOE and USEPA, so the two parties entered into a Consent Agreement in April 1990, which was subsequently amended.

The USEPA requires that mandated environmental monitoring and measurement programs must contain a centrally managed Quality Assurance (QA) program. Parties generating data under such a program are required to implement procedures that ensure precision, accuracy, completeness, and representativeness of the data and documentation thereof (U.S. Environmental Protection Agency, 1996b).

1.1 PURPOSE

Collection and analysis of environmental samples is an integral part of fulfillment of the site mission and compliance with environmental regulations. A single sample of a specific medium from a specific location may be capable of providing data for a number of investigation, restoration, waste management, and regulatory uses. Therefore, it is necessary that investigation sampling and analysis be conducted to provide useable, valid data of known quality so that use across programs is possible and that the level of uncertainty associated with such use is known.

The Sitewide CERCLA Quality Assurance Project Plan (SCQ) was developed for FEMP environmental sampling and analysis with a twofold purpose: (1) establish minimum standards of performance for operational and analytical activities, and (2) ensure that those standards are followed by parties covered by the plan (as defined in Section 3).

This document is a revision of the Quality Assurance Project Plan prepared for the FEMP Remedial Investigation/Feasibility Study (RI/FS), which fulfills requirements of the 1986 FFCA between the DOE and the USEPA. Inclusion of the FEMP on the NPL resulted in a subsequent decision to modify the RI/FS Quality Assurance Project Plan to encompass all site programs generating environmental data, ensuring useability of the data for the FEMP CERCLA program. The SCQ integrates CERCLA requirements into applicable sampling activities at the FEMP,

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consistent with USEPA recommendations to consolidate QA requirements and documents whenever possible (U.S. Environmental Protection Agency, 1989a).

1.2 SCOPE

The SCQ was developed to direct environmental sampling and analysis to support ultimate remediation of the site. To this end, ongoing and future environmental projects at the FEMP shall comply with Quality Assurance/Quality Control (QA/QC) requirements specified herein. The following projects are included in the FEMP activities that are now or previously were covered by the SCQ:

A. **Remedial Investigation/Feasibility Study (RI/FS) (Completed)** - Consists of two distinct but related studies conducted at NPL sites that are usually performed concurrently. During the FEMP RI, data were gathered to determine the nature and extent of contamination at and from the FEMP's operable units (OUs) and to assess risks to human health and the environment. The FS process also identified cleanup requirements and provided detailed analyses of potential technologies and estimated costs of remedial alternatives. With this information, Proposed Plans were issued for each OU. Following the appropriate period of public review and comment for each Proposed Plan, DOE formulated a Record of Decision (ROD) for each OU. RI/FS activities at the FEMP are now complete. The last scheduled ROD, that of OU5, was signed on January 31, 1996.

B. **Removal Site Evaluations (RSEs) (Completed)** - Assessment of the need for a removal action required by ongoing or threatened release of contaminants that, without immediate response, could adversely impact public health or the environment.

C. **Removal Actions (RvAs)** - Short-term, immediate actions that address releases of hazardous substances which require an expedited response.

D. **Remedial Design (RD)** - Engineering phase that follows the Record of Decision, when technical drawings and specifications are developed for subsequent remedial action.

E. **Remedial Actions (RA)** - Construction or implementation phase that follows remedial design of a selected cleanup alternative.

F. **Operable Unit Completion.**

G. **Closeout/NPL Deletion.**

H. **Operation and Maintenance.**

I. Other programs and activities at the FEMP (many of which are also incorporated into the RD and RA activities) that require collection and analysis of samples under SCQ criteria include the following:

   1. RCRA groundwater monitoring;

   2. RCRA closures;

3. CAA monitoring, including monitoring for National Emissions Standards for Hazardous Air Pollutants (NESHAP) compliance;

4. CWA;

5. Safe Drinking Water Act (SDWA);

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6. National Environmental Policy Act (NEPA);

7. Toxic Substances Control Act (TSCA);

8. DOE Orders 5400.1, 5400.5, 5820.2A;

9. Underground storage tank closures;

10. Waste management activities under RCRA, CAA, CWA, etc.;

11. Construction.

The SCQ is designed to ensure that work performed for environmental programs and supporting activities at the FEMP are of adequate quality to fulfill project-specific Data Quality Objectives (DQOs). The organization, objectives, functional activities, and specific QA/QC activities associated with the CERCLA program at the FEMP are presented. Basic requirements for sampling, sample handling and storage, chain of custody records, and laboratory and field analyses are specified in the sections and appendices of the SCQ.

1.2.1. Geotechnical Testing and the SCQ

Geotechnical tests conducted on soils, sludge, and waste for treatability studies or engineering design purposes are bound to the requirements of the SCQ. Analyses and measurements for engineering design shall be conducted in accordance with standard methods (see Section 5.3.3) at a laboratory facility that has been audited and approved by the FEMP QA Organization (see Sections 3.4, 9.9, and 12.4). Engineering data that will not be used for environmental decision making, as determined through the DQO process, are excluded from other administrative requirements of the SCQ.

1.2.2 Use of Data

Data generated in accordance with the requirements of the SCQ are intended to fulfill defined needs of the DOE, USEPA, Ohio Environmental Protection Agency (OEPA), and the public. Sampling efforts implemented under the SCQ are designed to accomplish the following:

A. Assess environmental conditions in air, soil, groundwater, surface water and other environmental media;

B. Assess variability in the measurement process along with sources and magnitude of variation in results generated;

C. Provide a means of determining whether a sampling program meets DQOs;

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D. Assess whether remediation activities meet specified cleanup levels for completion and closeout/deletion activities.

1.2.3 SCQ Development

QA/QC procedures in the SCQ were developed in accordance with applicable USEPA guidelines, DOE orders, professional technical standards, regulatory requirements, and specific project goals and requirements. The following documents were considered:

A. *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans* (U.S. Environmental Protection Agency, 1983);

B. *Superfund Remedial Design and Remedial Action (RD/RA) Guidance* (U.S. Environmental Protection Agency, 1986);

C. DOE Order 5700.6C Change 1, Quality Assurance (U.S. Department of Energy, 1996a);

D. 10 CFR 830.120, Quality Assurance Requirements;

E. DOE Order 241.1, Managing the Department of Energy's Scientific and Technical Information (U.S. Department of Energy, 1986);

F. *Data Quality Objectives for Remedial Response Activities* (U.S. Environmental Protection Agency, 1987a);

G. *Guidance for Conducting Remedial Investigations and Feasibility Studies (RI/FS) Under CERCLA* (U.S. Environmental Protection Agency, 1988);

H. *Content Requirements for Quality Assurance Project Plan* (Tsai, 1989);

I. *Final Standard - Quality Assurance Project Plan Content Document* (U.S. Environmental Protection Agency, 1989b);

J. DOE Order 2321.1, Auditing of Programs and Operations (U.S. Department of Energy, 1990a);

K. *Quality Assurance/Quality Control Guidance for Removal Activities* (U.S. Environmental Protection Agency, 1990a);

L. *Model Quality Assurance Project Plan* (U.S. Environmental Protection Agency, 1996a);

M. *Guidance for Data Useability in Risk Assessment* (U.S. Environmental Protection Agency, Interim Final, 1990b);

N. *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual* (U.S. Environmental Protection Agency, 1996b);

O. *EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations, Draft Interim Final.* EPA QA/R-5, August 1994. (U.S. Environmental Protection Agency, 1994a);

P. *Data Quality Objectives Process for Superfund, Interim Final Guidance.* EPA/540/G-93/071, September 1993. (U.S. Environmental Protection Agency, 1993);

Q. *Guidance for the Data Quality Objectives Process, Final.* EPA QA/G-4, September 1994b. (U.S. Environmental Protection Agency, 1994b).

R. *EPA Requirements for Quality Management Plans, Draft Interim Final.* EPA QA/R-2, August 1994. (U.S. Environmental Protection Agency, 1994g).

In addition, SCQ requirements are consistent with the intent of other DOE Orders and USEPA guidance documents that pertain to environmental sampling and analysis.

The SCQ provides for document changes in response to evolving program needs as new projects are implemented at the FEMP. The SCQ is intended to be a dynamic document in that it meets current site needs while retaining the flexibility to respond to advances in analytical methods, field techniques, operating procedures, and changes in the FEMP mission.

Techniques and procedures are specified in the SCQ. As improvements are proposed and accepted, document change requests (DCRs) will be drafted and distributed for comment and approval (see Section 4.4.3.3). References to USEPA guidance documents, journal articles, textbooks, and FEMP contractor methods and guidelines are an integral part of this document. Referenced documents are available to users and reviewers as public documents or upon request to the DOE Fernald Field Office (DOE-FEMP). Referenced DOE orders are available from the FEMP library.

1.3 USE OF THE SCQ

The FEMP SCQ is not a standard quality assurance project plan. It differs from the typical CERCLA RI/FS quality assurance project plan because of the complex and diverse nature of the activities and waste sources at the site. The SCQ provides overall sitewide quality assurance planning for sampling and analysis activities planned or ongoing at the FEMP. These activities include non-CERCLA environmental monitoring as noted in Section 1.2.I.

As previously stated in Section 1.1, the SCQ was developed to fulfill two primary purposes:

- To establish minimum standards of performance for operational and analytical activities;
- To ensure that those standards are followed by all parties covered by the document.

The SCQ is a cross between a quality assurance program plan and a quality assurance project plan. Requirements for planning, implementation of plans, and assessment of activities are included in the SCQ so that it may be used like a QA program plan as defined by the USEPA (1980 and 1994a). The SCQ also fulfills the requirements of a QA project plan as defined by the USEPA (1983 and 1994b), except that it does not include portions that refer to specific samples.

Planning requirements are identified in Sections 2, 3, and 4; Appendices C, E, and F; and, to a lesser degree, Sections 5, 6, and 7. Implementation requirements are set forth in Sections 5, 6, 7, 8, 9, 10, and 13, and in Appendices I, J, and K. Assessment requirements are defined in Sections 11, 12, 14, and 15; Appendices D and F; and, to a lesser degree, Section 4 and Appendix E.

1.4 ASSOCIATED DOCUMENTS

1.4.1 Laboratory Analytical Methods

Appendix G of the SCQ specifies standardized methods or performance criteria to be used for analyzing samples for a wide range of parameters of interest at the FEMP.

1.4.2 Project-Specific Plans

Project-specific plans (PSPs) shall be generated for each project requiring sampling and analysis. PSPs shall complement and enhance the SCQ where appropriate and are not intended to repeat information contained in the SCQ. PSPs shall serve as comprehensive plans (Section 3) that include the following information:

A. Historical information relevant to the specific project;

B. Assessment of existing data;

C. Identification of data needs, intended data use, and quality requirements through inclusion of the approved DQO;

D. Sample collection points and how they were chosen;

E. Methods for collecting samples, either by reference to the SCQ or through incorporation of specific procedures, including field QA/QC requirements and the types of samples that will be collected (grab, composite, core, COLIWASA, etc.);

F. Analytical methods to be used and corresponding analytical support levels (ASLs) (Section 2) including laboratory QA/QC requirements;

G. A summary of sample information which includes the following, at a minimum:

   1. The specified ASL;

   2. The analyte of interest for which sampling will be conducted. Be as specific as possible. If referring to a group of analytes, clarify this reference (i.e., state "all PCBs" or "all VOCs");

   3. The decision (action) level for each analyte, if applicable;

   4. The sample matrix;

   5. The analytical method. Reference the appropriate method in Section 9 and Appendix G. For ASL A, identify the field instrument used;

6. The sample summary table for all samples at all ASLs.

PSPs shall be scoped as required by the specific regulatory or program requirements. Section 1.5 outlines the relationship between the SCQ and PSPs.

1.4.3 Health and Safety Plan

Health and safety requirements, in accordance with 29 CFR 1910 and 1926, are documented in the Safety Performance Requirements Manual (RM-0021). Although some of the instruments used in health and safety monitoring are also used for environmental screening, the requirements of the SCQ do not apply to health and safety monitoring. Requirements for generation of project-specific health and safety plans are included in the site health and safety plan.

1.5 IMPLEMENTATION OF THE SCQ

The steps involved in implementing the SCQ are as follows:

A. Identify a problem or a project requiring collection and analysis of environmental data.

B. Identify applicable SCQ requirements.

C. Initiate generation of the PSP.

D. Define the DQOs.

E. Review and revise the DQOs.

F. Receive approval of the DQO.

G. Prepare the PSP.

H. Review and revise the PSP.

I. Submit the PSP for agency review, if applicable.

J. Revise the PSP, if necessary.

K. Receive agency approval of the PSP, if applicable.

L. Implement the PSP.

M. During project execution the project objectives may change and the DQOs and PSP may need to be revised. If so, the following additional steps shall be taken:

1. Revise the DQOs and the PSP.

2. Revisions shall be reviewed and approved by the persons or organizations who reviewed and approved the original document.

3. Submit revisions of DQOs or PSPs for projects mandated by the Amended Consent Agreement or Consent Decree to the appropriate agency for approval, if applicable.

4. Obtain agency approval of applicable revised PSPs.

5. Implement the revised DQOs/PSP.

6. If it is necessary to deviate from procedures or drawings when implementing PSP requirements, a variance may be written to identify those changes necessary for work to proceed (see Section 15.3).

1.5.1. DQO/PSP Process

The DQO process (Appendix C) focuses on providing data that are useful for the purposes of a project's stated objectives. The process results in preparation of a logic flow statement (including a decision rule or potential subsequent actions) that shall be kept as part of the permanent record. All potential uses of data shall be considered when preparing DQOs. For example, samples collected from domestic drinking water wells as part of DOE requirements may also be used in a planned risk assessment. This could result in choosing a different laboratory analytical method than if the data were used only for DOE environmental monitoring.

The project manager is responsible for ensuring that a DQO is developed for each PSP. The project manager shall also ensure that the appropriate persons or organizations, including QA, have reviewed the DQO. The completed DQO must be signed by the responsible project manager and the DQO Coordinator to note approval.

The DQO coordinator is responsible for overall control of the DQO process at the FEMP. This includes assigning DQO numbers, ensuring that all required approvals have been received, distributing the approved controlled documents, and storing the DQO files (see Appendix C).

A PSP shall be prepared for each project incorporating sampling and analysis (see also Section 3.3 *et seq.*). Each sampling activity conducted for the project shall be defined in the PSP. Preparation of the PSP can be started simultaneously with preparation of DQOs, but the DQO process must be completed before the PSP can be completed. A copy of the approved DQO must be attached to the PSP and incorporated as a reference. Based on the information in the DQOs, the PSP shall specify the following requirements:

A. Sample design:

1. Number of samples;

2. Location of sample collection points;

3. Frequency of sample collection;

4. Collection method.

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B. Analytical requirements:

1. Target parameters;

2. Detection limits;

3. Analytical support level.

C. QC Requirements;

1. Field QC samples;

2. Laboratory QC samples;

3. Parameters or measures;

4. Frequency;

5. QC limits;

6. Assessment and oversight activities;

7. Action levels;

8. Data validation;

9. Data management.

1.5.2. PSP Review and Approval

After a draft PSP is prepared, it shall be reviewed by the project manager, the designated FEMP QA organization, and groups potentially affected by the activity (see Section 3.3.3). The review serves the following purposes:

A. Provides a detailed technical review to ensure that accepted scientific and engineering practices and standardized or approved approaches are specified;

B. Ensures integration and coordination of individual activities of each PSP with overall FEMP restoration goals;

C. Reduces duplication of sampling efforts;

D. Improves the use of data for multiple purposes;

E. Provides consistency to sample collection efforts.

Upon comment resolution, the PSP will be approved by the project manager, the implementing organization, and FEMP QA for controlled distribution.

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1.5.3. PSP Implementation

PSPs or work plans required as part of the 1991 Amended Consent Agreement activities shall be reviewed by Ohio Environmental Protection Agency) OEPA and reviewed and approved by USEPA prior to implementation (see Section 3). PSPs generated in response to requirements of the Consent Decree with the state of Ohio shall be reviewed by OEPA and USEPA. Draft PSPs shall be revised until approved by DOE-FEMP for outside agency review. Based on agency review comments, PSPs shall be revised until approved. Upon receipt of agency approval, the PSP shall be implemented according to the schedule in the plan. Implementation of the PSP shall consist of the following major steps:

A. Sample collection and field work;

B. Laboratory analysis;

C. Data validation, if required;

D. Data management;

E. Data interpretation and analysis;

F. Reporting results;

G. Decision for action on problem or compliance with requirement.

Feedback loops shall be provided in the execution of the project between data validation and laboratory analysis and between data interpretation/analysis and DQO preparation. Data validation can result in a requirement for the laboratory to reanalyze a sample because of failure to comply with QC requirements. In extreme cases, resampling may be required. These feedback loops may require revisions in the DQOs and PSP.

Data analysis and interpretation may result in the realization that data may be used for a purpose different than originally intended. The DQO process shall then be reviewed to determine if the data are suitable for the new purpose.

Projects ongoing at the time of the original SCQ implementation require special consideration. The scope of work for these projects is included in previously approved documents and may include certain details which differ from the SCQ. These differences shall be identified and evaluated for each project to determine the effect of changes on data comparability and confidence. Changes to project-specific documents shall be made on a case-by-case basis when it is determined that the benefits to data quality and comparability outweigh potential losses due to the changes. Requirements will not be changed for ongoing projects where no discernable benefit will be gained. Ongoing projects do not require development of DQOs and PSPs if comparable documentation exists.

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Section 2

Section 2

PROJECT DESCRIPTION

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The Fernald Environmental Management Project (FEMP) is owned by the U.S. Government and was formerly a uranium processing facility known as the Feed Materials Production Center.

2.1 SETTING AND SITE HISTORY

2.1.1 Setting

The FEMP is located in a rural area of southwestern Ohio approximately 17 miles northwest of downtown Cincinnati, Ohio, and eight miles southwest of Hamilton, Ohio. The FEMP site comprises 1,050 acres bounded by State Highway 126 to the north, Willey Road to the south, Paddys Run Road and the Chesapeake and Ohio Railroad to the west, and a power transmission line right-of-way to the east. The former production area occupies approximately 136 acres in the center of the DOE property. The villages of Fernald, New Baltimore, Ross, New Haven, and Shandon are located within a few miles of the plant (U.S. Department of Energy, 1990c).

Ground elevations at the FEMP range from approximately 700 feet above mean sea level (msl) along the northern boundary to approximately 550 feet above msl where Paddys Run leaves the property near the southwest corner. Natural surface runoff at the plant is generally east to west into Paddys Run, which flows south to the Great Miami River. Runoff from the northeast corner of the FEMP drains into a small, intermittent tributary of the Great Miami River. Surface runoff within the former plant production area is captured in a storm sewer system that discharges to a storm water retention basin where solids are allowed to settle. Water from the basin is treated at the Advanced Wastewater Treatment Facility (AWWT) along with storm water from the waste pit area and other process wastewaters. The South Plume groundwater is extracted from a well field installed at the leading edge of the uranium contamination plume from the FEMP. A portion of the South Plume water is treated by the South Plume Interim Treatment system and some may be routed to the AWWT as capacity permits. The South Plume discharge was installed and approved under CERCLA Removal Action 3. The combined AWWT and South Plume discharge combines with wastewaters from the Sewage Treatment Plant and from the noncontaminated side of the General Sump at Manhole 176B and is discharged to the Great Miami River through an effluent line permitted under the National Pollutant Discharge Elimination System (NPDES) provisions of the Clean Water Act.

Before construction of the storm water retention basin, storm flows in excess of the capacity of the main effluent line were discharged to the storm sewer outfall ditch (SSOD). These runoff events are suspected of contributing significant amounts of contaminants from the main plant area to the surface water system (U.S. Department of Energy, 1990c).

A glacial overburden, ranging from zero to approximately fifty feet thick, underlies most of the FEMP. The overburden is composed primarily of poorly sorted, clay-rich till with various interbedded glaciofluvial (glacial stream), lacustrine (lake), and loess (wind blown) deposits of lenticular geometry (U.S. Department of Energy, 1990c).

Extensive valley-fill outwash deposits of medium- to well-sorted sands and gravels, averaging about 150 feet thick, underlie the glacial overburden deposits. The outwash overlies well-indurated shale and limestone bedrock. The outwash under the former production area is separated into an upper and lower unit by a clay-rich lacustrine deposit, locally referred to as blue clay, which ranges from zero to about 20 feet in thickness (U.S. Department of Energy, 1990c). A generalized cross section of the subsurface in the FEMP area is included in Figure 2-2 in Appendix A.

Perched groundwater is present in hydrologic zones composed of coarser, better-sorted lenses within the glacial overburden and in coarse fill below buildings and along utility lines. Groundwater flow within the overburden is discontinuous and may be subject to extreme seasonal fluctuation. The upper 20 to 30 feet within the outwash is unsaturated. The remainder forms the Great Miami Aquifer (GMA), which has been designated a sole source aquifer by the EPA. Under the plant area, the GMA is separated into an upper and lower unit by the blue clay. The upper portion is unconfined and receives recharge from Paddys Run (a losing stream) and the SSOD, as well as the overburden. The lower portion is semiconfined and, probably, is primarily recharged by leakage through the blue clay (U.S. Department of Energy, 1990c).

Groundwater quality and water levels are monitored in the glacial overburden and at three different levels in the GMA. A simple numeric system is used to identify wells at the FEMP. The first digit always designates the hydrogeologic zone in which the well is screened; the last digits are sequentially assigned numbers. Clusters of different type wells at the same geographic location are assigned the same sequential number. Thus, wells with one as the first digit of the identification number (Type 1) are screened in the glacial overburden; wells with two (Type 2) as the first digit of the identification number are screened across the top of the GMA; wells with three as the first digit of the identification number (Type 3) monitor the approximate middle of the GMA at a depth above, and equivalent to, a discontinuous clay lens in the FEMP area; wells with four as the first digit of the identification number (Type 4) are installed to monitor the base of the GMA; wells with six as the first digit of the identification number (Type 6) are installed at a depth between that of a Type 2 well and a Type 3 well to effectively monitor movement of the contaminant plume.

Groundwater users in the area surrounding the FEMP draw primarily from the GMA. The most significant usage is by the Southwest Ohio Water Company, which operates a series of radial collector wells east of the FEMP. Groundwater is also produced from extraction wells or from other wells for non-potable uses. Other groundwater users include production facilities to the south of the FEMP, residents around the site, and other private and commercial users (U.S. Department of Energy, 1990c).

In the area around the FEMP, the portion of the Great Miami River that is not affected by the Southwest Ohio Water Company collector wells is a discharge area under normal hydrologic conditions. The lower portion of Paddys Run between New Haven Road and the Great Miami River is a gaining stream during part of the year and a losing stream at other times. Paddys Run is also a gaining stream where its bed is on the clay-rich glacial overburden (north of the K-65 area), as evidenced by small seeps and springs along its banks and tributaries.

The Great Miami River is a losing stream where drawdown induced through pumping of Southwest Ohio Water Company collector wells reduces the aquifer head below the stream

level. Paddys Run is a losing stream between the K-65 area and approximately New Haven Road. It loses flow to the aquifer along other stretches during periods of low flow.

2.1.2 Production History

The U.S. Atomic Energy Commission, predecessor to the DOE, began construction of the Feed Materials Production Center (now the FEMP) in 1951 and began operations there in 1952. Operations consisted of foundry and other processes to convert natural uranium ore concentrates and recoverable, recyclable residues into uranium metal and compounds. The primary function of the plant was production of metallic uranium fuel cores and uranium compounds for use in U.S. defense programs.

In addition to the primary uranium products, small amounts of thorium were produced. The site currently serves as the thorium repository for the DOE, where a variety of thorium materials are stored in long-term storage facilities. These materials are included in the waste shipments being sent to the Nevada Test Site (NTS) for disposal. During the 1950s, pitchblende ores containing uranium, Ra-226/228, and daughter products were processed at the site.

A variety of chemicals (e.g., nitric acid, anhydrous hydrogen fluoride, tributyl phosphate, magnesium metal, metal cleaning solvents, coolants, and lubricating oils) were used in the production processes. As a result of these operations, various types of liquid and solid matrix wastes were generated. These wastes can be broadly categorized as hazardous, nonhazardous, radioactive, and mixed (hazardous wastes with radioactive material).

Many solid and liquid wastes were stored or disposed on site. Radium-bearing wastes from pitchblende processing were stored in two concrete silos in a waste storage area west of the former production area (Figure 2-1 in Appendix A). Metal oxide wastes were stored in a third silo. A fourth silo was constructed, but remains unused. Uranium metal production wastes were placed in pits in the waste storage area and an onsite landfill was operated to dispose solid waste. Construction debris was disposed on site separately from the waste storage area, as was fly ash from the boiler plant.

Releases of contaminants from the FEMP to environmental media have been noted during past investigations (U.S. Department of Energy, 1990c). These releases include runoff to the SSOD and Paddys Run; discharges of uranium to the Great Miami River; and releases and spills of uranium-bearing materials, solvents, and other material to soils on the site property. Affected media include perched groundwater (radionuclides and volatile organic materials), groundwater in the Great Miami Aquifer (radionuclides and volatile organic compounds), surface water and sediments in Paddys Run and the Great Miami River (radionuclides), and, possibly, aquatic and terrestrial biota. It is also suspected that air emissions contributed to both onsite and offsite deposition of radionuclides. More detailed descriptions of site history and previous investigations are included in Section 2.2.3.

2.2 REGULATORY HISTORY AND CURRENT STATUS

2.2.1 Federal Facilities Compliance Agreement

The DOE Oak Ridge Operations Office entered into a Federal Facilities Compliance Agreement (FFCA) with the EPA pertaining to the FEMP (then Feed Materials Production Center) on 18 July 1986 pursuant to Executive Order 12088 (43 Federal Register 47707). The FFCA set forth the steps that will be taken to put the FEMP into compliance with existing environmental

statutes and implementing regulations. Key elements of the FFCA include bringing the site into compliance with the Resource Conservation and Recovery Act (RCRA) and initiating a Site Remedial Investigation/Feasibility Study (RI/FS) under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

2.2.2 Consent Agreement

The Feed Materials Production Center (now the FEMP) was added to the National Priorities List (NPL) in 1989. A Consent Agreement outlining activities and schedules to be performed to remedy the site condition was entered into by the DOE and EPA in April 1990. This agreement was revised in September 1991 and has been subsequently amended via letter amendments. Key elements of the agreement include incorporation of the FFCA as an attachment, recognizing that significant previous work was conducted, grouping the site into five operable units (OU) for characterization and remediation, adding (and later deleting) requirements for an optional sixth sitewide OU and setting a schedule for activities from completion of the RI/FS for each OU through signing of a Record of Decision (ROD).

OUs are groupings of site areas suspected of past releases of contaminants to the environment based on similarity of use, process, proximity to other sites, or type of potential contaminant. OUs requiring characterization and remediation at the FEMP are described in the 1991 Amended Consent Agreement as follows:

- **OU1** - Waste Pit Area: Waste Pits 1 through 6, Clearwell, Burn Pit, berms, liners, and soil within the OU boundary as approved in the RI/FS Work Plan Addendum;

- **OU2** - Other Waste Units: Fly ash piles, other southfield disposal areas, lime sludge ponds, solid waste landfill, berms, liners, and soil within the OU boundary as approved in the RI/FS Work Plan Addendum;

- **OU3** - Former Production Area: production area and production-associated facilities and equipment, above- and below-grade improvements, structures, equipment, utilities, drums, tanks, solid waste, waste product, thorium, effluent lines, K-65 transfer line, wastewater treatment facilities, fire training facilities, scrap metals piles, feedstocks, and coal pile, as approved in the RI/FS Work Plan Addendum;

- **OU4** - Waste Silos: Silos 1, 2, 3, and 4; berms; decant tank system; and soil within the OU4 boundary as approved in the RI/FS Work Plan Addendum;

- **OU5** - Environmental Media: all potential migration pathways, including groundwater, surface water, soil not included in the definitions of OUs 1 through 4, sediments, flora, and fauna as approved in the RI/FS Work Plan Addendum;

- **Comprehensive Sitewide Operable Unit** - Evaluation of selected remedies and removal actions for OUs 1 through 5 to ensure that they are protective of human health and the environment. The requirement for OU6 was deleted by USEPA in a letter amendment in 1996.

2.2.3 Operable Unit Descriptions and Status

This section of the SCQ provides a description and status of each operable unit. All five operable units have completed the evaluation of the nature and extent of contamination (RI),

evaluation of alternatives for remediation (FS), preferred alternative (Proposed Plan), and the ROD, which includes the selected remedy, the body of the ROD, and the responsiveness summary. Table 2-1 (Appendix A) provides a summary of each operable unit, a summary of the selected remedy (or remedies) for that unit, and the site project organizations responsible for implementing each operable unit remedy.

2.2.3.1 OU1. Operable Unit 1 is a well-defined 37.7-acre area located in the northwest quadrant of the FEMP site. Large quantities of liquid and solid wastes were generated by various chemical and metallurgical processing operations, and these wastes were stored or disposed in six waste pits and the Clearwell, or burned in the Burn Pit. These pits are located in a portion of the FEMP Waste Storage Area and are contained within the boundaries of Operable Unit 1.

The following is a brief summary of each component of OU1:

Approximately 480,000 cubic yards of waste material were disposed of in units comprising OU1. The bulk of solid waste was disposed of in pits 3 (245,000 cubic yards), 4 (57,600 cubic yards), and 5 (101,000 cubic yards). Approximately 3,700 cubic yards of water are in pit 5 (748,000 gallons) and 7,700 cubic yards of water are in the Clearwell (1,550,000 gallons) (U.S. Department of Energy, 1991c).

Since the beginning of uranium production operations in 1952, on-property storage facilities at the FEMP have been used for storage of low-level radioactive wastes generated by chemical and metallurgical processes used at the facility. These wastes have been deposited in one of six waste pits or Clearwell, or burned in the Burn Pit. The following six pits, Clearwell, and Burn Pit make up the 37.7 acres identified as OU1 (Figure 2-1, Appendix A).

- **Waste Pit 1** was constructed in 1952, by excavating into an existing clay lens and then lining the waste pit with clay excavated from an area that became the Burn Pit. The dimensions of the oval-shaped pit are approximately 165 feet wide by 347 feet long. A portion of the clay liner is reported to be up to four and one-half feet thick on the bottom and one and one-half to two feet thick on the sides. The surface area of Waste Pit 1 is 82,693 square feet. Waste Pit 1 is an average of 29.5 feet deep, and holds an estimated 48,500 cubic yards of buried waste consisting of neutralized waste filter cake, fly ash, 55-gallon drums, scrap graphite, brick scraps, sump liquor, sump cake, and depleted slag (by-product of the chemical reaction between uranium tetrachloride and magnesium).

  Waste Pit 1 materials contain an estimated 115,352 pounds of uranium. The presence of a large (but unknown) quantity of drums in Waste Pit 1 was evident in photographs taken during the years of active pit operation. The photographs indicate that most drums were empty, but the origin and nature of materials stored in these drums is unknown. The general consistency of Waste Pit 1 contents is semisolid to saturated eight feet below the pit surface (U.S. Department of Energy, 1991c). In 1959, Waste Pit 1 was backfilled and covered with clean soil.

- **Waste Pit 2** was constructed in 1957, excavated to a maximum depth of 23.5 feet into native clay at the site of a small pond east of Waste Pit 1, and lined with compacted native clay. The surface area of Waste Pit 2 is 44,896 square feet. It holds an

estimated 24,200 cubic yards of buried waste consisting of neutralized waste filter cake, graphite, fly ash, 55-gallon drums, brick scrap, sump liquor, sump cake, depleted slag, and a large quantity of concrete and other construction rubble.

Waste Pit 2 materials contain an estimated 2.66 million pounds of uranium and 890 pounds of thorium. The general consistency of the pit contents indicates semisolid and wet conditions eight feet below the pit surface.

In 1964, the pit was taken out of service, backfilled, and covered with clean soil. Waste Pit 2 is overgrown with grass and is fairly level with a gentle slope toward a drainage ditch running along the east side of Waste Pit 3 (U.S. Department of Energy, 1991c).

- **Waste Pit 3** was constructed in 1959 by excavating about 42 feet into the glacial overburden and adding a clay layer along the pit walls. The surface area of Waste Pit 3 is 241,373 square feet. It holds an estimated 204,100 cubic yards of buried waste consisting of lime-neutralized raffinate, raffinate concentrate, slag, slag leach residues, filter cake, fly ash, lime sludge, and 55-gallon drums. Waste Pit 3 materials contain an estimated 288,041 pounds of uranium and 881 pounds of thorium. Wet-to-saturated conditions exist eight feet below the pit surface (U.S. Department of Energy, 1991c).

  Waste Pit 3 was taken out of service as a wet pit in the fall of 1968; dry material was added until 1977. At this point, the pit was taken completely out of service, backfilled, and covered with clean soil. Waste Pit 3 is overgrown with grass and is fairly level. The western side of the pit slopes steeply down to the perimeter fence and road and a gentle slope extends toward a drainage ditch running along the east side of the burn pit.

- **Waste Pit 4** was constructed in 1960 and excavated similarly to Waste Pit 3 to a depth of 32 feet using a clay layer approximately two-feet-thick along the pit walls. The surface area of Waste Pit 4 is 83,799 square feet. It holds an estimated 55,100 cubic yards of buried waste consisting of process residues, filter cake, slurries, raffinates, scrap graphite, noncombustible trash, asbestos, tributyl phosphate, 55-gallon drums, and an estimated 23,500 pounds of barium chloride. The general consistency of the contents indicates semisolid and wet-to-saturated conditions nine feet below the surface.

  Waste Pit 4 materials contain an estimated 6.7 million pounds of uranium and 136,000 pounds of thorium metal (in 55-gallon drums). Samples collected from borings exhibited levels of barium in the parts-per-thousand range resulting in a mixed-waste classification for Waste Pit 4.

  In 1986, the pit was covered with clean soil and graded for surface water diversion. An earthen berm surrounds the pit to retain surface water runoff. In December 1988, an interim RCRA cap, consisting of compacted clay overlain by a 45-mil-thick Hypalon, reinforced chlorosulfinated polyethylene liner, was installed on Waste Pit 4 (U.S. Department of Energy, 1991c).

- **Waste Pit 5** was constructed in 1968, excavated to a depth of about 30 feet, and lined with a 60-mil-thick Royal Seal, ethylene-propylene-diene monomer elastomeric membrane. The surface area of Waste Pit 5 is 161,103 square feet. It holds an

estimated 97,900 cubic yards of waste consisting of solids from neutralized raffinate, slag leach slurry, sump slurry, and lime sludge. In addition, the effluent tower was collapsed into the pit and is estimated to contain 8,000 pounds of steel and 64,000 pounds of concrete (U.S. Department of Energy, 1991c). Waste Pit 5 materials contain an estimated 111,737 pounds of uranium and 37,445 pounds of thorium.

Waste Pit 5 was taken out of service in 1987 but remains open. It is partially covered with an estimated 750,000 gallons of water ranging in depth from three feet near the west end to zero feet over one-third of the length of the pit to the east. During routine inspections, occasional liner-joint failures and tears occurring at the surface were noticed and ascribed to weathering effects (Weston, 1987). Corrective action consisted of gluing the seam and patching tears.

- **Waste Pit 6** was constructed in 1979, excavated similarly to Waste Pit 5 to a depth of 20 feet, and lined with an ethylene-propylene-diene monomer elastomeric membrane. The surface area of Waste Pit 6 is 32,400 square feet. It holds an estimated 9,600 cubic yards of waste consisting of green salt (uranium tetrafluoride), filter cake, slag, process residues, and asbestos. Waste Pit 6 materials contain an estimated 1.9 million pounds of uranium.

  The pit was taken out of service in 1985 but remains open. The surface is presently covered with up to two feet of standing water. The surface elevation of the water varies depending on the amount of rainfall and evaporation rates. A removal action to prevent airborne migration of exposed materials by pushing them below the water surface was completed in December 1990. Minor tears of the liner above the water line have been observed and repaired.

- The **Burn Pit** was constructed in 1957 at the site previously used to excavate the clay liner material for Waste Pits 1 and 2. The depth of the Burn Pit varies because of the sloping bottom used for access during excavation and disposal operations. The maximum depth is believed to be about 26 feet. The boundaries are no longer discernible from the boundaries of covered Waste Pit 4, but the Burn Pit area is assumed to be bounded by Waste Pits 2, 3, 4, and 5. The surface area of the Burn Pit is approximately 21,724 square feet. It holds an estimated 30,300 cubic yards of waste consisting of burned laboratory chemicals including pyrophoric and reactive chemicals, waste oils, and other low-level contaminated combustible materials such as wooden pallets.

  The Burn Pit is fairly level and overgrown with grass. A ditch two to three feet deep cuts across the area on the west side and drains toward Waste Pit 2.

- The **Clearwell** was constructed in 1959, when Waste Pit 1 was closed. It currently receives surface water runoff from the surfaces of Waste Pits 1, 2, and 3 and excess impounded storm water from Waste Pit 5.

  Before March 1987, the Clearwell was used as a final settling basin for process water that passed through Waste Pits 3 and 5 before discharge to the Great Miami River. Water of varying depth remains in the Clearwell at all times. The depth of sediment remaining in the Clearwell is presently estimated at 11 feet. The Clearwell holds an

estimated 3,700 cubic yards of waste, consisting principally of uranium, thorium, barium, and other metals.

The following Operable Unit 1 removal actions have been completed:

- Removal Action No. 2: Waste Pit Area Runoff Control - This removal action can be broadly defined as management of radioactively-contaminated storm water runoff from Operable Unit 1. Runoff from the concrete storage silos in Operable Unit 4 also was included in this removal action. The eight-phase removal action was completed in mid-1992. This removal action continues to provide runoff control and collection. The potentially contaminated storm water runoff is collected and pumped to the BioSurge Lagoon and the effluent treatment system before discharge to the Great Miami River. Thus, the potential for release of contaminants to the environment has been reduced.

- Removal Action No. 6: Control of Exposed Material in Pit 6 - Field activities for this removal action, which involved redistributing exposed soil and waste material such that all solids are below the water level in Waste Pit 6 to reduce particulate emissions to the environment, were completed on December 19, 1990. DOE and EPA jointly agreed to a procedure to ensure that none of the material will be exposed in the future.

- Removal Action No. 11: Waste Pit 5 Experimental Treatment Facility - Built in 1984, the Experimental Treatment Facility (ETF) was designed to test the feasibility of solar drying sludge material. However, in 1988 high winds removed the plastic roof from the facility and caused some sludge to be deposited on the surrounding soils. This removal action involved dismantling the ETF, removing the surrounding soils to prevent any potential spread of contamination beyond the immediate area, and packaging the waste materials generated during the removal action for storage pending final disposition. Field activities were completed in March 1992. All potentially contaminated material was packaged and stored temporarily, pending final disposition. The demolished site has been backfilled and capped with clay.

- Removal Action No. 18: Control of Exposed Material in Pit 5 - This removal action involved moving the exposed soil and waste material built up in the east end of the pit to below the waterline to prevent the release of airborne contaminants. The dredged materials were moved to the west end of the pit and redistributed. Activities for this removal action were completed in December 1992.

- Removal Action No. 22: Waste Pit Area Containment Improvement - This removal action involved minimizing the potential for wind and water erosion of contaminated materials by seeding exposed and stressed surfaces in the Operable Unit 1 study area. Field activities for this removal action were completed on June 30, 1993.

The OU1 Record of Decision was signed by U.S. EPA on March 1, 1995. The selected remedy presented in the OU1 ROD is summarized in Table 2-1 (Appendix A).

2.2.3.2 OU2. Operable Unit 2 consists of five site areas and their associated berms, liners, and soils.

The following is a brief description of each site unit: 1720

- The Solid Waste Landfill was reportedly used for the disposal of cafeteria waste, rubbish, and other types of waste from the nonprocess areas and onsite construction and demolition activities.

- The North and South Lime Sludge Ponds contain waste from the FEMP water treatment plant operations, coal pile storm water runoff, and boiler plant blowdown. The South Lime Sludge Pond is inactive and overgrown with grasses and shrubs. Use of the North Lime Sludge Pond was discontinued when the FEMP was connected to a public water supply in the fall of 1995, which eliminated the use of the water treatment operations.

- The Active Flyash Pile was the disposal area for flyash and bottom ash from the FEMP boiler plant.

- The Inactive Flyash Pile was used for the disposal of ash from the boiler plant and other nonprocess wastes and building rubble such as concrete, gravel, asphalt, masonry, and steel rebar.

- The South Field was reportedly used as a burial site for FEMP nonprocess wastes such as flyash, onsite construction and demolition rubble, and for soils that may have contained low levels of radioactivity. A slope at the southwest border of the South Field was used as the backstop for the FEMP security firing range for 35 years. Lead ammunition used during target practice is embedded in this slope.

The operational histories of the Lime Sludge Ponds and Active Flyash Pile are well understood, but the operational histories of the Solid Waste Landfill, Inactive Flyash Pile, and South Field are vague and not well documented. Much of what is known has been reported in the Final Remedial Investigation Report.

In addition to the field investigations conducted under CERCLA, a removal site evaluation (RSE) and several removal actions were conducted in the OU2 areas. An RSE was performed to assess lead contamination in the South Field Firing Range and to determine whether the nature and extent of lead contamination warranted a removal action. In 1992, vertical borings were completed in the western embankment of the South Field. It was determined from the sampling results that a removal action was not necessary for the lead contamination in the South Field Firing Range.

The following four removal actions have been performed in OU2:

- Removal Action No. 8: Inactive Flyash Pile/South Field Disposal Area Control - This removal action consisted of the installation of ropes, fences, and warning signs around the perimeter of these waste areas to control access. Phase I, fencing and roping the areas to be controlled, was completed in December 1991. Phase II, a radiological survey, was completed in June 1992.

- Removal Action No. 10: Active Flyash Pile Control - This was a time-critical removal action completed in June 1992 to mitigate wind and water erosion of the Active Flyash

Pile. Periodic inspections of the Active Flyash Pile and necessary maintenance of the erosion control measures are ongoing.

- Removal Action No. 29: Paddys Run Erosion Control - This time-critical removal action was completed in September 1993, in an effort to stabilize the bank adjacent to the Inactive Flyash Pile. Routine periodic inspections of the riprap stone that was installed and necessary maintenance of the erosion control measures are ongoing.

- Removal Action No. 30: South Field and Inactive Flyash Pile Seepage Control - This removal action was designed to collect contaminated surface water that seeps into drainage ditches and migrates directly to Paddys Run or to the Great Miami Aquifer. Installation was completed in 1995; pumping continues as needed.

The OU2 ROD was signed by USEPA on June 8, 1995. The major components of the OU2 ROD are identified in Table 2-1 (Appendix A).

2.2.3.3 OU3. Operable Unit 3 consists of the former production area, including production-associated facilities and equipment (including all at-, above-and below-grade improvements). Under this definition, OU3 includes, but is not limited to, all structures, equipment, utilities, drums, tanks, solid waste, waste products, thorium, effluent lines, K-65 transfer line, wastewater treatment facilities, fire training facilities, scrap metal and soil piles, feedstocks, and coal piles.

The former production area consists of about 200 buildings on approximately 136 acres near the center of the site. Most of the buildings are steel frame structures with transite siding, concrete block structures, or pre-engineered facilities with metal siding and roofing. The tallest building is approximately 100 feet high and the tallest structure, the Elevated Water Storage Tank, is about 265 feet high. There are 43 Hazardous Waste Management Units (HWMUs) identified within OU3 (7 active and 36 inactive). Based on past materials handling practices and potential chemical contaminants (identified later in this section), some of the materials and wastes associated with OU3 facilities may fall into the category of mixed waste.

The scope of the OU3 interim remedial action, defined in the OU3 IROD, consists primarily of structural D&D and interim storage of two material categories: nonrecoverable and nonrecyclable materials, and recyclable or reusable materials. Existing information on chemical, radiological, and mixed waste contamination associated with the OU3 facilities, as well as an overview of contaminant pathways and exposure routes, are presented in the OU3 RI/FS Work Plan Addendum. The USEPA approved the OU3 ROD for Final Remediation on September 26, 1996. The major components of the OU3 ROD are identified in Table 2-1 (Appendix A).

Four removal actions will be integrated with the OU3 final remedial action, as follows:

- Removal Action No. 9: Removal of Waste Inventories - This removal action involves the safe, offsite disposal of existing waste inventories.

- Removal Action No. 12: Safe Shutdown - This removal action was created to provide the planning, engineering, and program control for the removal and proper disposition of in-process residue materials, excess supplies, chemicals, and associated process

equipment that remained when the FEMP stopped production in 1989. The primary goal of this removal action is to reduce the overall risks posed by the production-related materials remaining in the facilities prior to final remediation. Residue materials removed are transported to NTS under this removal action. This removal action also provides for the isolation and de-energizing of former production-related equipment and utilities, and provides for the identification of customers for FEMP equipment and nuclear products. For most buildings, safe shutdown will be completed prior to the start of D&D activities for that building.

- Removal Action No. 17: Improved Storage of Soil and Debris - This removal action was initiated to provide controlled storage of excess contaminated soil and debris generated during maintenance, construction, removal, and remedial actions at the FEMP through a soil and debris management plan. This removal action establishes the framework and procedures for the management and storage of soil and debris that will be generated during sitewide remedial activities.

- Removal Action No. 26: Asbestos Removal - This removal action, established as a specialized maintenance-related activity to mitigate potential asbestos release and migration, includes in situ repair, encasement, encapsulation, and removal of asbestos-containing materials. It is a necessary step prior to initiating D&D activities.

2.2.3.4 OU4. OU4 consists of special facilities with waste characteristics requiring potential application of singular technologies to effect final remediation.

OU4 consists of the following:

- K-65 residue silos (Silos 1 and 2);
- A cold metal oxide silo (Silo 3);
- An empty silo (Silo 4);
- The decant sump (an underground tank and its contents);
- A radon treatment system;
- A portion of a concrete pipe trench and other concrete structures;
- An earthen berm surrounding Silos 1 and 2;
- Contaminated soils beneath and immediately surrounding all four silos;
- Perched groundwater in the vicinity of the silos that are encountered during the implementation of remedial actions.

Silos 1 and 2 (the K-65 silos) contain 8,012 cubic yards of K-65 residues generated from the processing of high-grade uranium ore. In addition, Silos 1 and 2 contain 878 cubic yards of Bentonite (R) (clay-like material), placed on top of the residues during Removal Action No. 4 to attenuate the rate of release of radon from the silo residues. The silos are large, cylindrical,

above-grade, concrete vessels with post-tensioned steel reinforcing. Each of the domed silos is 80 feet in diameter and 36 feet high to the center of the dome.

The K-65 residues contain large activity concentrations of radionuclides, including radium and thorium. These radionuclides contribute to an elevated direct penetrating radiation field in the vicinity of the silos and to the chronic emission of significant quantities of radon from the silos. The K-65 residues are classified as by-product materials, consistent with Section 11(e)2 of the Atomic Energy Act, generated consequential to the processing of natural uranium ores.

Silo 3 contains 5,088 cubic yards of residues, known as cold metal oxides, which were generated at the FEMP during uranium extraction operations in the 1950s involving uranium ores and ore concentrates received from a variety of uranium mills in the United States and abroad. Silos 3 and 4 are identical in design and construction to Silos 1 and 2. The residues within Silo 3 are similarly classified as by-product materials. Silo 4 was never used for waste storage; however, rainwater that infiltrated the silo was removed in 1989 and 1991.

Several improvements had been made to the silos prior to the initiation of removal actions. These improvements included the repair of concrete coating around each silo; the construction of an earthen berm around Silos 1 and 2 to counterbalance the outward load from the silo contents, to protect the silo walls from weathering, and to serve as a radiation shield; the expansion of the berm to reduce soil erosion; sealing the vents in the domes; installing plywood covers on the domes; adding a polyurethane coating to reduce weathering and to help reduce radon emissions; and the installation and later upgrade of the radon treatment system (RTS).

The following removal actions have also been undertaken:

- K-65 Silo Removal Action No. 4: Bentonite Clay Layer - The application of a layer of bentonite clay over the K-65 residues reduced the amount of radon escaping from the silos and helped prevent the release of contaminants into the air if a natural disaster should occur or if the silo dome should collapse.

- Removal Action No. 21: Expedited Removal of Silo 3 Dust Collector - This removal was conducted in December 1991 after an inspection revealed significant deterioration of the dust collector.

- Removal Action No. 5: Removal of Liquid from Decant Sump - In April 1991, a time-critical removal action was performed to remove approximately 8,000 gallons of liquid from the decant sump.

On December 7, 1994, U.S. EPA approved the final Record of Decision for OU4. See Table 2-1 (Appendix A) for a description of the OU4 remedy.

2.2.3.5 OU5. OU5 encompasses all environmental media, both on and off the FEMP property, affected by contaminants released from the FEMP site. It has no operating history of its own, but reflects the impacts of the "source" operable units (1, 2, 3, and 4) on the soil, surface water and sediment, groundwater, plants, and animals in the affected area. The OU5 ROD was signed by USEPA on January 31, 1996. Major components of the OU5 remedy are identified

in Table 2-1 (Appendix A). Note that Table 2-1 references the Integrated Environmental Monitoring Plan (IEMP) which specifies media-specific monitoring and sampling during remediation.

The following removal actions are wholly or in part the responsibility of OU5:

- Removal Action No. 1: Contaminated Water Beneath FEMP Buildings - A series of wells were installed to minimize the potential for contaminated water beneath the former production area buildings to reach the underlying Great Miami Aquifer. It ceased in December 1995.

- Removal Action No. 3: South Groundwater Contamination Plume - This five-part removal action is designed to prevent or minimize the further offsite migration of a plume of contamination within the Great Miami Aquifer, known as the South Plume and to mitigate the effects of the contamination on local users. This removal action includes an alternative source of potable and process water to affected industries, a groundwater recovery well system (completed in August 1993), an interim water treatment system to removal additional uranium from site wastewater streams (operational since July 1992), groundwater monitoring (ongoing since 1992), and additional investigations (completed) to identify the leading edge and extent of the plume down gradient of the recovery wells. A related supplemental DOE action is the South Plume Interim Treatment Project to reduce site uranium discharges to the Great Miami River. Removal Action 3 is being integrated in the aquifer restoration remedial action.

- Removal Action No. 16: Collect Uncontrolled Production Area Runoff - This removal action involved regrading and installation of drainage controls to control storm water runoff from the perimeter of the former production area and to redirect it to the existing storm water system.

- Removal Action No. 17: Improved Storage of Soil and Debris - This removal action provided an interim program to store and manage contaminated soil and debris generated by FEMP cleanup activities. The program described in Removal Action 17 is being incorporated into OU5 Remedial Action work plans and support documents.

- Removal Action No. 30: KC-2 Warehouse/Well 67 - This removal action involved semiannual sampling of this well for uranium and other metals to monitor the potential for contamination to migrate to the underlying Great Miami Aquifer. The sampling frequency has since been reduced to annual sampling.

2.2.4 Final Remediation Levels: Contaminants Pertinent to Remedial Action

Remedial Investigations and Feasibility Studies were conducted to collect data required for the EPA and DOE to choose remedial actions sufficiently protective to mitigate excessive risks to human health and the environment from the FEMP. RI/FS studies for each of the OUs have been completed. These studies determined the nature, extent, and threat of past releases and presented baseline risk assessments, evaluations of remedial alternatives, and detailed evaluations of preferred alternatives.

Since the SCQ was first issued, the USEPA has approved the ROD for each of the five operable units, thus ending the RI/FS phase of the CERCLA process at the FEMP. Each operable unit

ROD, with the exception of Operable Unit 3, identified remediation levels for specific contaminants. The OU3 ROD did not specify FRLs as no OU3 waste will remain in place. These remediation levels were specified for operable unit waste and for surrounding media (soil, groundwater, surface water, sediment). The specific tables that identify these leads in each ROD are referenced in each OU discussion that follows in Sections 2.2.4.1 thru 2.2.4.5. The remediation levels that each of the Operable Units 1-4 identified for soils were "preliminary" in that they deferred to the soil final remediation levels (FRLs) identified in the Operable Unit 5 ROD.

2.2.4.1 **OU1**. Tables 9-2 and 9-3 in the OU1 ROD identified remediation levels for the following contaminants:

A. In surface soils:
   1. Radionuclides: cesium-137 and one daughter, thorium-230, uranium-235, uranium-238 and two daughters;

   2. Chemicals: beryllium and uranium.

B. In pit subsurface soil:

   1. Radionuclides: technetium-99 and uranium-238 and two daughters;

   2. Chemical: PCBs.

2.2.4.2 **OU2**. Tables 9-1 and 9-2 in the OU2 ROD identified primary and secondary cleanup levels for the following contaminants in soil. For the primary levels, the contaminants of concern for cleanup contribute 90 percent of the risk from OU2 and over 99 percent of the volume to be excavated under the selected alternative. For the secondary levels, the contaminants of concern pose risks that are close to the 10^{-6} point of departure and contribute a small percentage of the overall risk from OU2.

A. Primary Levels for:

   1. All Subunits: radium-226 and -228, thorium-228 and -232.

   2. Solid Waste Landfill: uranium-234, -235/236, and -238, and total uranium.

   3. Lime Sludge Pond: uranium-234, -235/236, and -238, and total uranium.

   4. Inactive Flyash Pile: arsenic, uranium-234, -235/236, and -238, and total uranium.

   5. South Field: lead, thorium-230, uranium-234, -235/236, and -238, and total uranium.

   6. Active Flyash Pile: arsenic, uranium-234, -235/236, and -238, and total uranium.

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B. Secondary Levels for:

1. South Field Waste/Soil: aroclor-1260, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, dieldrin, indeno(1,2,3-cd)pyrene, phenanthrene, technetium-99, and thorium-230.

2.2.4.3 OU3. The OU3 ROD identified the following chemical and radiological contamination of OU3 materials as follows:

Most OU3 remediation materials contain low levels of contaminants and are therefore not a principle threat. For these materials, utilization of the On-Site Disposal Facility (OSDF) for disposal is consistent with the balanced approach employed for the FEMP operable units. Only materials exceeding OSDF Waste Acceptance Criteria (WAC) or administratively identified for off-site disposition or eligible for alternative disposition (i.e., recycling or free release) would be dispositioned off site.

The OSDF WAC for OU3 were based on the OU2 and OU5 feasibility study modeling, and then adjusted to apply to OU3-specific materials. Of the OU3 RI/FS analytes, only uranium and Technetium-99 were identified as having the potential to exceed acceptable groundwater levels beneath the OSDF. Experimental lab studies were conducted to determine uranium and Technetium-99 leachability from various construction materials. For conservativeness, samples of OU3 materials with the highest Technetium-99 and uranium concentrations were used. The results of the studies demonstrated that uranium that leached from all test samples had concentrations that were well below acceptable levels for on-property disposal. Conservative modeling also showed that the small volume of OU3 materials that was not tested for uranium leachability was also acceptable for on-property disposal. Therefore, all uranium-contaminated materials, with the exception of highly contaminated process materials, can be safely disposed of in the OSDF. On the other hand, the studies showed that Technetium-99 has the potential to leach at levels that could impact groundwater. Modeling was then used to determine that a safe level of Technetium-99 within the OSDF is 105 grams; this level was adopted as the OU3 on-property WAC for Technetium-99.

2.2.4.4 OU4. Tables 9-2 and 9-3 in the OU4 ROD identified preliminary remediation levels (PRLs) for radionuclides and chemicals in soils that are within the OU4 physical boundary. All are subject to the final determination for soils made in the OU5 ROD. The OU4 PRLs are:

A. Radionuclides: lead-210 and two daughters, radium-226 and five daughters, radium-228 and one daughter, strontium-90 and one daughter, technetium-99, thorium-228, and uranium-238 and two daughters.

B. Chemicals: antimony, arsenic, barium, cadmium, chromium (III), molybdenum, nickel, silver, thallium, vanadium, zinc, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-c,d)pyrene.

2.2.4.5 OU5. Tables 9-3, 9-4, 9-5, and 9-6 in the OU5 ROD final remediation levels (FRLs) for the various media found in that operable unit.

A. The OU5 ROD identified the following FRLs for soil:

1. Radionuclides: cesium-137 and one daughter, neptunium-237 and one daughter, lead-210 and two daughters, plutonium-238 and -239/240, radium-226 and eight daughters, radium-228 and one daughter, technetium-99, thorium-228 and seven daughters, thorium-230, thorium-232 and 10 daughters, and total uranium.

2. Chemicals: acetone, antimony, aroclor-1254 and -1260, arsenic, barium, benzene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, beryllium, bis(2-chloroisopropyl) ether, bis(2-ethylhexyl)phthalate, boron, bromodichloromethane, bromoform, bromomethane, cadmium, carbazole, carbon disulfide, carbon tetrachloride, chlordane, chlorobenzene, chloroform, chromium VI, chrysene, cobalt, copper, cyanide, dibenzo(a,h)anthracene, 3,3'-dichlorobenzidine, 1,2-dichloroethane, 1,1-dichloroethene, dieldrin, di-n-octylphthalate, ethylbenzene, fluoride, heptachlorodibenzofuran, heptachlorodibenzo-p-dioxin, indeno(1,2,3-cd)pyrene, lead, manganese, mercury, methyl-2-pentanone, methylene chloride, 4-methylphenol, molybdenum, nickel, 4-nitroanaline, n-nitrosodiphenylamine, n-nitrosodipropylamine, octachlorodibenzo-p-dioxin, pentachlorophenol, selenium, silver, tetrachloroethene, thallium, toluene, tributyl phosphate, 1,1,2-trichloroethane, trichloroethene, vanadium, vinyl chloride, total xylenes, and zinc.

B. The OU5 ROD identified the following FRLs for Great Miami Aquifer groundwater:

1. Radionuclides: neptunium-237 and one daughter, radium-226 and eight daughters, radium-228 and one daughter, strontium-90 and one daughter, technetium-99, thorium-228 and seven daughters, thorium-230, thorium-232 and 10 daughters, and total uranium.

2. Chemicals: alpha-chlordane, antimony, aroclor-1254, arsenic, barium, benzene, beryllium, bis(2-chloroisopropyl)ether, bis(2-ethylhexyl)phthalate, boron, bromodichloromethane, bromomethane, cadmium, carbazole, carbon disulfide, chloroethane, chloroform, chromium VI, cobalt, copper, 1,1-dichloroethane, 1,1-dichloroethene, 1,2-dichloroethane, fluoride, lead, manganese, mercury, methylene chloride, 4-methylene chloride, 4-methylphenol, molybdenum, nickel, nitrate, 4-nitrophenol, octachlorodibenzo-p-dioxin, selenium, silver, 2,3,7,8-tetrachlorodibenzo-p-dioxin, trichloroethene, vanadium, vinyl chloride, and zinc.

C. The OU5 ROD identified the following FRLs for surface water in Paddys Run and the Great Miami River:

1. Radionuclides: cesium-137 and one daughter, neptunium-237 and one daughter, lead-210 and two daughters, plutonium-238 and -239/240, radium-226 and eight daughters, radium-228 and one daughter, strontium-90 and one daughter, technetium-99, thorium-228 and seven daughters, thorium-230, thorium-232 and 10 daughters, and total uranium.

2. Chemicals: alpha-chlordane, antimony, aroclor-1254 and -1260, arsenic, barium, benzene, benzo(a)anthracene, benzo(a)pyrene, beryllium, bis(2-chloroisopropyl)ether,bis(2-ethylhexyl)phthalate, bromodichloromethane, bromomethane, cadmium, chloroform, chromium VI, copper, cyanide, dibenzo(a,h)anthracene, 3,3-dichlorobenzidene, bi-n-butylphthalate, 1,1-dichloroethene, dieldrin, di-n-octylphthalate, fluoride, lead, manganese, mercury, methylene chloride, 4-methylphenol, molybdenum, nickel, nitrate, 4-nitrophenol, selenium, silver, tetrachloroethene, 1,1,1-trichloroethane, 1,1,2-trichloroethane, vanadium, and zinc.

D. The OU5 ROD identified the following FRLs for sediment:

1. Radionuclides: cesium-137 and one daughter, neptunium-237 and one daughter, lead-210 and two daughters, plutonium-238 and -239/240, radium-226 and eight daughters, radium-228 and one daughter, strontium-90 and one daughter, technetium-99, thorium-228 and seven daughters, thorium-230, thorium-232 and 10 daughters, and total uranium.

2. Chemicals: aroclor-1254 and -1260, arsenic, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, beryllium, bis(2-ethylhexyl)phthalate, bromoform, cadmium, carbazole, chromium VI, chrysene, cobalt, indeno(1,1,2-cd)-pyrene, manganese, 4-methyl-2-pentanone, n-nitrosodiphenylamine, phenanthrene, and thallium.

E. In addition, Table 9-7 in the OU5 ROD identified the waste acceptance criteria for the On Site Disposal Facility.

All five operable units are in varying stages of remedial design and remedial action, in accordance with the accelerated remediation case. Each operable unit's remediation activities must meet the remediation levels of each media in each operable unit.

2.2.5 Projectization of Operable Unit Remediation

The FEMP remedial strategy reflects the culmination of nearly 10 years of CERCLA activities at the site, including extensive site characterization activities to determine the nature and extent of contamination, baseline risk assessments, and detailed evaluation and screening of remedial alternatives leading to a final remedy selection as documented in the ROD for each operable unit. As a management approach to streamlining the RI/FS decision-making process under CERCLA and expediting implementation of cleanup activities, the Consent Agreement divided the site into five operable units. The definitions of the operable units were established considering factors such as geographic location, similarity in waste forms, and the availability of data on discrete waste units or areas.

When the remedy selection process was nearly complete, the FEMP developed an integrated remediation strategy focusing on accelerated remedial design and action. At the heart of this strategy is integrated project planning which consolidates cleanup activities and schedules across the projects to accelerate remediation (referred to as the accelerated remediation case). Successful implementation of the accelerated remediation case is dependent upon the close coordination and sequencing of remediation activities, such as onsite disposal facility

preparation, facilities D&D, and final soil and groundwater remediation, among all project organizations throughout the remedial design/remedial action process. The FEMP accelerated remediation strategy is reflected in the site master schedule.

While the operable unit management approach was successful for completing the RI/FS process, it does not represent the most effective organization of site responsibility to complete remedial design/remedial action. To align sitewide responsibilities and regulatory obligations across the five operable units to most efficiently complete remedial design/remedial action, the site has established fully integrated project organizations. Each operable unit remedy identified requirements for addressing contaminants in specific operable unit media, so it is logical that the FEMP should organize projects around these commonalities during remediation. Project organizations are focusing on planning and implementing remedial activities for discrete segments of the total remediation project scope, based on the similarity and sequencing of remediation activities. Realignment into project organizations reflects the actual work processes and operations to be performed during remediation and does not alter the requirements of the FEMP's RODs. Table 2-1 (Appendix A) provides the crosswalk between each operable unit remedy and the FEMP project organizations' responsibilities for implementing each remedy.

A. The project organizations with primary responsibilities for CERCLA remediation are as follows:

1. Waste Pits Remedial Action Project: Completion of remedial actions for the excavation, drying (as required), loading, and rail transport of contents of waste pits 1-6, the burn pit, and the clearwell to an offsite disposal facility, and responsibility for the offsite disposal of contaminated soil and debris that exceed the waste acceptance criteria for the onsite disposal facility.

2. Soil Characterization and Excavation Project: Completion of remedial actions to address contaminated soil at the FEMP and miscellaneous waste units including the south field, flyash piles, lime sludge ponds, and the solid waste landfill; also excavation/removal of building foundations, roadways, underground utilities and piping systems, and sitewide restoration activities and management of perched water encountered during remediation.

3. Facilities D&D Project: This work scope includes the completion of the D&D of the above-grade portion of the former uranium processing facilities and all remedial action facilities.

4. Silos Project: Completion of remedial actions for the contents of Silos 1-3, including the removal, solidification and transport of the inventoried residues for offsite disposal.

5. Aquifer Restoration Project: Completion of activities necessary to restore the water quality in the affected portions of the Great Miami Aquifer including the pumping, treating, reinjecting, and discharging of extracted groundwater. This project will continue to maintain responsibility for all sitewide fate-and-transport modeling and groundwater monitoring.

6. Advanced Wastewater Treatment (AWWT) and Wastewater Project: Design, construction, and operation of all wastewater, storm water, and drinking water holding, conveyance, treatment, and discharge systems at the FEMP. (Note that each project is responsible for containing and transporting remediation wastewater to the AWWT facility for treatment.)

7. On Site Disposal Facility Design Project: Design, installation, and closure of the onsite disposal facility; and monitoring leachate within the onsite disposal facility and perched groundwater in the till beneath the onsite disposal facility.

B. In addition, three support organizations provide services related to the scope of the SCQ. These support projects are:

1. Environmental Monitoring Project: Responsible for non-project-specific, sitewide environmental monitoring.

2. Sample and Data Management Project: Responsible for tracking, storing, and retrieving sampling and monitoring data. This group also manages laboratory subcontracts.

3. Analytical Laboratory Services: Responsible for performing onsite laboratory analyses of samples.

The realignment of the implementing organizations into an integrated project structure concentrated on remedy design and implementation is a critical step in positioning the site to accelerate final cleanup as reflected in the FEMP remediation strategy. While this realignment will facilitate efficient implementation of the FEMP remedial strategy, it will not affect cleanup levels that the DOE is required to meet. All FRLs identified in each operable unit ROD will be addressed for all media.

2.2.6 Other Regulatory Issues

In addition to compliance with CERCLA, the FEMP shall also comply with DOE Orders and other regulatory requirements including RCRA, CAA, CWA, NPDES, Safe Drinking Water Act (SDWA), National Environmental Policy Act (NEPA), Toxic Substances Control Act (TSCA), and the Pollution Prevention Act of 1990. The FEMP contractor intends to meet or exceed the substantive requirements of each of these regulations during the sitewide remedial action. Compliance with other requirements that are fully applicable (both administratively and substantively) to the FEMP (i.e., RCRA, CAA, CWA) is discussed below.

On December 2, 1988, the DOE entered into a Consent Decree with the State of Ohio that outlined specific actions to characterize and manage hazardous waste in accordance with RCRA and to protect waters of the State as required by the CWA. The Decree arose in response to allegations by the State that the DOE and National Lead of Ohio (NLO), the first site operator, violated various provisions of both state and federal laws and regulations. Amendments to the Consent Decree were proposed in December 1990 specifying additional actions to comply with RCRA. Specific actions and tasks to meet the requirements of the Decree were completed by Westinghouse Environmental Management Company of Ohio (WEMCO), the second site operator. Effective December 1, 1992, responsibility for maintaining compliance with the requirements of the Decree was assumed by Fernald

Environmental Restoration Corporation (FERMCO) [now Fluor Daniel Fernald (FDF)]. The stipulated amendment to the Consent Decree was signed on January 22, 1993.

Revision 2 (dated June 28, 1991) of the RCRA Part A Permit application identified 47 Hazardous Waste Management Units (HWMU) at the FEMP. The FEMP will continue to operate seven HWMUs under the RCRA Part B application (October 1991). One of the HWMUs, the barium chloride salt treatment facility, has been closed. The remaining 39 HWMUs will be closed in accordance with closure plans provided by the FEMP to the Ohio Environmental Protection Agency.

Individual HWMU closure plans will specify sampling and analysis necessary to evaluate potential contamination of the surrounding environment resulting from hazardous waste management activities. Seven HWMUs to be closed are land-based units (surface impoundments, landfills, and land treatment units) that are subject to RCRA groundwater monitoring requirements. The other HWMUs, which are not classified as land-based, will not be subject to groundwater monitoring requirements unless it is determined that contaminants have been released that could result in groundwater contamination.

Wastes generated at the FEMP are subject to waste determination and characterization. These evaluations are based on a combination of process knowledge and sampling and analysis. RCRA hazardous waste characterizations and determinations will follow the current FEMP Waste Analysis Plan which is required by Ohio Administrative Code 3745-54-13.

Stack monitoring is conducted under the CAA and to fulfill requirements of DOE Order 5400.1. The main areas affected by these regulations include certain elements of site remediation (e.g., stacks at treatment units) and landlord activities.

Water discharges from the FEMP to the Great Miami River through the main plant effluent line fall under CWA (via the FEMP's NPDES permit), DOE Order 5400.5, DOE Order 5400.1, and the FFCA. Discharges shall be maintained within limits specified in the site NPDES permit.

2.3 PROJECT OBJECTIVES

2.3.1 Specific Objectives

Specific objectives of an environmental sampling and analysis project shall be defined in the Project-Specific Plan (PSP).

2.3.2 Intended Data Usages

The intended use of acquired data is to assess the nature of the site and the degree and extent of potential problems resulting from past activities, evaluate the potential hazard to human health and the environment, evaluate remedial actions, choose and implement preferred remedial actions, and monitor plume migration and the effectiveness of remedial actions. Data partially fulfilling these requirements have been collected in previous and ongoing studies. Use of these data, and identification and collection of additional data needs, will fulfill the intent of the 1991 Amended Consent Agreement and the stated site remediation objectives of the DOE.

2.3.3 Data Quality Objectives

Data Quality Objectives (DQOs) are qualitative and quantitative statements that specify the quality of data required to support decision making. Because they are based on end use of the

data to be collected, different uses require different levels of data quality. DQOs are developed as specified in Appendix C to determine the appropriate ASL for the data collected. All approved DQOs shall be controlled in a separate document (the DQO Manual) by the FEMP DQO coordinator (see Section 1.5.1).

2.3.4 Analytical Support Levels

There are five FEMP-defined analytical levels that will be assigned depending on intended use of the data and the Quality Assurance/Quality Control (QA/QC) methods required to achieve the desired level of quality. The following are definitions of ASLs A through E.

A. **ASL A (Qualitative Field Analyses)** - Provides the most rapid (real or short time) results. ASL A is often used for preliminary comparison to Applicable or Relevant and Appropriate Requirements (ARARs), initial site characterization to locate areas for subsequent and more accurate analyses, field screening of samples to select those for fixed laboratory analysis, and engineering screening of alternatives (bench scale tests). These types of data include those generated on site through the use of photo- or flame-ionization detectors, pH and conductivity meters, alpha and beta/gamma friskers, or radiological wipe samples.

   Example: Field screening for alpha, beta, and gamma radiation conducted with portable field equipment provides real time qualitative analysis for the presence or absence of radioactive isotopes.

   Example: Field screening for chemical gases in the well bore of groundwater monitoring wells using photo-ionization detectors provides real time qualitative analysis for presence of volatile organic compounds (e.g., benzene, toluene).

   Example: Use of a radiological survey meter to qualitatively estimate the areal extent of radioactive contamination.

   Example: Determination of gross radiological contamination with a field survey meter to select a limited number of heavily contaminated, lightly contaminated, and apparently uncontaminated samples for confirmatory analysis in a fixed laboratory. Field screening will save time and decrease costs by limiting the number of samples going to the fixed laboratory.

B. **ASL B (Qualitative, Semiquantitative and Quantitative Analyses)** - Provides more quality control checks than ASL A, and results obtained can approach similar QA/QC credibility and accuracy/precision determinations to ASL C. ASL B can be assigned when more rapid turnaround results are needed. These analytical results can be taken in the field or laboratory, but with similar QC checks and QA protocols as those utilized in ASL C, the results can be validated to a level that offers confirmation and support to samples analyzed at ASL C and D. This ASL allows for selection, via the PSP, of items such as QA/QC, data reporting and data validation requirements from FEMP-specified analytical protocols. These items are similar to those used for ASLs C and D but have different QA/QC sample type and frequency, quality control criteria for acceptance ranges and requirements for data packages.

Also included in ASL B are standard methods (e.g., EPA 500-series drinking water methods and SW-846 methods with QA/QC requirements different than those specified for ASLs C and D) and conventional parameter analysis in support of regulatory requirements such as NPDES permit monitoring. In the event that an ASL B standard method needs to be modified for a specific analyte or group of analytes in support of a higher ASL (i.e., ASL C or D), the appropriate sample preparation method and calibration information will be prescribed and specified in the Project-Specific Plan (PSP) as an ASL E. PSPs related to Consent Agreement items are subject to review by the USEPA and Ohio EPA; and, proposed modifications of standard methods would thus receive their review and approval.

Example: Measurement of gross alpha and beta radioactivity in water in compliance with the Safe Drinking Water Act to provide information on drinking water quality.

Example: Determination of volatile halogenated organic compounds (e.g., chloroform) in water by purge and trap gas chromatography without second column confirmation, with a limited suite of field and laboratory QC samples, and a minimal data package.

Example: Determination of volatile organic compounds in drinking water at low levels (to 1 ppb) by gas chromatograph/mass spectrometry for comparison to U.S. EPA MCLs to assess risks associated with use of the water as a drinking water supply. This would be use of a modified existing method with user defined special requirements.

Example: Routine monitoring of conventional wastewater discharge parameters for compliance with the site NPDES permit.

Example: Analysis of residues from a bench scale treatability test to assess whether the technology might be applicable to site wastes. Since the technology is only being screened for applicability, a full data package and review is not required.

C. **ASL C (Quantitative with Fully Defined QA/QC)** - Provides data generated with full QA/QC checks of types and frequencies specified for ASL D (see below) according to FEMP-specified analytical protocols for radiological and nonradiological parameters. The analytical methods are identical to ASL D for QA/QC sample analysis and method performance criteria. However, the data package does not typically contain raw instrument output but does include summaries of QA/QC sample results. ASL C may be used when analyses require a rigid, well-defined protocol, but where other information is available, so that a complete raw data package validation effort is not required. Laboratories shall be required to retain, in the project file, raw instrument data required to upgrade ASL C reports to ASL D.

Example: Analysis of total uranium by the fluorometric method with a full set of QA/QC samples as specified for ASL D. A summary data package is provided including QA/QC sample performance without raw instrument output. A limited level of data validation is required because only the summary forms need review.

Example: Determination of volatile organic compounds in soil by purge and trap gas chromatography/mass spectrometry with a full complement of QA/QC samples as specified for ASL D. A summary data package is provided including QA/QC sample

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performance without raw instrument output. A limited level of data validation is required because only the summary forms need review.

Example: Long term groundwater monitoring where there is an established history of available data. The use of ASL C will reduce the effort to review and validate the data. However, if significant changes or deficiencies are noted the Level D package can be obtained from the laboratory for more detailed validation.

Example: Analysis of residues or products from a treatability test to assess performance of a treatment technology. More rigorous QC requirements can be used to assess the capability of the treatment technology to meet the remediation performance objectives. ASL C would be used when knowledge of the waste or process was such that a full data package is not required to assess performance.

Example: Analysis of soil samples for total Uranium to assess areal extent of contamination. The nature of the contamination is well known and understood. The use of ASL C will allow validation of method performance by review of QC summary forms but a complete data package is not required because of the prior knowledge.

Example: Assessment of nature and extent of contamination in a remedial investigation sampling event. Many samples can be analyzed at ASL C and a small number at ASL D. Validation of the ASL D data will provide confirmatory analysis of the nature and extent of the contamination. The ASL C data will provide additional supporting data and require less effort to validate. If deficiencies are noted in either the ASL C or D data packages, full data packages can be obtained for the ASL C data and they can be validated at ASL D to assess the impact of the deficiency on project objectives.

D. **ASL D (Quantitative with Fully Defined QA/QC and Complete Data Package, Including Raw Data)** - Provides data generated with a full complement of QA/QC checks of specified types and frequencies according to FEMP-specified analytical protocols for radiological and nonradiological parameters. The data package includes raw instrument output for validation of ASL D data.

Example: Analysis of total uranium by the fluorometric method, with a full set of QA/QC samples per analytical batch. (See Glossary Terminology.) Analytical results and the full raw data package are reported from the laboratory. Data may be required to support risk assessment, determination of nature and extent of contamination or other uses where the highest possible degree of confidence in the useability of the data is required.

Example: Determination of volatile organic compounds in soil or water by purge and trap gas chromatography/mass spectrometry with a full complement of field and laboratory QA/QC samples. A complete raw data package is provided and validated for the analyses. Data may be required to support risk assessment, determination of nature and extent of contamination or other uses where the highest possible degree of confidence in the useability of the data is required.

E. **ASL E (Nonstandardized Protocols)** - Analyses by nonstandard protocols that often require method development or validation (e.g., when exacting detection limits or

analysis of an unusual chemical compound are required), or when specific performance standards for a standard protocol cannot be met. ASL E methods may be significantly different from those specified for ASLs B, C, or D data. New methods may be developed for ASL E data to allow for parameters or matrices that cannot be analyzed using existing standard methods. This could be caused by interferences, analyses performed outside of accepted requirements for existing methods, or new methods developed to meet site requirements or project-specific requirements that cannot be met by existing analytical methods.

Example: Analysis of a nonstandard matrix such as transite building material for total Uranium. A nonstandard preparation technique would be required to prepare the sample for analysis. The results may be used to assess the degree of contamination, assess risks associated with exposure to the transite, and evaluate disposal options for the material.

Example: Analysis or evaluation of a geotextile material for suitability to use as a component of a remedial action at the site. Existing evaluation methods may not be adequate to evaluate site-specific needs so development of a new method is required.

Example: Determination of organic compounds (e.g., benz(a)anthracene) in drinking water at sub-part per billion levels by special method on-column injection gas chromatography/mass spectrometry with selective ion monitoring detection and a full suite of field and laboratory QA/QC samples as required for ASLs C and D data. A complete raw data package may be required for validation. The results are required to assess risks associated with use of this water as a drinking water source.

The useability of data is determined by DQO requirements. ASL A data are considered as "good" as level D data if in compliance with DQOs.

2.3.5 ASL Uses

ASLs provide the basis for collecting and analyzing samples to meet a variety of end uses. For each end use, a different specific quality level may be appropriate. The range of data quality needs is reflected in ASLs A through E. The specific definitions for the FEMP-specific ASLs are provided in the Section 2.3.4 of the SCQ.

The following paragraphs illustrate, in general, how data are used for risk assessment. The following discussion is consistent with guidance on data use in the risk assessment process, "Guidance for Data Useability in Risk Assessment" (U.S. Environmental Protection Agency 1990b). It is critical to maintain that all information is both useful, and necessary, for developing a comprehensive risk assessment.

In the risk assessment process, ASL A information is used to establish the areal extent of the contamination. The areal extent is later used to detail the source term for purposes of both exposure scenario and fate and transport development.

ASL B information is used to evaluate the magnitude of the source term and to adjust fate and transport models to site-specific parameters and data. The level B data are used in this respect due to the quantity of data available. Level B data are also used in the development of the list of potential contaminants of concern. The results of the level A data, defining the extent of

contamination, coupled with information obtained from the level B sampling results, form the basis for establishing the nature and extent of contamination.

ASL C data are collected after careful consideration of all the level A and B data. The locations for samples are specified on the basis of the "hot spots" and thereby provide a high degree of confidence in the magnitude of the source term. The results of the C level sampling provide the basis for establishing the upper confidence limits (UCL) as defined in the Risk Assessment Work Plan Addendum. The UCL is determined by taking the upper 95 percentile, for the range of observations, as the value to be used to characterize the source strength. This method then results in the ability to completely describe the uncertainty associated with the source term and ultimately the risk.

ASL D data are also used to determine the UCL as discussed above. Both ASL C and D data are used to determine the UCL since the only difference between data collected at these levels is the laboratory documentation accompanying the results. The same QA/QC procedures are implemented and at any time the entire QA/QC documentation package can be requested from the laboratory. Together the level C and D data provide the final step in the quantification of the source term for use in fate and transport modeling and exposure assessments.

During remediation, certification samples will be analyzed at ASL D, unless otherwise specified in the approved Integrated Remedial Design, Certification Design Letter, or agency-approved project-specific plan. If ASL D acceptance criteria are not specified in Appendix G for a contaminant of concern that must be certified, ASL D acceptance criteria shall be developed according to the specific needs of the project, taking into consideration the Final Remediation Levels, sample matrices, and any other relevant factors. Upon agency approval, these criteria will be documented in the project-specific plans for all applicable areas.

2.4 SAMPLE NETWORK DESIGN AND RATIONALE

The sample network design and rationale shall be specifically described in PSPs. The description shall include the method and justification for determining sampling locations, number of samples to be collected, frequency of sampling, sampling methods, quality assurance samples, and the degree of confidence that DQOs will be met. Whether sampling locations are determined by judgmental, random, or systematic method shall be justified based on DQOs.

2.5 PROJECT SCHEDULES

A schedule for completion or for conducting routine, ongoing projects shall be included in each PSP as applicable. It shall consist of the anticipated start date, duration of each project phase including field work, laboratory analysis, data validation, data assessment and interpretation, and submittal of interim and final reports. For PSPs related to Consent Agreement items, thirty calendar days shall be allowed for each phase of regulatory review, and thirty days shall be allowed for comment resolution and resubmittal of documentation by the FEMP. Consult the 1991 Amended Consent Agreement or addenda and the operable unit RD and RA work plans for official schedules.

Section 3

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PROJECT ORGANIZATION AND RESPONSIBILITIES

Lead agency responsibilities under the National Contingency Plan for Oil and Hazardous Substances Pollution at the FEMP lie with the Department of Energy Fernald Environmental Management Project (DOE-FEMP). Under a 1990 Consent Agreement entered into by DOE with the USEPA and amended in 1991, the DOE agreed to identify, characterize, and remediate environmental contamination at and originating from the FEMP.

3.1 PROJECT MANAGEMENT

Remediation activities of the FEMP environment are conducted by DOE and regulated by the USEPA and the Ohio Environmental Protection Agency (OEPA). Responsibilities of each group are defined in the 1991 Amended Consent Agreement, the Federal Facilities Compliance Agreement, the Consent Decree with the OEPA, and other agreements between the DOE and the regulatory agencies. Organizational and management structures showing the relationships among regulatory agencies and FEMP are provided in Figure 3-1 (Appendix A).

3.1.1 U.S. Environmental Protection Agency

The USEPA has review and comment responsibility for Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) documents. The USEPA Remedial Project Manager (RPM) is responsible for project oversight, review of documents, and interactions with FEMP personnel. The USEPA RPM is also responsible for distributing deliverables to appropriate reviewers within the USEPA and transmitting and resolving comments with the DOE. Additional responsibilities are outlined in the 1991 Amended Consent Agreement. The USEPA administrator is ultimately responsible for resolution of disputes as specified in the 1991 Amended Consent Agreement. At the FEMP, the USEPA also has regulatory authority through the Resource Conservation and Recovery Act (RCRA), Clean Water Act (CWA), Clean Air Act (CAA), Safe Drinking Water Act (SDWA), Toxic Substances Control Act (TSCA); Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), and the Atomic Energy Act (AEA).

3.1.2 Ohio Environmental Protection Agency

The OEPA has review and comment responsibility for CERCLA documents as stated in the 1991 Amended Consent Agreement. The OEPA also has jurisdiction over certain delegated RCRA, CAA, SDWA, CWA, PCB, and asbestos activities.

3.1.3 U.S. Department of Energy

The DOE-FEMP is responsible for day-to-day site management, program decisions, interpretation of DOE Orders, interaction with regulatory agencies, milestone compliance, and transmission of deliverables. The DOE-FEMP hierarchy includes the Project Director, Deputy Project Director, Associate Director for Environmental Affairs, and a Project Manager for each operable unit.

The DOE-FEMP Project Director reports directly to the DOE Ohio Field Office (DOE-OH). Procedures for site operations are outlined at headquarters level through DOE Orders and guidance and are interpreted and implemented at the DOE-FEMP level.

3.1.4 Fluor Daniel Fernald (FDF)
FDF is responsible for day-to-day operation of the site, including operation of all facilities, services, and utilities. The DOE has assigned radiological and industrial health and safety duties to FDF. FDF's environmental safety and health organization may utilize expertise and resources of other subcontractors to fulfill its duties.

FDF is responsible for day-to-day execution of the FEMP environmental programs, including the collection and evaluation of data pertaining to those programs. Additional duties include the evaluation of remedial alternatives and responsibility for initial preparation of remedial investigation, feasibility study, and other reports specified in the 1991 Amended Consent Agreement.

3.1.5 Subcontractor Requirements
Each DOE subcontractor at the FEMP must have internal management structure as defined in contractor-specific documents. There may be several levels of subcontractors to provide services in any area. However, completion and quality of subcontracted work is the direct responsibility of FDF.

Subcontractors and lower tier subcontractors shall comply with applicable site procedures, policies, and the SCQ. This requirement shall be included in all contracts between subcontractors and their lower tier subcontractors. Subcontractors shall document that personnel are technically qualified to perform designated tasks and will comply with site QA and health and safety requirements. Provisions shall be made to update subcontracts predating the current approved SCQ to be consistent with new requirements. Failure of a subcontractor to comply with the SCQ or other contractual requirements may be viewed as a breach of contract and grounds for contract termination.

Subcontractor laboratories performing sample analyses covered by the SCQ shall perform work in accordance with SCQ requirements. Exceptions shall be approved by the DOE on a case-by-case basis. Compliance shall be determined during surveillances and audits described in Section 12.

3.1.5.1 <u>Subcontractor Procurement System</u>. FDF shall use a documented procurement system which meets DOE requirements for procuring subcontractors.

3.1.5.2 <u>Laboratory Subcontractors</u>. Procurement of laboratory subcontractors for analyzing environmental samples (including all chemical, radiological, and geotechnical analyses) shall be strictly controlled. Only laboratories that have a demonstrated capability to provide the level of data quality required for a program or project shall be employed (see Section 12 and Appendix E).

A. Minimum elements of analytical services procurement shall include the following:

1. Demonstrated ability to perform the analyses required at a specified capacity;

2. Ability to handle the types of material to be analyzed, including applicable licenses and permits;

3. Implementation of required quality elements verified through an onsite, pre-award audit conducted by FEMP personnel;

4. Successful analysis of performance evaluation samples;

5. Verification of continuing satisfactory performance through (at least) annual audits by FEMP personnel as well as through performance evaluation sample analyses such as the Interlaboratory Data Comparability Program;

6. FEMP notification to the USEPA Region V RPM of intent to use a laboratory;

7. Upon USEPA request, provision of audit and performance evaluation data;

8. Opportunity for USEPA to perform its own audit of the laboratory.

Performance evaluation samples may be provided by FEMP personnel or may be part of an ongoing program, such as the USEPA contract laboratory program. FEMP-supplied performance evaluation samples shall be traceable to standards purchased from the USEPA, the National Institute of Standards and Technology, or other equivalent program.

B. A list of approved laboratories shall be prepared by FDF, documenting the following information for each laboratory:

1. Laboratory name and facility locations;

2. Types of analyses the laboratory is approved to perform by analytical support level;

3. Types of samples the laboratory is qualified to handle;

4. Date last audited;

5. Period of performance for the FEMP;

6. Approval status (see E.2.3.F).

FDF shall maintain an up-to-date list of analytical laboratories approved for FEMP analyses. An example list of laboratories, indicating the performance requirements, is provided in Table 3-1 (Appendix A). Only laboratories meeting performance requirements specified in Appendix E shall be included on the list. If a subcontractor owns more than one laboratory, only those included on the list may perform FEMP work.

Approved laboratories must have successfully analyzed performance evaluation samples for the required time period and have been audited by FEMP personnel. Additions or deletions of laboratories to the list shall be based on audits and analysis of performance evaluation samples

by the designated FEMP QA organization. When laboratories are added to the list, DOE will notify USEPA, and the list shall be modified accordingly. If a laboratory will no longer be used by the FEMP, an ending date of performance will be added and the laboratory listing will remain to aid investigators evaluating historical data.

FEMP personnel shall notify USEPA of the intent to add a laboratory to the list after the laboratory has demonstrated its ability to fulfill performance requirements. The laboratory shall be designated "proposed for approval." USEPA may accept FEMP laboratory performance data and approve the laboratory, conduct an audit in cooperation with FEMP QA personnel, or conduct its own audit. Analyses performed by the laboratory between the time of FEMP approval and USEPA acceptance shall be considered "at risk". When the laboratory is accepted by USEPA, "at risk" data shall be accepted.

If the laboratory does not pass the USEPA audit, data considered "at risk" shall remain so if corrective actions are pending, or the data may be rejected outright.

If a laboratory that has performed work for the FEMP is disqualified from performing further work, it shall remain on the list with the period of performance indicated for reference.

3.2 QUALITY ASSURANCE MANAGEMENT

DOE, USEPA, OEPA, and their respective subcontractors have QA management and oversight responsibilities as shown in Table 3-2 (Appendix A) and described in the following paragraphs.

3.2.1 U.S. Department of Energy

As stated in Section 3.1.3, the DOE-FEMP has overall responsibility for QA activities at the FEMP. The DOE-FEMP has delegated independent QA assessment duties to the FDF QA department.

The designated FEMP QA organization (FDF quality assurance department) is independent of direct job involvement and day-to-day operations and has direct access to DOE-FEMP management to resolve QA disputes (independent assessment). The QA organization is responsible for the following QA management functions:

A. Conducting audits and surveillances to verify that the QA program is implemented in compliance with sitewide and project-specific requirements, DOE orders and guidance, and USEPA regulations;

B. Verifying and approving corrective actions;

C. Auditing compliance with training procedures;

D. Review and signature approval of plans, procedures, drafts, and final documents covered by the SCQ.

The manager of each project is responsible for quality assurance within the project scope (self assessment). A member of the designated QA organization may be assigned to a project and be responsible for verifying training, conducting audits and surveillances, performing data validation, and verifying compliance with requirements. If the project manager is part of an

organization other than FDF, the subcontract technical representative (STR) is responsible for reviews and approvals by affected groups. The applicable DOE project managers are responsible for PSP approval (see Section 3.3.3).

3.2.2 U. S. Environmental Protection Agency

USEPA Region V is responsible for review and approval of the SCQ. Requests to modify the SCQ or other USEPA-approved documents shall be transmitted by DOE to the USEPA RPM, who is responsible for distributing change requests to appropriate reviewers. Work plans prepared as part of the 1991 Amended Consent Agreement activities shall be reviewed and approved by USEPA prior to implementation.

The following USEPA organizations have quality assurance responsibilities as indicated:

A. The USEPA Region V Regional QA Reviewer is responsible for approval of the SCQ;

B. The USEPA Region V is responsible for external laboratory audits (see Section 12 for audit requirements and responsibilities);

C. The USEPA Region V is responsible for external field audits;

D. The USEPA RPM is responsible for approval of all plans required by the 1991 Amended Consent Agreement and for coordinating communications between USEPA and DOE.

E. The USEPA Region V Field Support Section is responsible for review and approval of field and laboratory procedures.

3.2.3 Ohio Environmental Protection Agency

The OEPA reviews and comments on the SCQ. The OEPA also evaluates and comments on the SCQ for completeness relative to tasks for which the state has primacy including RCRA, the Clean Air Act, and the Clean Water Act. State involvement and concurrence is vital to achieving the goal of an integrated environmental program at the FEMP.

3.3 DATA QUALITY OBJECTIVES AND PROJECT-SPECIFIC PLANS

Prior to implementing any project that involves environmental sampling and analysis, it is necessary to prepare project-specific DQOs and a Project-Specific Plan (PSP). The steps involved in this process are briefly described in Section 1.5. This discussion will provide more detailed information on the contents of the PSP.

3.3.1 Data Quality Objectives

DQOs are quantitative and qualitative statements that specify the quality of data required to support decision making. Intended use of the data is the driving consideration in the formulation of DQOs. The result of the DQO process are project-specific quality assurance objectives. These objectives (precision, accuracy, representativeness, comparability, and completeness) should be reflected in the DQO (see Section 1.5.1). Screening data from Analytical Support Levels (ASL) A and B analyses are used most often at FEMP. However, parameter-specific data for ASLs C, D, and E are necessary for projects such as risk assessment, characterization, treatability analyses, containment verification and cleanup attainment. ASLs are discussed in detail in Section 2.

USEPA guidance has been used to develop a process for defining DQOs for projects at the FEMP (U.S. Environmental Protection Agency, 1987b and 1994b). Description of this process is provided in Appendix C. Support documentation for DQOs are filed by the DQO coordinator (see Section 1.5.1) and, upon request of the project manager, may become part of project files.

3.3.2 Project-Specific Plans

PSPs shall be developed for each project performed at the FEMP that includes environmental sampling and analysis. These plans include details applicable to the specific project for which they are written and shall be in a form that can be used on a day-to-day basis by project personnel.

The PSP is designed to provide for project-specific planning and QA/QC considerations. Specific projects rely directly on the SCQ for overall guidance and QA/QC requirements. The PSP provides the specific details not provided in the SCQ or DQO and provides documentation of exceptions or additions to the SCQ. Sections of the SCQ may be included by reference in the PSP. Project-specific variations to the SCQ requirements shall be identified and justified in the PSP. Health and safety requirements are addressed in project-specific addenda or other health and safety documents, such as job safety analyses.

A. A PSP must, at a minimum, address seven aspects of the project for which it is prepared:

   1. Project background;

   2. Project objectives;

   3. Project organization;

   4. Sample design;

   5. Analytical requirements;

   6. Project requirements for surveillances and audits;

   7. Methods for data management, storage, and evaluation.

B. If a technology, procedure, or method not described in the SCQ and not set forth in any operable unit ARARs table will be implemented during a project, include the following in the PSP:

   1. Reason the technology, procedure, or method was chosen;

   2. References or other data confirming that the technology, procedure, or method is sufficient to support data needs;

   3. Procedure for implementation of technology/method by reference after USEPA approval;

4. Types of required preventive maintenance, if appropriate.

C. If the technology, procedure, or method is not set forth in the operable unit ARARs table, it must be approved by DOE-FEMP senior management with review from the FDF Legal Affairs Department.

D. If the technology, procedure, or method replaces one previously used, the following shall be included in the PSP:

1. Document Change Request (specified in Section 4);

2. The reason for the change;

3. A means for comparing results of the old and new technologies/methods;

4. Full validation at ASL D of any new method used to calculate upper confidence limits for use in risk assessment until completeness requirements have been met for the initial stage or phase of use.

3.3.2.1 **Project Background**. Project background shall include historical information about the activities that have previously occurred at the site that are germane to the current project. The following may be included:

A. Waste generating activities;

B. An evaluation of a summary of previous monitoring activities;

C. The results of any previous remediation studies or activities;

D. A summary of the contaminants of concern and the probable sources, potential transport routes, and environmental fate;

E. A summary of previous monitoring activities.

3.3.2.2 **Project Objectives**. Development and clarification of the project's objectives are integral parts of the DQO and PSP process. Project objectives need to be stated with sufficient detail so that the sample design, analytical methods, and QC requirements are consistent with the goals of the project. A copy of the approved DQO must be attached to the PSP and incorporated by reference.

3.3.2.3 **Project Organization**. Clearly describe the project organization and responsibilities to accomplish the goals of the specific project.

3.3.2.4 **Sample Design**. The sample design incorporates all concerns related to the collection of environmental samples. Maximum use of reference to the SCQ is encouraged. Descriptions of supplemental information, site specific details, maps, and new information shall be provided in the PSP. Collected samples should be representative of the media sampled and support the

intended data use. The PSP must specify the number of samples to be collected in order to achieve the quality objectives of the PSP.

The PSP sample design shall include the following:

A. Identify the method or methods used for determining sampling locations and number of samples (including background);

B. Describe the location, number, and description of sample collection locations, including background stations;

C. Identify field screening measurements and other field observations to be taken prior to and during sample collection;

D. Identify the media to be sampled;

E. Define the frequency of sampling;

F. Specify Quality Control samples to be collected and protocols to be followed;

G. Specify the methods for collecting samples (Section 6) and the types of samples;

H. Include detailed method descriptions if they differ from those in the SCQ or are not included in the SCQ;

I. Specify the volume of samples to be collected, the types of containers to be used, and the sample preservation techniques;

J. Include a sampling table;

K. Define the roles and responsibilities of the sampling team members;

L. Determine and identify equipment and materials necessary to perform required sampling activities and field analyses;

M. Identify appropriate field collection sampling reports pertinent to the particular sampling activity;

N. Specify sample preservation, packaging, storage, and shipping requirements in accordance with the SCQ;

O. Specify the sample labels and chain of custody documentation (Section 7) to be used by reference, providing any project-specific variations in detail;

P. Specify decontamination procedures for sampling activities in accordance with decontamination requirements in Appendix K by specific reference, providing any project-specific variations in detail.

3.3.2.5 **Analytical Methods**. The description of the analytical methods to be used shall incorporate the target parameters, required detection limits, and the required ASL. Maximum use of reference to the SCQ is encouraged. Supplemental information, site-specific details, and new information shall be included in the PSP.

A. Specify analytes of interest, detection limits, and performance requirements;

B. Specify analytical methods and ASL (see Appendix G for approved methods);

C. Methods must be included as ASL E if they differ from those identified in Appendix G or performance specifications in the case of radionuclides;

D. Identify the types of field analyses;

E. Identify the type and kind of laboratory analyses (Section 9);

F. Identify any additional quality control checks;

G. Define data validation requirements for ASLs B, C, D and E data;

H. Specify all data validation and data reporting requirements that differ from SCQ requirements;

I. Specify calibration requirements for equipment (Section 8 and Appendix I).

J. Specify field measurements, including replicate measurements.

3.3.2.6 **Project Requirements for Surveillances and Audits**. Project-specific surveillance and audit requirements shall be included in the PSP. Surveillance and audit information shall include the number and frequency, the scope, and the organizations responsible for conducting the surveillances or audits.

3.3.2.7 **Data Management, Evaluation, and Storage**. Requirements for data management, data evaluation, and storage shall be included in the PSP. The PSP must specify requirement for field-generated data documentation and analytical data, including both electronic and hard copy data. Responsibilities for each requirement must be stated. Additional requirements for data management are provided in Section 4.4.2.

3.3.3 PSP Review and Approval

Project-Specific Plans shall receive both technical and quality reviews and approvals (Table 3-2, Appendix A). The designated project manager is responsible for development of PSPs in accordance with requirements of the SCQ and the appropriate DQO(s), and for ensuring that all appropriate organizations review the PSP prior to implementation. The sampling team leader or other appropriate implementing personnel shall review the PSP and provide technical comments, as applicable. The designated FEMP QA organization is responsible for QA review and approval of PSPs and for providing technical comments consistent with QA program requirements. The FEMP health and safety organization is responsible for reviewing and approving PSPs for consistence with site safety requirements.

PSPs required as part of the 1991 Amended Consent Agreement or the Consent Decree with the state of Ohio shall be reviewed by DOE-FEMP and approved by the appropriate agency prior to implementation (see Section 1.5.3) unless other arrangements are made for certain time-critical PSPs. For normal PSPs, the regulatory comment resolutions will be incorporated in the final PSPs before implementation. For time-critical PSPs (see Section 15.3.1), uncontrolled copies will be forwarded to regulatory agencies at the direction of DOE-FEMP. Comments generated by regulatory agency review will be evaluated, and if a significant change to scope is required and is agreed to by both the regulatory agency and DOE-FEMP, a Variance/Field Change Notice to the PSP (see Section 15.3) will be issued to incorporate the change.

3.3.4 Additional Project Concerns

Apart from technical requirements, these additional factors shall be addressed in project scoping, as applicable.

A. **Personnel Protection** - Safety is a top priority at the FEMP. Each employee is expected to consider how their work tasks may be performed more safely. Methods for performing work shall minimize the probability of an accident and keep hazard exposure to an acceptable level in accordance with USEPA, Occupational Safety and Health Administration, and Nuclear Regulatory Commission requirements through the use of personal protective equipment and safe work practices. Exposure to potentially harmful ionizing radiation shall be As Low As Reasonably Achievable.

B. **Protection of the General Public and the Environment** - The FEMP's commitment to safety, which includes minimization of accidental exposure to hazards, is extended to protection of the general public. Activities at the site shall be performed with primary consideration given to protection of human health and the environment.

C. **Meeting Data Quality Objectives (DQOs)** - DQOs shall be defined before data collection activities begin. Data shall be collected in a manner consistent with specified data quality objectives. Documentation shall be adequate for DOE, USEPA, or a third party to be able to evaluate and confirm compliance with those objectives.

D. **Waste Minimization** - Activities shall be planned to prevent unnecessary generation of waste, including consideration of sample location selection, sample collection methods, parameters to be analyzed, use of screening analyses where applicable, and prudent use of materials. Generated wastes shall be handled in an environmentally sound and safe manner, in compliance with all applicable requirements.

E. **Timeliness** - Every attempt shall be made to meet schedule commitments, perform activities safely, and produce useable data within a reasonable time frame.

F. **Cost Effectiveness** - Activities shall be performed to maximize production of useful, valid information and minimize expenditures.

3.4 ANALYTICAL LABORATORY RESPONSIBILITIES

Analytical laboratories providing services for the FEMP are responsible for compliance with the requirements of the SCQ and their specific contract. Laboratory performance will be evaluated on an ongoing basis through use of audits (Section 12), performance evaluation samples, and

review/validation of the laboratory's data package. All laboratories performing analyses on FEMP samples must be capable of meeting the requirements listed in Appendix E.

3.5 FIELD RESPONSIBILITIES

Field responsibilities for FDF personnel and subcontractors shall be defined in PSPs and Statements of Work (SOW). These responsibilities shall include project management responsibilities, field personnel qualifications, sample handling specifications, and data management and interpretation requirements.

Assessment of field activities is performed by the designated FEMP QA Organization. Reports shall be issued to the responsible project manager, who shall resolve all discrepancies or problems. The independent QA assessment may consist of surveillances and field inspections.

Field responsibilities for environmental activities are assigned as follows:

A. The project manager is responsible for project planning and for providing personnel and subcontractors to conduct the work. The field supervisor shall oversee each phase of work, and field teams shall implement plans.

B. The project manager also ensures support for identifying utilities, gaining access to controlled areas, providing change-out facilities and clothing, and providing health and safety assistance; provides decontamination facilities; and coordinates with other FEMP field teams.

C. The drilling subcontractor shall perform drilling, soil sampling, and well construction, development, and completion, as directed.

D. Self assessment is provided by the project organization.

E. Field inspection of sampling activities is conducted by the designated QA organization.

Functional responsibilities at the individual project level are defined as follows. The designated project manager is responsible for planning, managing the day-to-day conduct of the project, providing personnel and subcontractors to conduct the work, and serving as a liaison between the individual project and other projects and programs. The project manager is supported in field activities by field activity leaders, including but not limited to the geologist in charge of field investigations for the project (Appendix J.3.3) and sampling team leaders (Appendix K.3.2). Each of these field activity leaders supervises other members of their team and is responsible for coordinating that field team in a specific activity for a specific project.

Field team members may include members of sampling teams (Appendix K.3.3) or other teams organized for the completion of field activities. Training and proficiency requirements for team members shall be fulfilled as specified in Section 4, in procedures, and in the PSP, as applicable. Documentation of training and qualifications shall be readily retrievable by the project manager.

The FEMP project contact's responsibilities include coordinating with the project manager regarding the types of analyses that will be required for the project; arranging for analytical

services with an appropriate, approved laboratory; and arranging for sample containers, labels, and custody record forms to be provided to the sampling teams.

The FEMP analytical project manager works with the analytical laboratory services organization and is assigned to act as the liaison between the individual project and the laboratories used to support that project. The analytical project manager also ensures that the laboratory analyzes the samples and provides reports consistent with a prearranged schedule.

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Section 4

QUALITY ASSURANCE OBJECTIVES

The overall Quality Assurance (QA) objective for environmental sampling and analysis at the FEMP is to verify that FDF personnel and subcontractors comply with the requirements of the SCQ, including those for DQOs, PSPs, field sampling, chain of custody, laboratory analysis, and reporting. Meeting this objective will result in compliance with CERCLA and other regulations listed in Section 1. This section presents specific objectives for the level of the quality control effort; accuracy, precision, and sensitivity of analytical data; and data completeness, representativeness, and comparability.

Details for attaining QA objectives for environmental sampling and analysis programs are described herein. These include field quality control samples; analytical quality control samples; training requirements; records administration; document control; and requirements for completeness, representativeness, comparability, precision, accuracy, and sensitivity.

A successful QA program must establish controls over planning, implementation, and assessment of data collection activities. In addition, personnel training, document control, field and analytical QC checks, and records management are necessary to fulfill QA objectives. Although administrative in nature, they are required to achieve validated data, ensure data comparability, provide reasonable access to the data, and prevent duplication of efforts in site projects.

Specific requirements for sampling, chain of custody, laboratory instrument calibration, laboratory analysis, data reporting, internal quality control, surveillance/audits, preventive maintenance of field equipment, and corrective actions are described in other sections of the SCQ.

Responsibility for overall direction, implementation, and maintenance of the QA program rests with the designated FEMP QA organization (Section 3). The organization also ensures that audits, surveillances, and inspections are conducted to verify program implementation.

4.1 LEVEL OF QUALITY CONTROL

Data generated shall be of known quality and in compliance with specified Data Quality Objectives (DQOs). Guidelines for development of FEMP DQOs are included in Appendix C. Data shall be traceable, technically accurate and legally defensible, and shall have definable characteristics.

Traceability is a legal requirement that provides a documented trail beginning with requirements for data and ending with effective use of the data. Elements that provide traceability include defined data quality objectives, documented collection and measurement techniques, sample and data custody records, and original and final data used to support decisions.

Legal defensibility requires that data generated be scientifically defensible (i.e., accurate, precise, and representative). Complete files of generated data and supporting documentation sufficient to support litigation are required.

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Fundamental mechanisms for achieving established quality goals can be categorized as prevention, quality assessment, and correction and include the following:

A. Prevention of errors by planning and careful selection and training of skilled, qualified personnel;

B. Quality assessment through a program of audits and surveillances to supplement continual informal review;

C. Correction of processes to prevent recurrence of conditions adverse to quality;

D. Incorporation of new processes as they develop to increase quality.

The SCQ has been prepared to guide attainment of these goals. It describes the QA program to be implemented and the Quality Control (QC) requirements to be followed by FDF and subcontractors during the course of remediation of FEMP. The SCQ also describes the project organization structure and specifies the procedures, documentation requirements, sample custody requirements, acceptance criteria, and audit and corrective action provisions to ensure that operations and activities meet the intent of regulatory requirements.

4.1.1 Type and Frequency of Field Quality Control Samples

Field precision is assessed through the collection and measurement of field duplicates. Accuracy in the field is assessed through the use of field and trip blanks and through the adherence to all requirements for sample handling, preservation, and holding time. Field QC samples include the following:

A. Trip blanks;

B. Field blanks;

C. Equipment rinsate samples;

D. Preservative blanks;

E. Container blanks;

F. Duplicate samples;

G. Split samples;

H. Spiked samples;

I. Material blanks (e.g., cleaning solutions).

Collection of field QC samples is based on the requirements of the project's DQO. Requirements and justification for field QC samples for each sampling event (see Glossary) shall be documented in the DQO and the corresponding Project-Specific Plan (PSP). Appendix K

summarizes requirements for field samples; field QC sample frequencies are listed in Appendix A, Table 2-3. The rationale for selection of specific field QC samples and minimum requirements for use follow.

Trip blank analyses are used to determine whether conditions encountered during sample container shipment and handling have affected sample quality. Trip blanks are prepared in a controlled environment and transported to the field with other sample containers. A trip blank for VOCs is prepared by pouring certified deionized or certified deionized, organic-free water (see K.11.1) into a volatile organic analysis (VOA) bottle as specified in Table 6-1 (Appendix A) and sealing it with a teflon-lined septum lid. Trip blanks are required when ASL C or D samples are collected for volatile organic analysis and may be specified for analyses for ASLs B and E (definitions of ASLs are provided in Section 2). In addition to volatile organic analysis samples, trip blanks may be specified for other parameters if technically justified in the DQO. If trip blanks are collected for parameters other than VOCs, then a container appropriate for the determination to be made will be used instead.

Field blank analyses are used to determine whether the sample collection process or conditions at the collection site have affected sample quality. Field blanks are collected for aqueous samples only. Field blanks are prepared by the sampling team before the sample is collected, at the sample location, by pouring certified deionized or certified deionized, organic-free water (see Section K.11.1) into appropriate containers for each type of analysis to be conducted. Field blanks are required for ASLs C and D and may be appropriate for other ASLs as specified in the DQOs.

Equipment rinsate analyses are used to determine the effectiveness of decontamination procedures and to help ensure that cross contamination of samples does not occur. Rinsate samples are prepared by the sampling team at the decontamination site (see Section K.11). A final rinse from the decontamination process is collected in appropriate containers, and analyzed for the constituent of concern. In addition to sampling frequencies specified in Table 2-3 and Appendix K.11.7, a sample is collected when visibly contaminated equipment is cleaned prior to use at a different sampling point or (see Section K.11.7.C). Rinsate samples are required for ASLs C and D and may be appropriate for other ASLs as specified in the DQOs. If dedicated or disposable equipment is used, the DQO may specify that equipment rinsate samples are not required.

Preservative blank analyses are used to determine the quality of sample preservatives. Preservative blanks are prepared in a controlled environment by pouring certified deionized or certified deionized, organic-free water (see K.11.1) into an appropriate sample container along with the preservative specified in Section 6. Preservative blanks may be specified for ASLs B, C, D, and E analyses, but are not required if certified ultra-pure acids/bases are used.

Container blank analyses are performed to determine quality and integrity of containers used in sampling. Container blanks are prepared in a controlled environment. This type of by taking a clean, empty sample container , closing and sealing it, and submitting it to the laboratory for analysis. Preservation techniques are not used for this type of blank. In the laboratory, an extract from the container is prepared and analyzed for parameters of interest. Container suppliers provide QA certification information on batches of pre-cleaned containers if requested. In some cases, additional container blanks may be necessary. Container blanks may be

necessary when unsealed containers are used, container custody seals and associated documentation is not available, or locally cleaned containers are used. Use of container blanks is appropriate for ASLs B, C, D, and E analyses.

Duplicate sample analyses are used to evaluate precision of analytical laboratory performance and sample collection techniques. Duplicate samples are independent samples prepared by field sampling teams in the same manner as the original sample. They are collected as close as possible to the same point in space and time as the original sample, placed in separate sample containers, assigned unique identification numbers and sent as blind samples to the same laboratory as the original samples to be analyzed independently, providing an intra-laboratory comparison of results. Duplicate samples are required for ASLs C and D and may be appropriate for other ASLs as determined by DQOs.

Split sample analyses are used to evaluate precision of analytical laboratory performance as well as some aspects of field sample handling practices. Split samples are prepared by field sampling teams at sampling locations by subsampling a homogenous sample into two or more portions or sets of sample containers and submitting each portion (split sample) as a separate sample to the laboratory for analysis. Split samples provide results for interlaboratory or intralaboratory comparison. When a non-fluid matrix split sample is collected, the homogenization and subsampling procedures shall be presented in the work plan. Split samples may be required for ASLs B, C, and D.

Field spike control samples are used to determine precision and accuracy of analytical laboratory performance. They are prepared in a laboratory environment and transported to the sampling site for numbering and shipment to the laboratory with the remaining field samples. If required, field spike control samples are included once every sixty days or at least once per project, more frequently if appropriate, or when accuracy of a particular laboratory is in question. When necessary, the collection of a field spike control sample shall be stipulated in the PSP, and the quantitative requirements for accuracy the by chosen analytical method shall be justified. Field spike control samples may be specified for ASLs B through E.

Material blanks are samples of material used in construction, decontamination, or other activity (e.g., drilling fluids, annular sealants, cleaning solutions) that are retained for quality control purposes when unexpected contaminants are detected in related media. A material blank shall be collected in a controlled environment from each solution or mixture of materials (e.g., cleaning solutions and drilling fluids) that have the potential to introduce contamination not otherwise present in the media being sampled. These samples shall be clearly marked as retained samples and placed in an archive for future analysis if an anomalous contamination is identified upon review of sample analysis. Material blanks may be analyzed at any ASL.

4.1.2 Type and Frequency of Analytical Quality Control Samples

The following types of QC samples shall be analyzed as applicable for analytical methods identified in Appendix G. Types of QC samples required for specific analytical methods are based on ASLs. Internal QC checks are also described in Section 10.

Frequency of QC sample collection and analysis may be increased but shall not be less stringent than that specified in Table 2-2 (Appendix A) or Appendix G unless so specified in a DQO.

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A. Laboratory Control Samples (LCS), are prepared from certified reference materials. They serve as a monitor of the overall system performance of each step during the analysis including the sample preparation.

B. A method blank (e.g., reagent blank, preparation blank) consists of the reagents used in sample processing added to analyte-free, deionized water (or an empty container) in the same volume or proportions required by the method. Method blanks are submitted to the full analytical procedure and used to assess background contamination levels in the laboratory. Guidelines shall be established for acceptance or rejection of analytical data based on the level of contamination in the blank.

C. A matrix spike is an aliquot of a sample spiked with a known amount of target analytes for the purpose of monitoring laboratory accuracy. Matrix spikes shall be prepared when required by PSPs or DQOs and must be prepared with NIST-traceable materials whenever such materials are readily available. The requirements for collecting matrix spike samples are specified in K.4.6.I (aqueous matrices) and K.5.4.E (solid matrices). Matrix spike acceptance criteria are listed in Appendix G.

D. Matrix duplicate/replicate or matrix spike duplicates are used to assess the matrix effects. A matrix duplicate/replicate is an intra-laboratory split and spiked sample used in organic analyses. The requirements for collecting matrix duplicates or matrix spike duplicates are specified in K.4.6.I (aqueous matrices) and K.5.4.E (solid matrices).

E. Surrogate spikes are used to assess matrix interferences with individual organic samples. A surrogate is an organic compound not normally found in the environment that is similar to target analytes in chemical composition and behavior relative to the method. A surrogate is added to each analytical and QC sample (organics only) prior to analysis. Surrogate spikes can also be used for radionuclide samples.

F. Blind and double blind QC samples are used for long term assessment of accuracy and precision of the analysis or operator. Blind samples are submitted so the analyst knows it is a QC sample but does not know the analyte concentration. Double blind samples are submitted so the analyst is not aware it is a QC sample and does not know the analyte concentration. Types of blind and double blind QC samples include LCSs, spikes, and duplicates/replicates. Some types of these QC samples are included in requirements for certain methods at frequencies specified in Table 2-3 or the PSP. If additional types or frequencies of these QC samples are required, they will be specified in the PSP.

G. Interlaboratory comparison study samples are supplied by National Performance Evaluation Programs and the FEMP QC laboratory to all laboratories performing analysis for the FEMP. Results are evaluated against the expected value and against results from other participating laboratories. Each laboratory shall participate in at least one study for the analytes that it analyzes for the FEMP.

4.2 ACCURACY, PRECISION, AND SENSITIVITY OF ANALYSIS

The fundamental QA objective, with respect to accuracy, precision, and sensitivity of laboratory analyses, is to meet QC acceptance criteria of analytical protocols. The accuracy,

precision, and sensitivity objectives for each major measurement parameter at the FEMP are pertinent to laboratory methods. Specific information on accuracy, precision, and sensitivity is presented in Section 14.

Standard operating procedures shall be written for laboratory analyses and field analyses, and shall include required accuracy, precision, and sensitivity specifications for the analyses. PSPs shall include project required precision, accuracy, representativeness, completeness and comparability guidelines.

4.2.1 Analytical Precision

A routine program of duplicate or replicate analysis must be established to assess the precision of an analytical method, instrument, or laboratory analysis. Results of these analyses are used to calculate relative percent difference for duplicates, matrix spike duplicates, or replicates (see Section 14 for further explanation, including the equation for evaluating relative percent difference). Relative percent difference values may be used to generate precision control charts for organic and inorganic laboratories. The Relative Error Ratio (RER) is used to assess the precision of duplicate measurements for radiochemical analyses. See Appendix G, Table G-4 for a definition of RER.

Range analysis may be used to evaluate the precision or reproducibility of radiological data derived from methods for which performance data are not currently available. Statistical range analysis is used to calculate the expected mean range and control limits for a replicate or duplicate result and assess whether the result is "in control." A range analysis result that lies within three standard deviations of the mean is considered in control. Range analysis results greater than three standard deviations from the mean are considered to be "out of control." Results that are out of control may be re-analyzed as required by the method, or results may be flagged or qualified for use during data validation (refer to Appendix D).

4.2.2 Laboratory Accuracy

Analytical results of laboratory control samples, method blanks, matrix spikes/matrix spike duplicates, field blanks, and container blanks must be assessed along with a periodic program of sample spiking to assess the accuracy of a chemical method or a chemical laboratory analysis. The results of sample spiking are used to calculate percent recovery, which is the quality control indicator for accuracy. Percent recovery of matrix spikes is used to generate accuracy control charts. Percent recovery is calculated from the equation in Section 14.4.

Range analysis may be used to evaluate the accuracy of radiological data. Statistical range analysis is used to calculate the expected mean range and control limits for a replicate or duplicate result and assess whether the result is "in control." A range analysis result that lies within three standard deviations of the mean is considered in control. Range analysis results greater than three standard deviations from the mean are considered to be "out of control." Results that are out of control may be re-analyzed as required by the method, or results may be flagged or qualified for use during data validation.

4.2.3 Instrument Sensitivity

Method detection limits (MDLs) are the objective measures of instrument sensitivity for inorganic and organic analyses. Minimum detectable concentrations (MDCs) are the objective measures of instrument sensitivity for radiochemical analyses. These detection limits are

statistically determined as described in Section 14.6. Instrument sensitivity during a specific analysis is monitored by the analyses of method blanks, calibration check samples, and laboratory control samples.

4.3 COMPLETENESS, REPRESENTATIVENESS, AND COMPARABILITY

4.3.1 Completeness

Completeness can be defined by the percentage of total useable points from the set of total data points collected, analyzed, and available. A formula for estimating completeness is presented in Section 14.5. Data points may be judged to be unusable for their intended purpose if sample holding times were exceeded, quality control criteria were not met, or it is not possible to re-analyze the sample. Also, data points may not be useable if sample bottles were damaged during shipment to the laboratory. Completeness is expected to be at least 90 percent for FEMP projects.

If sufficient valid data points are not obtained to meet project objectives, the valid data obtained shall be used and additional sampling and analysis may be considered to meet project objectives.

Example: Fifty soil samples are collected and analyzed. After data validation, forty four data points are determined to be valid. Completeness is estimated as (44/50) x 100 = 88 percent. Completeness was not achieved.

4.3.2 Representativeness

Representativeness is a qualitative parameter based on professional judgement that reflects the design of the sampling program, standard operating procedures, the proper selection of sampling locations, and collection of a sufficient number of samples. Representativeness expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at sampling points, or an environmental condition.

For FEMP, representativeness is addressed through selection of appropriate sample locations and design of adequate procedures. The goal is to obtain samples representative of the specific matrix (solids, liquids, and air) so that sampling performance can be evaluated.

Example: The objective is to obtain data that is representative of the worst case releases from an outfall. The sampling program includes sampling at times when outfall contaminant concentrations are expected to be highest.

4.3.3 Comparability

Comparability refers to one of five criteria identified by the USEPA to ensure data quality. It is a qualitative expression of the confidence with which one data set can be compared to another. Analytical data generated by the same analytical procedures are comparable provided that relevant, specified quality control elements, such as detection limits, initial and continuing calibration performance, accuracy, precision, and matrix interference acceptance criteria, are met or exceeded. Data generated for the same analytes generated by different analytical procedures are also comparable, provided that relevant QC performance criteria similar to those above are met or exceeded.

4.4 TRAINING, RECORDS ADMINISTRATION, AND DOCUMENT CONTROL

Training records administration, and document control are important to achieving QA objectives. These additional elements are described in paragraphs 4.4.1, 4.4.2, and 4.4.3.

4.4.1 Training

FEMP contractors and subcontractors shall use personnel that have appropriate education, training, and experience to perform an assigned task. Regulatory drivers, the PSPs, and the FEMP procedures and policies define the scope of the training requirements. Personnel qualifications and training needs shall be identified and documented. Training shall be performed in accordance with formally planned, executed, and documented training activities. Special training required to achieve project-specific objectives shall be identified in PSPs. The following site-level and job-specific training is specified for FEMP activities.

4.4.1.1 **Site Training.** Site training requirements are very diverse and are determined by the nature and location of the work or task. The training program conducted at the FEMP prepares hazardous waste personnel to maintain, operate, and remediate the facilities at Fernald in a safe, efficient, and environmentally sound manner. The program emphasizes compliance with USEPA, Ohio Environmental Protection Agency, U.S. Department of Transportation (DOT), and OSHA regulations. It provides personnel with a consistent level of training to respond in a prompt and effective manner if abnormal or emergency situations occur.

Although the training program and specific classes change to meet the needs of the site, typical site-level classes include General Employee Training (GET), Site Worker Training, Radiological Worker Training (two levels of courses), Respirator Training and Fit Testing, Supervised Field Experience, Supervisor/Management Training, and annual refresher courses. These courses fulfill the 29 CFR 1910 series requirements.

4.4.1.2 **Job-Specific Training.** Pre-job briefings are a routine practice for all FDF activities as an integral part of assuring safe and adequate work performance. Additional job-specific training shall be conducted when required or deemed necessary to assure work is performed by thoroughly knowledgeable and capable personnel. These tasks may include, but are not limited to, the following:

A. Nondestructive examination and inspection techniques;

B. Environmental sampling methods;

C. Field and analytical laboratory sample analysis;

D. Data reduction and analysis;

E. Sample packaging and shipping requirements;

F. Sample disposition and inventory;

G. Surveillances and audits;

H. Installing boreholes, and wells;

I. Implementing change proposals;

J. Field tests;

K. Change control procedures;

L. Project quality assurance requirements (including the SCQ);

M. Equipment operation.

4.4.1.3 Implementation. FDF is responsible for verifying that required site training at the FEMP is implemented (Section 3), including training for subcontractor personnel. Instructors shall be technically qualified with the appropriate required combination of experience and training to present the topic of instruction. Training shall be conducted in accordance with approved lesson plans and shall include testing and on-the-job training as appropriate. Training shall be completed before an individual may perform an unsupervised task. Job-specific training is the responsibility of the organization conducting the work (including contractors and subcontractors). The organization shall verify the individual's education and experience to determine that the assigned task is within the realm of capability of the individual. Documentation of training shall be retained in training files.

Before an untrained individual is allowed to perform a task unsupervised, the following requirements shall be completed as a minimum:

A. Documented reading of the applicable procedure or work instruction for the task or duty and understanding it sufficiently to pass a written test if required;

B. Observing the task being done by a trained and qualified worker;

C. Performing the task under supervision of a trained and qualified individual until completion of formal training.

4.4.1.4 Documentation. Training shall be conducted in accordance with approved lesson plans and shall include testing and on-the-job training as appropriate. Personnel training documentation shall include the following as a minimum:

A. Name of trainee;

B. Job title of trainee;

C. Name of trainer;

D. Training subject;

E. Baseline training requirements (regulatory and FEMP);

F. Training dates;

G. Training results (pass or fail, if applicable);

H. Required frequency of training;

I. Educational and job experience requirements;

J. On-the-job training received;

K. Trainee signature indicating that training was received and understood.

4.4.2 Records Administration

Records are stored in onsite, laboratory, and offsite project files. A records management system in accordance with the requirements of this section and DOE Order 0 200.1, has been established at record-keeping locations that cover preparation, control, and retention of project-related records. Records control includes receipt from sources, transmittals, and transfer to storage. Retention includes receipt at the storage areas, indexing and filing, storage and maintenance, and retrieval from storage.

The CERCLA Administrative Record and the Post Record of Decision Files are part of the official FEMP CERCLA record and contain information and reports used to support CERCLA decision making. Copies of their contents are available to the public. Evidence files (see Section 7.3) are maintained to support all reports and information officially entered into the CERCLA Administrative Record and Post Record of Decisions Files. The FEMP Administrative Record Coordinator is responsible for maintaining the analytical evidence files to support the CERCLA Administrative Record and Post Record of Decisions Files and for maintaining files of all other environmental sampling and analysis files that could be used to support future decisions.

4.4.2.1 **Record Preparation**. Hard copy records shall be legible, accurate, and complete; indexed to permit quick and accurate identification of items or activities to which they apply; and authenticated by preparer's signature and completion date. Electronic records [e.g., magnetic diskettes, magnetic tapes, Compact Disk Read-Only Memory (CD ROM)] shall be stored in duplicate. Each diskette, tape, or other data medium shall be identified by a unique identifier. A hard copy index of contents shall be maintained in project files.

When appropriate, corrections may be made to records by authorized personnel (e.g., originating personnel/organization, QA personnel). Corrections shall be made by drawing a single line through the incorrect information on hard copies, making the correct entry, and initialing and dating the revised entry. Electronic files in the archives shall be write-protected. If changes to an electronic file are required, both the original and the back-up copies shall be replaced entirely.

4.4.2.2 **Records Control**. Control over current projects shall be accomplished using a filing system based on subject and task, which will effectively segregate records from different projects and contractors into identifiable and retrievable files. Program and project records shall be controlled as follows.

A. **Incoming Records** - Includes project-related correspondence, data, sketches, logs, authorizations, or other information.

1. The FEMP project manager or designee shall mark original with receipt date and shall assign an identification number to the document in accordance with approved FDF procedures.

2. The FEMP project manager or designee shall determine who will review the materials and route copies of the material to that person.

3. As soon as practical, incoming correspondence originals shall be placed in project files.

4. If correspondence is required by project personnel for reference, a copy shall be marked as such and routed accordingly.

5. Quality-related correspondence shall be routed to the designated FEMP QA organization.

6. Communications relative to FEMP that are initiated by third parties (e.g., media, interested individuals, and groups) are referred directly to designated DOE representatives unless otherwise directed by the DOE site manager.

B. **Outgoing Records** - Includes externally (i.e., external to the specific project) transmitted correspondence, reports, drawings, and sketches.

NOTE

At a minimum, correspondence shall be signed by the originator and, if joint signatures are desirable, appropriate managers. QA correspondence is signed by a representative of the designated FEMP QA organization. DOE correspondence is signed by appropriate DOE officials.

1. Outgoing records shall be approved and signed before transmittal as required. Each outgoing record shall be assigned an identification number to the document in accordance with approved FDF procedures.

2. Routing information shall be attached to the office copy of project correspondence.

3. Records transmitted between the site and remote locations shall be protected from damage and loss during transfer (e.g., copying prior to shipment and hand carrying).

4. Transmittal letters shall be numbered and traceable and copies of attachments filed with transmittal letters unless otherwise indicated. Each FEMP contractor and subcontractor shall have a controlled system for numbering transmittal letters.

4.4.2.3 <u>**Records Retention**</u>. All validated data supporting FEMP CERCLA decisions shall be submitted to the FEMP Administrative Record Coordinator. Copies of all other environmental sampling and analysis files shall be submitted to the FEMP Administrative Record Coordinator

for inclusion in the Administrative Record. Following the receipt of information from Central Data Files external sources and the issuance of reports, associated records (including those generated by subcontractors) shall be placed in the CERCLA Administrative Record, or the Post Record of Decision Files as required.

Files shall also include correspondence, data, and references supporting entries into the CERCLA Administrative Record and the Post Record of Decision files; supporting documentation for CERCLA-driven programs; and supporting documentation for CERCLA-covered programs. Documents exempt from the Freedom of Information Act (e.g., personal dosimetry, urinalysis, and medical records) are specifically excluded from these requirements. The CERCLA Administrative Record Index shall list sampling data specifically listed in the RI/FS reports and indicate where that sampling data can be found. Each FEMP contractor and subcontractor shall maintain project files as required.

Records shall be identified by source and date of receipt. Files shall be identified by project, subject, and task and by keywords in a central file data base management system. Files shall be maintained for the length of time specified in DOE and/or USEPA records management guidelines.

A. **Records Facility** - Files shall be located in an area that, at a minimum, provides the following:

1. Suitable environment to prevent record deterioration, damage, and loss;
2. Controlled access;
3. Steel file cabinets;
4. Protection against excess moisture and temperature extremes;
5. A record review area if practical.

B. **Records Handling** - Files and records contained in project files shall be maintained by designated personnel who are responsible for the following:

1. Review of incoming records for original receipt date prior to filing (as specified in paragraph 4.4.2.2);
2. Indexing;
3. Filing in labeled folders or binders as applicable;
4. Maintaining sign-out sheet.

C. **Records Index** - A numbered index for each project file shall be prepared and maintained in the project records storage area. The index shall list individual file numbers and identify records therein and may be part of an electronic database management system with appropriate backup.

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4.4.2.4 **Offsite Project Files.** Record storage offsite (e.g., at analytical laboratories) shall meet project onsite file storage requirements. Upon completion of the project phase, offsite files shall be transferred to and integrated with onsite files.

Laboratories shall maintain record systems for documents pertinent to testing performance that provide record control and retention similar to that outlined in paragraphs 4.4.2.2 and 4.4.2.3 for onsite office files.

4.4.2.5 **Final Disposition.** Upon completion of the project phase, the original or certified copies of data and records shall be transferred to DOE. With approval from DOE, laboratory data files and records may be microfilmed for archive storage at any time during a project. If requested to transfer original files to DOE, laboratories may retain copies of project data and records for their files unless specifically prohibited in writing at the time of the request.

4.4.3 Document Control

Documents and drawings shall be prepared, reviewed, approved, revised, and distributed in accordance with the following requirements. Documents and drawings that are controlled shall be identified as such and updated as required. Uncontrolled documents and drawings are issued once and not updated. Document listings shall be maintained by each FEMP contractor and subcontractor for quality-related documents, project-specific documents and drawings, computer graphics, maps, and other controlled documents.

FEMP controlled document lists are maintained by the FDF controlled document coordinators. These lists identify holders of controlled document copies. Distribution of document revisions shall be conducted by the FEMP controlled document coordinators. Maintenance of individual controlled copies shall be the responsibility of the document holder and shall be an auditable requirement.

Subcontractors, specifically including analytical laboratories, shall be given a minimum of one controlled copy of the SCQ at the time of document approval or new contract issuance, as appropriate.

4.4.3.1 **Preparation, Review, and Approval of Documents and Drawings.** Prior to implementation or use, documents and drawings shall be reviewed and approved. Each approved document or drawing shall be signed and dated. Documents and drawings requiring DOE approval shall be reviewed and approved by designated personnel before submittal to DOE. Copies of documents or drawings released for any purpose before they have gone through the complete review and approval process shall be dated and marked "PRELIMINARY" for drawings and "DRAFT" for documents.

Each FEMP contractor and subcontractor shall have a documented process for preparation, review, and approval of documents and drawings for which they are responsible. This process shall include the following.

A. Standardized document and drawing format;

B. Identification of required reviewers;

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C. Review process including documented resolution of reviewer comments to include concurring signature for comments submitted as significant;

D. Procedure for obtaining required approvals and authorization to issue;

E. Periodic review.

FEMP sitewide documents shall be reviewed and commented upon by each affected FEMP contractor.

4.4.3.2 **Changes to Documents and Drawings**. Changes to approved plans and procedures may be necessary during the course of project performance. Review and approval of changes to documents shall be in accordance with requirements of the original document. Organizations approving the original document shall also approve changes. Changes shall be approved prior to implementation. Each FEMP contractor and subcontractor shall have a written procedure for initiating changes to documents and drawings for which they are responsible.

Revisions shall be submitted for review and approval with approval sheets as appropriate. Review and approval of other documents, if not documented on re-issued approval title sheets, shall be documented in another manner (e.g., associated document change request DCR approval signature blocks) to attest to review and approval in accordance with requirements of the original document.

4.4.3.3 **SCQ Document Change Requests**. A Document Change Request (DCR), FS-F-5233 (Form 4-1, Appendix B), is the only means of initiating a change to the SCQ. Review and approval of DCRs ensure compliance with requirements of the original document before they are implemented. At a minimum, the FEMP project manager and the designated FEMP QA organization representative shall review the DCR. DCRs shall also be reviewed by the FEMP project managers and QA representatives of all other organizations whose activities will be affected by the proposed changes.

Verbal concurrence may be requested from other signers if necessary. If the other signers verbally consent to the DCR being signed for them, the FEMP project manager or designated FEMP QA organization representative may sign their own name in the other person's signature space and write "for" before the person's title below the signature space.

4.4.3.4 **SCQ DCR Process**. The DCR shall be completed in the following manner:

A. The originator shall complete the DCR through the CONTENT OF CHANGE section and forward it to the DCR coordinator for evaluation.

B. The DCR coordinator shall review the DCR and resolve any discrepancies with the originator.

C. The DCR coordinator shall assign a request number and enter it in REQUEST NO. space.

D. The DCR coordinator shall enter pertinent information in the DCR status and tracking log, which shall include the following information:

1. DCR number,
2. Originator,
3. Request date,
4. Subject matter,
5. Affected document,
6. Section numbers,
7. Approval date for each signer,
8. Date of distribution to each document holder,
9. Issue date of revised document pages.

E. The DCR coordinator shall forward copies of the DCR to applicable FEMP organizations with a request for review and comments.

F. If a reviewer refuses to sign the DCR, that person shall communicate to the DCR coordinator the reasons for not signing.

G. The DCR coordinator shall coordinate resolution of the disagreement. If a decision is made not to proceed with the DCR, the DCR coordinator shall notify those who signed the DCR. An appropriate entry to this effect shall be made in the DCR log.

H. The DCR coordinator shall receive signed DCRs from reviewers and record dates in the DCR status and tracking log.

I. When all appropriate signatures have been received, the DCR coordinator shall sign the DCR and forward the DCR to DOE-FEMP for approval.

J. When DOE-FEMP has signed the DCR, the DCR coordinator shall distribute copies to all SCQ controlled copy holders (see steps M and N).

K. The DCR coordinator shall forward the signed DCRs to the DOE-FEMP for signature and transmittal to the USEPA for approval.

NOTE

EPA approval is required for primary documents listed in the 1991 Amended Consent Agreement. USEPA approval is not required for secondary documents of the 1991 Amended Consent Agreement. The USEPA shall be advised of any modification to documents that received USEPA comments.

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L. The DCR coordinator shall coordinate resolution of external FEMP comments and obtain required internal FEMP approvals.

M. The DCR coordinator shall issue the DCR to holders of controlled copies of the SCQ upon completion of FEMP external approval process.

NOTE

The effective date of change and issuance of the DCR is dependent on DOE completion of the section of the DCR specifying EPA notification, EPA approval, or immediate implementation.

N. Changes described in the DCR shall be implemented by the applicable organization on the date specified in the EFFECTIVE DATE space.

4.4.3.5. SCQ Distribution. The FEMP SCQ controlled document coordinator is responsible for controlled distribution of the SCQ. Each FEMP contractor and subcontractor is responsible for controlled distribution of documents for which they are responsible. Delegation of distribution activities shall be documented.

Distributed documents shall be identified by a copy control number unique to each recipient. Each organization responsible for controlled distribution shall maintain a distribution list containing the name of the document, control number, and copy-holder name and mailing address. If controlled documents and drawings become obsolete or are no longer needed, instructions for return to the FEMP controlled document coordinator for appropriate disposal shall be issued to copy holders. Each returned document shall be logged into the document tracking log. An uncontrolled copy of a controlled document shall be so identified in a conspicuous manner.

NOTE

It may not be practical to identify drawings, graphics, and maps with a copy control number. If not, they shall be identified in some other manner.

Distribution of Revisions - Distribution of DCR documents and drawing revisions and addenda shall be made to original-issue copy holders in the same manner. The transmittal of revisions and addenda shall include instructions for revision inclusion and disposition of superseded material. Each limited revision (paragraph 4.4.3.3) shall be transmitted by a revision log sheet that lists revised pages for that revision. The log sheet shall be filed in front of the revised document section. A record of document transmitted, recipient, and transmittal date shall be maintained in the tracking log.

Incorporation of Changes - Each controlled document copy holder who receives an approved DCR shall insert it in the SCQ until revised document pages incorporating the DCR changes are received. When the changed pages are received, they shall be incorporated in the SCQ and the DCR shall be removed.

4.5 COMPUTER HARDWARE AND SOFTWARE VALIDATION

All computer hardware and software used to provide analytical data, manage and maintain analytical data, or support environmental decisions must be validated and verified. The verification/validation must be consistent with the requirements of ANSI/ASME NQA-1 (1994 edition), supplement 11-S2, *Supplementary Requirements for Computer Program Testing.* Recommended guidance on this subject is available in ANSI/ANS-10.4-1987, *American National Standard Guidelines for the Verification and Validation of Scientific and Engineering Computer Programs for the Nuclear Industry.*

Computer hardware and software configuration integral to measurement and testing that are calibrated for a specific purpose (including commercial software validated by the manufacturer) do not require further testing unless the scope of software usage changes or modifications are made to the hardware or software configuration. If any components are changed or modified, the resulting new configuration must be documented and tested.

Computer software and computer hardware/software configurations include experimental design, design analysis, modeling of environmental processes and conditions, operation or process control of environmental technology systems (including automated data acquisition and laboratory instrumentation), and data bases containing environmental data.

4.5.1 Test Requirements

Test requirements and acceptance criteria shall be provided by the organization responsible for the design or use of the program to be tested, unless otherwise specified. Required tests including, as appropriate, verification tests, hardware integration tests, and in-use tests shall be controlled. The proposed test requirements and acceptance criteria shall be based upon applicable design or other pertinent technical documents.

4.5.1.1 <u>Verification Tests</u>. Verification tests shall demonstrate the capability of the computer program to produce valid results for test problems with a known data set. The test shall encompass the range of permitted usage defined by the program documentation. The results from the tested software shall be compared with hand calculations, calculations from comparable proven programs, or empirical data and information from technical literature to verify their accuracy and precision.

For programs used for operational control, testing shall demonstrate required performance over the range of operation of the controlled function or process.

Depending on the complexity of the computer program being tested or the degree of customization that has occurred, testing may range from a single test of the completed computer program to a series of tests performed at various stages of computer program development to verify correct translation between stages and proper working of individual modules, followed by an overall computer program test. Regardless of the number of stages of testing performed, verification testing shall be sufficient to establish that test requirements are satisfied and that the computer program produces a valid result for its intended function.

4.5.1.2 <u>In-Use Tests</u>. Test problems shall be developed and documented to permit confirmation of acceptable performance of the computer program in the operating system. Test problems shall be run whenever significant hardware or operating system configuration changes are made. Periodic in-use manual or automatic self-check routines shall be prescribed and

performed for those application where computer failures or drift can affect required performance.

The system administrator charged with maintaining each application is responsible for determining whether a proposed change to underlying hardware or software has the potential to impact the operation of that application. The system administrator then determines what testing and modifications, if any, are needed to assure proper operation of the application.

A. Examples of operating system changes that would require testing and possible modifications include:

   1. Changing client operating system from Windows 3.1 to Windows-95;

   2. Upgrading database server software (e.g., moving to new version of Oracle);

   3. Upgrading to new version of server operating system.

B. Examples of hardware system changes that would require testing and possible modifications include:

   1. Moving from terminal-based to PC-based user workstation;

   2. Changes in location/designations of server disk drives;

   3. Changes in printer hardware or print queue definitions.

4.5.2 Test Procedures

Test procedures or plans shall specify the following, as applicable:

A. Required tests and test sequence;

B. Required ranges of input parameters;

C. Identification of the stages at which testing is required;

D. Criteria for establishing test cases;

E. Requirements for establishing test cases;

F. Requirements for hardware integration;

G. Anticipated output values;

H. Acceptance criteria;

I. Reports, records, standard formatting, and conventions.

4.5.3 Test Results

Test results shall be documented. Verification test results shall be evaluated by a responsible authority to assure that test requirements have been satisfied. When verified test results require validation, an independent authority will qualify verification test results.

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4.5.4 Test Records

A. Verification tests records shall identify the following:

1. Computer program tested (including the file name and version number);
2. Computer hardware used;
3. Test equipment and calibrations, where applicable;
4. Date of test;
5. Person performing the test or recording the data;
6. Simulation models used, where applicable;
7. Test problems;
8. Results and acceptability;
9. Action(s) taken in response to any problems noted;
10. Person evaluating test results.

B. In-use test results shall identify the following:

1. Computer program tested;
2. Computer hardware used;
3. Test equipment and calibrations, where applicable;
4. Date of test;
5. Person performing the test or recording the data;
6. Acceptability.

4.5.5 Modification Control

Software shall be controlled to prevent the use of modified packages that have not been verified. Unauthorized modifications to verified software must be prevented. If a verified package has been modified but not tested, it must be clearly identified via a new file name or other mechanism to prevent unintentional use until all verification testing is successfully completed. Each project manager shall ensure that only tested and approved computer hardware and software are used to generate or manage data that is used for environmental decision making.

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Section 5

Section 5

FIELD ACTIVITIES

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Requirements for field activities are provided in this section. It should be noted that these requirements pertain to record keeping and actions that are distinct from the actual act of physically collecting a sample. All field activities must be performed in accordance with the Applicable or Relevant and Appropriate Requirements (ARARs) for each Operable Unit (OU). Specific requirements for field activities are contained in Appendix J. Detailed procedures shall be referenced in PSPs as a supplement to the SCQ. Each field procedure shall specify reasons or uses for the activity, methods to be used, applicable material specifications, and documentation requirements specific to that activity.

Minimum requirements for field activities in this section and in Appendix J may be incorporated into PSPs by reference to the SCQ. Surveillances and audits shall be conducted in accordance with requirements specified in Section 12 and with PSP requirements. Information obtained from site field activities shall be recorded and filed as specified in Section 5.1.

5.1 DAILY LOGS

NOTE

Field activity logs shall be written in a narrative manner that sufficiently describes the event so that the sampling team may reconstruct that event without reliance upon memory. Field activity logs shall be updated as significant activities occur, at a minimum of every 30 minutes.

Field personnel are required to keep a daily log of project activities. Daily logs are written records of activities and measurements conducted in the field on a given date (see J.4.1 *et seq.*). The log shall be in a bound book with printed, sequentially numbered pages, or on uniquely numbered field forms. Uniquely numbered field forms must be cross-referenced with a control number which links together all field forms associated with a field activity. Daily logs shall include all documentation of field activities, including but not limited to the following, as applicable:

A. All logs generated during the installation, development, or abandonment of monitoring wells and boreholes;

B. Test data forms;

C. Field activity logs;

D. Sample collection logs;

E. Chain of custody records.

Requirements for the documentation of sampling activities are listed in Section 6.1; chain of custody requirements are listed in Section 7; requirements for additional field activity documentation are listed in Appendices J.4.1 and K.9.

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At least weekly, copies of daily logs shall be sent by field personnel to the FEMP project manager or representative and others as required in PSPs. Original field records shall be maintained in the project central file. During performance of the field program, the FEMP project manager or representative shall maintain copies of field records and store them separately from the originals. These copies will provide adequate documentation of work activities if originals are destroyed, lost, or stolen.

5.2 FIELD ACTIVITY POLICIES

The following general requirements for field activities are supplemented by specific requirements in Appendix J and project-specific requirements in PSPs.

5.2.1 Drilling

The nature, arrangement, thickness, and extent of subsurface strata can be determined by implementing a well-designed drilling program. Number, location, and depth of borings and type of sampling and testing required are dependent on intended use of the data generated.

The type of drilling method selected for a particular project at the FEMP depends on project objectives. Factors to be considered in selecting a drilling method include the ability to acquire data of sufficient quality for the intended use, the need to maintain environmental integrity (preventing the possible spread of contaminants during drilling operations), and personnel health and safety. The particular drilling method shall be specified in the PSP.

Descriptions of various drilling methods are presented in Driscoll (1986) and Aller, et al. (1989). Drilling methods that may be considered for use at the FEMP include rotasonic; cable tool; hollow-stem auger; drive casing; spin casing; direct mud rotary; air rotary with casing driver; air rotary with a swing-out, under-reaming bit, and casing advancer; and reverse-air or mud rotary. Although direct-push technology is not generally considered a "drilling" method, these techniques may be used to obtain soil samples by using coring methods or to collect groundwater samples by using temporary well points.

Drilling operations shall be conducted to minimize, to the maximum extent possible, the introduction of contaminants into the environment or their spread between zones. Surface casing shall be set when a potentially contaminated zone is penetrated prior to reaching the target zone. When drilling through areas where contaminated perched water is present, surface casings shall be grouted in place and made a part of the permanent installation. In outlying areas not suspected of being contaminated, temporary casings shall be advanced as necessary for borehole control.

Consistent with the FEMP policy of waste minimization, the chosen drilling method shall require the least possible fluids and generate the fewest possible cuttings and the least waste.

Potable water from a public water system shall be used for drilling operations. If extenuating circumstances dictate that another source must be used, the quality of the other water source used shall be documented through water certification or analysis of samples by the FEMP prior to use.

The FEMP project manager shall approve additives used in drilling fluids prior to use. Before an additive is approved, a sample shall be analyzed for parameters of interest and the results

reviewed for potential impact on the objectives of the data collection program. Use of additives is discouraged.

The PSP shall specify how drilling wastes shall be contained. Sumps dug for containment of drilling fluid are prohibited except where absolutely necessary and shall have prior approval by necessary regulatory agencies.

As specified in Appendix K.11, drilling equipment shall be decontaminated before each use to prevent contamination of the borehole. Following project completion, the drilling equipment shall be decontaminated to prevent transport of contaminants out of the project area.

A qualified geologist, hydrogeologist, or geological engineer shall be responsible for operations at each drilling site and shall be at the field site during selected drilling activities as specified in Appendix J.3.2. The geologist or individual assigned to this project role is also responsible for logging activities at the work site including, but not limited to, drilling and sampling activities, footage drilled, materials used, sample descriptions, well installation activities, and unusual occurrences. Subsurface boring logs (Appendix J.4.5.1) shall be generated for each boring.

The FEMP project manager is ultimately responsible for securing permits required by state, local, or onsite authorities, or otherwise satisfy permit requirements under the CERCLA process. As part of the permit process, underground and above ground utilities shall be identified so they do not pose a danger to drilling operations. Copies of permits and other appropriate documentation shall be available at the work site when drilling operations are conducted.

5.2.2 Monitoring Well Design, Installation, and Abandonment

Existing monitoring well locations and depths at the FEMP were selected to allow monitoring of chemical and hydraulic properties of subsurface materials. They were primarily constructed according to procedures in the USEPA-approved *Remedial Investigation/Feasibility Study Quality Assurance Project Plan* (U.S. Department of Energy, 1988c) and included borehole installation by the cable tool method; four-inch diameter, 316-stainless steel casing and screen; annular seal of bentonite grout; and locking protective casing.

New drilling and well construction shall be done in accordance with the requirements of Appendix J.

A sequential numbering system is used to identify wells at the FEMP. The first digit designates the hydrogeologic unit in which the well is constructed. Thus wells beginning with a number 1 are Type 1 wells; Type 2 well numbers begin with the number 2, and so forth. Type 1 wells are screened in the till. Type 2 wells are screened across the top of the Great Miami Aquifer (GMA), while Type 3 wells monitor the approximate middle of the GMA at a depth above, and equivalent to, a discontinuous clay lens in the area of the FEMP. Type 4 wells are installed to monitor the base of the GMA (Figure 2-2). Type 6 wells are installed at a depth between that of a Type 2 well and a Type 3 well to effectively monitor the movement of the contaminant plume. The remaining digits of the well number are sequentially assigned.

Sequential numbers are assigned regardless of the planned depth of penetration. However, wells of different depths placed in clusters at the same geographic location will be assigned the

same sequential number. Thus, 21355 and 41355 identify wells at the top of the aquifer and the base of the aquifer at the same geographic location.

Wells are installed at nonstandard intervals to supply specific data requirements. Wells completed for special data needs should be specified in the PSP. Applicable Appendix J.4.3 requirements shall be followed to ensure quality control of well design, installation, and successful completion of field drilling investigations for obtaining hydrogeological and future water quality information.

5.2.3 Well and Borehole Abandonment.
Improperly abandoned wells or boreholes can serve as a pathway for pollutants to migrate from one zone to another. Proper abandonment is necessary to maintain a credible monitoring program. Objectives of proper well and borehole abandonment include the following:

1. Eliminate physical hazards;
2. Prevent groundwater contamination;
3. Conserve aquifer yield and hydrostatic head;
4. Prevent intermixing of subsurface waters (Aller et al., 1989);
5. Comply with reasonable requests from property owners;
6. Remove a well that is no longer necessary to support FEMP project activities;
7. Remove a well that does not yield groundwater data representative of conditions in the monitored hydrogeologic zone;
8. Comply with OU5 ARAR for abandoning test holes and wells, as specified in Ohio Administrative Code (OAC) 3745-09-10.

Factors to be considered in well abandonment and requirements for abandoning a well are provided in Appendix J.4.3.3.

5.2.4 Well Development
Wells must be properly developed to yield accurate aquifer test results and groundwater samples representative of aquifer conditions. Personnel developing a well shall have documented training in the operation and calibration of applicable field instrument (pH, specific conductivity, turbidity and temperature meters), and shall be responsible for documenting all monitoring well development activities. Well development requirements are provided in Appendix J.4.4.

5.2.5 Well Maintenance
It is necessary to maintain groundwater wells in order to extend the life of the wells and to provide representative water levels and samples of the groundwater surrounding the wells. Maintenance shall be performed on a case-by-case basis pursuant to the results of the inspection as specified in Appendix J.4.7.

FDF is responsible for performing and documenting well maintenance activities. FDF shall conduct a maintenance survey of groundwater wells and evaluate appropriate concerns such as structural integrity, and wellhead protection. Well maintenance activities shall comply with applicable regulatory and site requirements. If problems are noted, existing groundwater wells shall be evaluated prior to use to assess whether the status will allow for collection of representative groundwater samples. The assessment process is detailed in Appendix J.

5.2.6 Aquifer/Permeability Testing

This section defines the requirements for hydraulic tests to characterize certain properties of hydrogeologic units (e.g., hydraulic conductivity, transmissivity, and storage coefficient). Requirements to conduct an aquifer test for each project shall be made in accordance with guidelines in the PSP. Guidelines for determining test type, location, and objectives for each project shall be specified in the PSP. Methods for testing aquifer/permeability are provided in Appendix J.4.6.

Equipment used in the test shall be based on approximations of properties of interest from previous drilling and testing data.

Tests shall be designed and managed by a geologist or hydrogeologist with demonstrated experience in conducting the specified test. Data obtained during aquifer tests shall include the following, at a minimum:

A. Static water level;

B. Pumping well water discharge rate or volume of water displaced;

C. Drawdown or pressure versus time for pumping wells and observation wells;

D. Water temperature, pH, dissolved oxygen, redox potential, and specific conductance.

5.2.6.1 <u>Slug Tests</u>. Slug tests are a quick and inexpensive method of estimating the hydraulic conductivity or transmissivity near the screened zone of the well. The transmissivity, hydraulic conductivity, and storage coefficient may be calculated based on rate of decay of the pressure slug and geometry of the test zone. The method to be used for conducting and analyzing slug tests shall be based on project-specific considerations including, but not limited to, expected and observed aquifer response, degree of confinement, thickness of saturated zone, well construction, and ability to handle evacuated fluids. The methods of test conduct and analysis, as well as instrumentation, shall be specified in PSPs.

5.2.6.2 <u>Aquifer Tests</u>. Aquifer tests are used to determine hydraulic properties of water-bearing zones. They influence a larger area and provide results that are often more representative of the overall aquifer characteristics than slug tests. The design of the test well is an important consideration in aquifer testing. In some cases, an existing well may be pumped. When conditions permit, a well can be designed and constructed specifically for the test. Under ideal circumstances, the test well is screened throughout the thickness of the aquifer to be tested (a fully penetrating well) using a standard well screen with openings sized to the aquifer material. However, under some circumstances, a partially penetrating well screened in a specific portion of the aquifer may be preferable.

The well should be filter-packed in unconsolidated, fine-grained aquifers to prevent sand production. It should be sealed from overlying and underlying units that will not be directly pumped and so that leakage along the well annulus cannot occur. Such leakage can interfere with data interpretation. The completed test well should be developed to minimize influences related to drilling and well construction. Proper development of the well may prevent unexpected variations in the pumping rate during the test that can lead to inconsistent drawdown data. Standard well construction techniques are discussed in Driscoll (1986).

As a general rule, observation wells are screened or completed in a substantial portion of the aquifer thickness in approximately the median depth of the test zone. In some cases, special tests require that observation wells be selectively completed in several depth zones in order to accurately determine aquifer characteristics such as anisotropy and vertical hydraulic conductivity.

Any number of observation wells may be considered. A number of guidelines for location of observation wells are presented in the Ground Water Manual (U.S. Department of Interior, 1981) and Kruseman and DeRidder (1976). The layout of observation wells shall be included in pumping test plans.

The location and number of observation wells depend on several factors including the following:

A. Whether the designated aquifer is confined or unconfined;

B. Thickness of the aquifer;

C. Inferred anisotropy of the aquifer;

D. Location of screened interval of pumping well relative to total aquifer thickness;

E. Location of positive (lake or stream) or negative (impermeable) aquifer boundaries;

F. Logistic and economic considerations.

For most aquifers with fully penetrating pumped wells, observation wells are located at a distance estimated by using the Theis (1935) formulation, which is described by Walton (1970). Assumed aquifer parameters are used to determine a location that will give the amount of drawdown required for proper analysis. In thick isotropic aquifers with a partially penetrating pumped well, observation wells are located one and one-half to two times the aquifer thickness from the pumped well. For thick anisotropic aquifers with a partially penetrating well, observation wells are located a minimum distance from the pumped well equal to twice the thickness of the aquifer times the square root of the ratio of the horizontal to the vertical hydraulic conductivity.

Duration of the test is determined by project needs and aquifer response. One test for determining adequacy of data is if log time versus drawdown for the most distant observation well begins to plot as a straight line on semilog graph paper. There are several exceptions to this rule of thumb, so criteria for termination of the test shall be defined in the PSP.

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5.2.6.2.1 **Aquifer Pumping Tests**. Pumping tests influence a larger area and provide results that are often more representative of the overall aquifer characteristics than slug tests. Every pumping test should be considered unique. Methods of test conduct and analysis, as well as instrumentation, shall be specified in PSPs.

Equipment, personnel, and time commitments needed to conduct pumping tests are greater than those required for slug tests. Briefly, a pumping test consists of pumping one well and recording the drawdown in the pumping well and in other nearby observation wells.

Aquifer characteristics that may be obtained from pump tests include hydraulic conductivity (K), transmissivity (T), specific yield (S_y) for unconfined aquifers, and the storage coefficient (S) for confined aquifers.

There are several types of pumping tests, the most common being the constant-rate discharge test (Todd 1980). Variable-rate tests are also employed under some conditions. Although analysis is more complicated, any sort of temporal variations in flow rate can be accounted for by assuming the law of superposition holds true, which is usually a valid assumption. The most widely used variable-rate tests are the step-drawdown test, the constant-head test, and the airlift pump test (Kruseman and DeRidder, 1976). The method of test conduct and analysis, as well as instrumentation, shall be specified in PSPs.

5.2.6.2.2 **Injection Tests**. Injection tests, both constant and variable rate, are analytically identical to pumping tests except for consideration of flow into, rather than a withdrawal from, an aquifer. Data quality is similar.

Injection tests are commonly used in the petroleum industry (Earlougher, 1977), and numerous applications exist in environmental investigations. Water sampling for geochemical characterization of an aquifer shall be conducted prior to application of this technique. Injection water shall be free of suspended solids and of equal or higher quality than groundwater at the test site. Injection tests require special permission from USEPA and the Ohio Environmental Protection Agency, which shall be obtained prior to scoping the test.

One major advantage of injection tests is that contaminated groundwater is not removed from the formation and, thus, is not a disposal or safety problem. A potential disadvantage of the injection test is that, in certain cases, the injection well may have to withstand some induced hydraulic pressure. The injection rate shall be kept low enough to prevent raising the water level above the top of the well casing to prevent leakage of injected fluid on the ground surface.

5.3 GEOPHYSICAL SURVEYS

The understanding of subsurface hydrogeologic and geochemical conditions at the FEMP can be enhanced by geophysical surveys. Specific techniques used are dependent upon project-specific data quality objectives.

There is currently a wide variety of geophysical instruments on the market and the field is in a stage of rapid innovation and improvement. Specific instruments and methods shall be chosen based on physical surroundings, size and shape of expected targets, anticipated fluid properties, degree of saturation, and desired resolution. Instruments and methods shall be

specified in PSPs. Minimum quality assurance/quality control measures for borehole logging and surface surveys are discussed in Sections 5.3.1 and 5.3.2.

5.3.1 Borehole Geophysical Logging

Borehole geophysical methods are used to acquire information about the following subsurface geological characteristics:

A. Formation breaks;

B. Thickness of individual beds;

C. Porosity;

D. Nature of borehole and formation fluids;

E. Identification of high-permeability zones;

F. Depth of penetration of drilling fluids;

G. Borehole size.

Some commonly used geophysical methods include spontaneous potential, resistivity, natural gamma, neutron density, and calipers. Certain methods (e.g., neutron density) require use of a radioactive source, which requires special handling methods.

Basic requirements for performing and documenting subsurface geophysical logging activities are presented in Appendix J.4.5.1. Suites of logs shall be generated depending on the geologic environment, borehole fluids, information desired, borehole size, and resolution. A number of excellent references exist on the use of borehole geophysics including Dresser Atlas Division (1975), Schlumberger (1972), and Sengel (1981).

The PSP shall specify the following:

A. Boreholes to be logged;

B. Suite of logs to be run;

C. Tool size;

D. Borehole preparation;

E. Special source material handling requirements;

F. Resolution desired;

G. Logging speed;

H. Frequency of quality control runs.

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A minimum of one quality control duplicate run shall be made with each tool used on each logging project. The FEMP project manager shall ensure that necessary permits and operator licenses or certifications have been acquired and are current.

5.3.2 Surface Geophysical Surveys

Surface geophysical methods provide subsurface information without the need for excavation of surface materials. The following methods are commonly used for geophysical surveys:

A. Seismic refraction and seismic reflection;

B. Gravimetric surveys;

C. Electrical resistivity;

D. Ground-penetrating radar;

E. Ground conductivity;

F. Magnetometry;

G. Metal detectors.

Information provided includes delineation of contaminant plumes, identification of high permeability zones, location of subsurface anomalies, and identification of subsurface utilities. Surface geophysical methods are subject to interferences such as buildings, metal fences, power lines, and subsurface utility lines.

The nature of the designated site and the information desired shall be evaluated before choosing a surface geophysical method. The field of surface geophysics is currently in a state of development with new methods and advances on established methods geared towards the environmental industry becoming commonplace.

An expert on surface geophysics should be consulted during the scoping phase of the project if use of this tool is anticipated. A number of excellent references are available on the use of surface geophysics including Costello (1980); Micham, Levy, and Lee (1984); Mooney (1981); and Zohdy, Eaton, and Mabey (1974).

Requirements for performing and documenting surface geophysical surveys are presented in Appendix J.4.5.2. PSPs shall specify the purpose of the survey, the method and instruments to be used, grid spacing, speed at which survey is to be conducted, and frequency of duplicating lines for quality control purposes. A minimum of five percent of the total linear distance of the survey shall be duplicated. Provisions for verifying interpretations through use of borings or excavations shall be included in the PSP. Project-specific logs shall be maintained with information recorded as specified in Appendix J.4.1 and J.4.5.2.

Operators shall be trained in use of equipment, and training shall be documented in project files as specified in Section 4. Instruments shall be operated in accordance with the manufacturer's instructions. If these instructions are not used, a complete description of variations along with

justification shall be provided in the PSP, or a variance shall be approved as specified in Section 15.3.

5.3.3 Geotechnical Testing

All geotechnical testing must be conducted to the requirements of this document (see Section 1.2.1). DQOs must be prepared and used as the basis for the development of the project-specific plan. All testing methods must be identified in the project-specific plan.

5.4 FIELD RADIOLOGICAL CONTAMINATION SURVEYS

Radiological contamination surveys at the FEMP are conducted to determine personnel protection requirements, monitor for or detect releases of radioactive materials, and screen samples for laboratory analyses for gross characterization of areas or materials for the presence of radiological contaminants. Surveys are conducted in accordance with DOE Order 5400.5, DOE Notification N 441.1, and 10 CFR, Part 835 in support of activities such as decontamination and decommissioning of facilities and equipment, construction, and release detection. Radiological contamination surveys in support of CERCLA activities include health and safety monitoring in the field and screening of samples to determine need for laboratory analysis, laboratory licensing requirements, and shipping and packaging requirements. Such surveys are conducted in the field to characterize an area, a facility, or equipment for contamination.

Requirements for health and safety contamination surveys are included in FEMP Safety and Health procedures and are not subject to the requirements of the SCQ. However, this information should be integrated with environmental characterization information to support a comprehensive assessment of field conditions and ensure areas of significant contamination are identified. Requirements for screening of samples are included in Section 6 and Appendix K. Requirements for radiological surveys follow.

NOTE

The following requirements apply to field contamination surveys only. Radiological testing to demonstrate compliance with EPA-approved Final Remediation Levels must be formally addressed through the DQO/PSP process.

Contamination survey techniques at the FEMP shall be based on standard nuclear industry techniques combined with process knowledge of potential contaminants at the site. Field radiological contamination surveys may include loose alpha and beta/gamma surveys and fixed alpha and beta/gamma surveys.

Loose contamination is defined as radiological contamination, including soils and sediments, that can be readily removed from a surface by collecting a smear sample. Surveys are performed for area characterization, determining level of personnel protection required, ensuring that vehicles and packages meet Department of Transportation requirements (Section 6), and identifying free releases.

Fixed contamination is defined as radioactive contamination that has become part of the structure being surveyed at conditions prevailing at the time of the survey. Fixed

contamination cannot be measured with smear samples; it must be measured directly from the material of interest.

Total contamination of a material or structure is defined as the sum of loose and fixed contamination. Direct survey techniques are used to measure the amount of total activity on various surfaces. The type of material surveyed shall determine the survey technique used. Survey methodology and techniques shall be specified in PSPs.

A. Scoping Requirements.

Scoping requirements for radiological contamination surveys shall be documented in PSPs and shall include the following:

1. Regulatory driver or other reason for conducting survey;

2. Types of radiation expected;

3. Types of measurement equipment plus calibration and operating requirements;

4. Types of samples to be collected (e.g., smears, surface soil, sediment).

B. Instrumentation for Radiological Field Screening.

The following requirements apply to instruments used for radiological field screening:

1. Instruments used shall be calibrated at least annually and after any adjustments or repairs and in accordance with manufacturer's specifications. Response shall be checked daily using a source of known activity.

2. PSPs for field surveys shall specify the type of instrument to be used, specifications for geometry of detector and source used, maximum speed allowable for the specified instrument, and maximum allowable background for given lower limits of detection.

3. The lower limit of detection for instruments used shall be determined so that a 95-percent confidence level is achieved.

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Section 6

Section 6

SAMPLING REQUIREMENTS

Samples are collected at the FEMP to provide data for specific project objectives (see Section 1 for the scope of projects covered by this document). All sampling activities must be performed in accordance with the Applicable or Relevant and Appropriate Requirements (ARARs) for each Operable Unit (OU). This section identifies the most common types of sampling performed at the site, and specifies minimum requirements for the field storage and shipment of those samples. Matrix-specific requirements are described in individual sampling sections. Additional requirements are provided in Appendix K.

The following general requirements apply to all sampling activities covered by this document.

A. Ensure that all documentation is accurate and complete.

B. Ensure that sampling equipment which may contact the sample during collection is constructed of materials which will not contribute to or react with the constituents of concern.

C. Do not place sampling equipment directly on the ground or on other potentially contaminated surfaces prior to sampling. Place equipment on a clean plastic sheet adjacent to the sampling point.

D. Document all field activities completely and accurately as they are performed.

E. Maintain proper sample custody at all times.

The minimum requirements for sampling activities described in this section and in Appendix K shall be incorporated by reference in the applicable Project-Specific Plans (PSPs). Additional requirements may also be described in PSPs.

6.1 SAMPLE COLLECTION FORMS

NOTE

Information in activity-specific logs (including sample collection forms) shall be written in such a manner that the sampling team may reconstruct that event without reliance upon memory.

Sample collection forms shall be completed for all sampling activities throughout the performance of field activity and are considered part of the daily log (Section 5). The sample collection form is the beginning of the chain of custody, and it should be carefully completed to ensure a defendable chain of custody. Specific information about sampling location and collection shall be recorded on the forms, including the following minimum information:

A. Project identifiers;

B. Sample identifier and/or description of sampling points (e.g., east bank of Miami River 500 feet upstream of confluence with Paddys Run);

C. Sampling date or dates;

D. Sample screen results (PID and RAD);

E. Start and finish time of sampling activity and sample collection times;

F. Weather conditions, including significant changes during the activity;

G. Sample numbers;

H. Field measurements;

I. Visual description of samples;

J. Unusual occurrences (e.g., "semivolatile sample could not be collected because of insufficient recovery of well" or "truck passed while sampling, stirring up significant volume of dust upwind of sample collection site");

K. Sampling team members;

L. Types and identification numbers of equipment used;

M. Calibration information.

6.2 COLLECTION OF AQUEOUS SAMPLES

Aqueous samples include natural and waste waters. Groundwater and surface water (see Glossary) are defined for the purpose of this document as natural waters. Regulatory drivers determine whether a sample can be a grab or composite sample; review the appropriate driver prior to determining the type of sample. Water collected after use or in storm sewers is considered wastewater. The following are specific types of aqueous samples collected at FEMP:

A. Groundwater from monitoring wells, lysimeters, and private wells;

B. Surface water from the Great Miami River, Paddys Run, other natural surface bodies of water, and the storm sewer outfall ditch;

C. Wastewater from manholes, the sewage treatment plant, and any other point in the plant wastewater system;

D. Other wastewater, specifically water collected in the storm water retention basins prior to discharge.

Samples shall be collected for analytical parameters in the order of stability. The order of sample collection is provided in Appendix K.

6.2.1 Field Analytical Requirements for Natural Water Samples

Temperature, pH, and specific conductance shall be measured in the field and documented on groundwater and surface water sample collection forms unless otherwise specified in the PSP. Other measurements, including, but not limited to, dissolved oxygen, turbidity, and redox potential, may be specified for certain projects. Measurements may be obtained either directly from the well or from unpreserved samples. Surface water measurements may be collected directly from the surface water body. Groundwater field measurements may also be taken *in situ* (downhole) to avoid changes that might occur if the sample is removed from the well.

Field requirements for the measurement of temperature, pH, specific conductance, turbidity, dissolved oxygen, and redox potential (Eh) are provided in Appendix K.4.1 *et seq.*

6.2.2 Groundwater Sampling

Groundwater monitoring shall meet the requirements of the Amended Consent Agreement and the Ohio EPA's Director's Findings and Orders regarding integration of RCRA and CERCLA groundwater monitoring requirements. Groundwater sampling is currently being conducted at FEMP for various projects and programs, including those listed in Section 1.2 of this document.

6.2.2.1 <u>Water Level Measurements</u>. Groundwater elevation data are used to monitor aquifer storage, estimate rate and direction of groundwater movement, define recharge/discharge relationships relative to surrounding features, estimate baseflow to streams, and calculate the volume of water in a borehole or well. Requirements for collecting water level data from wells, including water level measurements prior to sampling, are provided in Appendix K.4.2 *et seq.*

6.2.2.2 <u>General Groundwater Sampling Requirements</u>. The primary technical consideration in groundwater sampling is to obtain a representative sample of the groundwater body at the well location. Additionally, groundwater sampling at the FEMP must meet certain quality assurance requirements in order for subsequent data to be used by the CERCLA program. Requirements for collecting groundwater samples are provided in Appendix K.4.2 *et seq.* Additional requirements specific to a project shall be included in PSPs.

The installation and use of dedicated groundwater sampling equipment is encouraged when well accessibility is a problem, when the handling and decontamination of sampling equipment is difficult due to the presence of high concentrations of contaminants at the well site, and when multiple sampling events will occur at the same well or set of wells at regular intervals over a significant period of time.

6.2.2.3 <u>Parameter-Specific Sampling Requirements</u>. Groundwater samples are collected from monitoring wells and lysimeters to fulfill the requirements specified in the associated DQO. Samples must be collected in accordance with the requirements provided in Appendix K, unless otherwise justified in the PSP.

6.2.2.4 <u>Sampling Groundwater from Private Wells</u>. Selected private water wells near the FEMP may be sampled as part of FEMP programs. In addition, DOE has authorized the sampling of private wells at the request of the homeowner. Requirements for collecting water samples from private wells are stated in Appendix K.4.2.5.

6.2.3 Surface Water Sampling

Surface water sampling is currently being conducted at the FEMP in support of remediation projects. Requirements are described in Appendix K.4.3 for the collection of water samples from streams, ponds, lakes, rivers, springs, seeps, and surface runoff.. Two different techniques are used for collecting surface water samples: grab sampling and composite sampling. These techniques are discussed in Appendix K.4.3.

6.2.4 Wastewater Sampling

Wastewater sampling is regulated by the Ohio Environmental Protection Agency (OEPA) under the Clean Water Act. As such, data are collected in accordance with National Pollutant Discharge Elimination System (NPDES) permit-specific requirements. Samples are also collected for DOE environmental monitoring purposes and to fulfill requirements of the 1986 Federal Facility Compliance Agreement. Work performed according to Section 6.2.4 must comply with these ARARS.

FEMP personnel routinely monitor wastewater discharges on a per-work-shift basis. These data become part of the wastewater treatment plant records. Uranium data are reported monthly to the USEPA as required under the Federal Facilities Compliance Agreement attachment to the 1991 Amended Consent Agreement.

The FEMP participates in the Discharge Monitoring Report-Quality Assurance Study (DMR-QA) under the authority of Section 308 (a) of the Clean Water Act. Periodically, samples of the same type of normally tested constituents are sent to the FEMP for analysis. Analysis is performed and data are reported to the USEPA or their designated contractor in accordance with instructions provided with the samples. Results are compared to the true values to determine accuracy of FEMP laboratory analyses.

6.2.4.1 <u>**NPDES Sampling**</u>. NPDES is a statutory requirement under Title IV, Section 402, of the Clean Water Act. Regulatory authority is provided under 40 Code of Federal Regulations (CFR), Part 122. The NPDES program requires that point source discharges into the nation's waterways have a permit that stipulates the allowed limits for certain pollutants entering a particular body of water. The FEMP was issued an NPDES permit renewal (number 1IO00004 ED) on November 1, 1995; the permit is scheduled for renewal in September 1998. The permit covers six outfalls to receiving streams and one internal monitoring point. It also requires the testing of sewage treatment plant sludge after dewatering and the collection of samples from the Great Miami River to be tested for acute toxicity. The permit is based on the water quality goals of OEPA and the best available technology for treating wastewaters specific to an industry.

Permitted discharges are as follows.

- 1IO00004001: Final effluent at parshall flume chamber prior to discharge to the Great Miami River.
- 1IO00004002: Storm water retention basin spillway overflow discharge to Paddys Run via a drainage ditch.
- 1IO00004003: Storm water runoff discharge to Paddys Run via the Storm Sewer Outfall Ditch.

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- 11000004004: Storm water runoff from the inactive flyash pile area prior to discharge to Paddys Run.

- 11000004005: Storm water runoff from the area west of the former production area prior to discharge to Paddys Run via the Pilot Plant ditch.

- 11000004006: Storm water runoff from the north end of property prior to discharge to Paddys Run via a drainage swale.

- 11000004589: Sewage treatment plant sludge after dewatering.

- 11000004601: Final effluent from the sewage treatment plant at the UV disinfection building prior to discharging to Outfall 001 through Manhole 175.

- 11000004901: Downstream monitoring station on the Great Miami River for acute toxicity.

The NPDES permit includes a self-monitoring program to ensure compliance with permit limits. The program consists of sampling wastewater, analyzing it for regulated parameters, and reporting results in a monthly discharge monitoring report, which is the end use of the data for the FEMP. However, OEPA collects these data, plus data from other facilities discharging into waters of the state, and uses them to track and regulate water quality in Ohio.

The FEMP has an ongoing program of sampling, analyzing, and reporting as required by its NPDES permit, the Federal Facility Compliance Agreement, and the DOE. A sampling schedule for NPDES is developed based on the permit requirements and State of Ohio policy to ensure that, over the course of time, the reported data provide an accurate picture of the volume and nature of wastewater flow in the permitted discharges. Test procedures for the analysis of pollutants shall conform to regulation 40 CFR, Part 136, "Test Procedures for the Analysis of Pollutants" unless other test procedures have been specified in the permit. The analytical procedures to be performed by the FEMP for NPDES compliance are listed in Appendix G of this document.

Laboratories conducting acute toxicity testing (or any other biomonitoring testing) for the FEMP must perform those tests in accordance with "Reporting and Testing Guidance for Biomonitoring Required by the OEPA." Each laboratory must develop their procedures, including quality control procedures, in accordance with this manual and submit those procedures to OEPA for approval.

The NPDES permit requires bimonthly testing for a period of one year. Provided that no acute effect is observed in any of the tests, the testing may cease after the first year. In January 1996, the FEMP began conducting acute toxicity testing on the wastewater effluent and on samples collected at a point in the Great Miami River approximately 20 feet downstream from the FEMP discharge. Testing was completed in November 1996. No acute effects were observed, so additional testing was not warranted in accordance with the current NPDES permit.

An Integrated Environmental Monitoring Plan (IEMP) covering both radiological and nonradiological parameters has been developed for the FEMP in accordance with

DOE Order 5400.1. The IEMP serves as the project-specific plan (PSP) for the routine effluent monitoring and environmental surveillance activities including liquid effluent monitoring.

NPDES and other aqueous environmental samples must be collected, managed, and analyzed in accordance with the requirements of the SCQ and all applicable regulations and permits. All sampling and monitoring equipment must be properly operated and maintained by trained and qualified personnel.

6.2.4.2 **Field Requirements**. The FEMP NPDES program requirements are described in the IEMP. The NPDES permit requires that effluent be monitored for flow when a discharge occurs at each sampling location. Meters are in place to fulfill the permit requirements at outfalls 4001 and 4601. Flows are estimated for other outfalls as required by the NPDES permit.

6.2.4.3 **Additional Sources of Information**. Sampling procedures are governed by 40 CFR, Part 136. FEMP standard operating procedures are implemented for wastewater sampling and analysis and are available upon request from the DOE-FEMP. Analytical procedures used in FEMP laboratories for testing wastewater are identified in Appendix G. Additional methods may be specified in the IEMP, if applicable.

6.2.5 Compliance with DOE Order O 441.1

The FEMP is also required to monitor all liquid effluent to comply with DOE Order O 441.1 (U.S. Department of Energy 1996b). Currently operating systems are described in paragraph 6.2.4 *et seq.* and Appendix K.

6.3 SOLID MATRIX ENVIRONMENTAL SAMPLES

6.3.1 Surface Soil Sampling

Surface soil samples are from soils that can be collected with manually operated, hand-held tools, usually within six inches of the surface. Samples are collected for various reasons, including geotechnical testing and characterization of soil for the presence of hazardous or radioactive constituents. Requirements for collecting surface soil samples are provided in Appendix K.5.1.

6.3.2 Sediment Sampling

Sediments are materials that have been transported from their place of origin by fluid action and redeposited. Stream sediments are of interest at the FEMP. Sediment sampling in Paddys Run and the Great Miami River is conducted for routine characterization. Other sediment samples are collected to determine the concentration of target radionuclides. Specific sampling stations are documented in PSPs. Requirements for collecting sediment samples are provided in Appendix K.5.2.

6.3.3 Subsurface Soil Sampling

Subsurface soil samples for hazardous or radioactive constituents are collected as part of preliminary studies, RI/FS, remedial design, geotechnical testing, and for verification sampling. Additional samples may be collected as part of long-term monitoring and for remedial design/remedial action purposes. Requirements for collecting subsurface soil samples are provided in Appendix K.5.3.

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Methods are provided in Appendix K.5.3.1 for screening subsurface soil samples for radioactive contamination. The methods describe the technique for screening subsurface soils for intermediate and high-energy gamma ray emitters. The appropriate screening level is chosen for instrument gross count rates that exceed the background count rate by three standard deviations when the sample is counted in a low background area. Screening may be performed with gamma-sensitive instrumentation capable of detecting the desired level of contamination (e.g., a portable multichannel analyzer with associated sodium iodide detector). Screening shall be performed with field instruments specified in PSPs.

6.3.4 Container Sampling

Containers such as drums are commonly used to store RCRA, non-RCRA, radioactive, and mixed wastes at the FEMP. Samples of drummed materials have been and continue to be collected to determine whether material is RCRA hazardous waste. If it is RCRA hazardous waste, additional sampling may be completed to evaluate treatment or disposal options.

PSPs for container sampling must describe the objectives for container sampling, representative drum selection criteria, analytical testing methods, statistical analyses for drum sample testing (e.g., confidence levels), and disposal requirements. Basic drum sampling requirements are provided in Appendix K.5.5.

6.3.4.1 <u>RCRA Waste Determination</u>. The following process is based on information supplied in the FEMP Waste Analysis Plan, which was prepared in accordance with requirements of Ohio Administrative Code (OAC) 3745 and 40 CFR, Parts 264, 268, and 270.

The FEMP is operating under a Stipulated Amended Consent Decree between DOE, the State of Ohio, and the Westinghouse Environmental Management Company of Ohio (now assumed by FDF). All parties have agreed to a schedule for RCRA characterization of waste materials stored on site.

RCRA characterizations are being completed according to the schedule agreed upon in the Stipulated Amended Consent Decree. A quarterly report is submitted to OEPA that identifies all hazardous waste streams characterized under the Consent Decree.

A. Information is collected to accomplish the following tasks. Acquiring this information may require sampling and analysis.

   1. Characterize hazardous and chemical properties of each waste stream and assign applicable hazardous waste codes.

   2. Ensure proper handling and storage of waste.

   3. Evaluate preacceptance conditions for receipt of waste from onsite and offsite sources.

   4. Determine applicable land disposal restriction information for each hazardous waste stream.

B. The following three generic categories of waste constitute the majority of hazardous waste presently generated at the FEMP. Examples of these categories are included.

1. Closure and CERCLA-Controlled Wastes - Soil samples, drill cuttings, well development water, water used for decontamination, sampling and decontamination equipment, contaminated soils and groundwater, contaminated facilities (e.g., demolition material, process equipment).

2. Maintenance and Construction Wastes - Scrap metals, wires, wood, and other construction debris and rubble; excavated soils; waste hydraulic and lubricating oils; cleaning solvents; boiler residues; floor sweepings; used rubber parts and products; paints and painting equipment; and off-specification commercial products.

3. Miscellaneous Activities - Other wastes, disposable equipment, and personnel protective gear.

The procedure for identifying hazardous waste relies on process knowledge supplemented by analytical data and is described in the FEMP Waste Analysis Plan. The first step of the procedure is evaluation of the accuracy of process knowledge and whether it is sufficiently conclusive to make the waste determination.

When process knowledge is deficient, either more information shall be requested or a request for waste stream (see Glossary) sampling and analysis shall be processed as described in Appendix K. After completion of sampling and analysis, results shall be evaluated and RCRA waste codes assigned as warranted.

For each waste stream, a table shall be prepared that lists the waste stream name, physical state, hazardous waste codes, the basis for the hazard listing, waste source, land ban status, and FEMP material and source code. This table shall be submitted to OEPA quarterly to update the ongoing waste determination process taking place at the FEMP under terms of the Stipulated Amended Consent Decree.

6.3.4.2 **Containerized Waste**. Hazardous waste is stored at the FEMP in containers such as 55-gallon steel and polyethylene drums and 85-gallon steel overpack drums. However, waste storage containers are not limited to these types. Sampling containerized waste not stored in drums is conducted in accordance with established site procedures.

Prior to placing waste in a container, compatibility of material with the container must be verified by comparing analytical data or process knowledge to compatibility information for the container. Samples may require analysis prior to selection of a container to determine compatibility. Most of the waste generated at FEMP is compatible with carbon steel or stainless steel containers. Containerized wastes are stored in designated hazardous waste storage areas at FEMP. Two categories of waste characterization data are used to determine the appropriate storage area:

A. Physical state and presence of free liquids, and

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B. Chemical constituency and compatibility.

Presence or absence of liquids is determined by application of process knowledge or visual inspection of the waste. The Paint Filter Liquids Test, an analytical procedure, is also used for determining whether there is free liquid in the waste.

Chemical constituents within each waste container are determined to ensure that wastes stored in a unit are compatible with each other and with the construction of the unit. To ensure that incompatible wastes are not stored together, a reactivity group code is assigned to each waste stream.

6.3.4.3 **Waste Categorization**. Because of the large number of drums at the FEMP, representative samples are taken from selected drums containing waste from a particular waste stream. Nonaqueous liquid samples shall be collected in a manner similar to aqueous samples (see Section 6.2), depending on the chemical characteristics of the liquid. Drum sampling methods are described in Appendix K. The drums are then categorized based on waste characteristics as follows:

A. **Backlog Waste** - This includes RCRA-Controlled, non-RCRA-Controlled, and mixed waste that has been stored onsite for a long period of time. Selection of drums from a backlog lot is based on process knowledge, waste stream type, and random sampling techniques that ensure representative samples.

B. **Newly Generated RCRA-Controlled Waste** - Waste streams are currently being generated onsite that fall under RCRA jurisdiction. These streams are sampled at a frequency that ensures availability of accurate, current data for timely disposition of the waste. Sampling strategy depends on the rate of waste production and inherent stream variability. Drums are sampled before being transported to a warehouse to limit drum handling.

NOTE

Composite sampling of large waste streams may be specified to reduce analytical effort.

C. **Newly Generated Non-RCRA-Controlled Waste** - These are wastes currently being generated on site that are not hazardous according to RCRA definitions or criteria and have little potential of becoming RCRA hazardous waste. These wastes are monitored to ensure that they do not become RCRA hazardous. The sampling and analysis required for these wastes vary widely and are specified in PSPs.

6.4 GASEOUS MATRIX SAMPLES

Air sampling conducted at the FEMP includes stack monitoring, radon monitoring, general area air sampling, and monitoring for specific organic and inorganic contaminants while conducting field activities. Data may also be used for modeling contaminant transport, determining compliance with national emissions standards for hazardous air pollutants, determining exposure levels, and determining respiratory protection requirements.

6.4.1 Stack Monitoring

Stack sampling is done at the FEMP to measure radionuclide emissions. Stacks with a potential for delivering a dose of 0.1 mrem effective dose equivalent in one year to any individual, or as required by permit, shall be monitored and inspected at least weekly to meet requirements of the Clean Air Act, 40 CFR, Part 61 and DOE 5400.5. Stack sampling methods are provided in Appendix K.6.1.

OEPA requires an estimate of emissions from the Boiler Plant as part of the FEMP's efforts to demonstrate compliance with the Clean Air Act. The FEMP estimates the amount of nonradioactive pollutants including particulate matter (PM), sulfur dioxide (SO_2), nitrogen oxides (NO_X), and carbon monoxide (CO).

The oil supplier's fuel analysis reports, in which the heat content and sulfur content of the fuel are identified, are used to estimate SO_2 emissions for fuel oil burned in the boilers. For all pollutants of concern in natural gas and the other pollutants in fuel oil combustion, the estimates of emissions from combustion are based on USEPA developed emission factors.

6.4.2 Radon Monitoring

In addition to the radon-222 (referred to in this document as radon) found naturally in the environment, radon is also produced at the FEMP from radioactive materials stored onsite. The primary source of radon at the FEMP is from the radium-bearing material stored in the K-65 silos. The Waste Pits and the Thorium Warehouse (Building 65) are relatively small radon sources.

The FEMP has established a radon monitoring program to monitor radon levels at the FEMP and to assess the impact on the public and the environment. This program operates in compliance with the requirements of DOE Order 5400.5, Radiation Protection of the Public and the Environment. This order provides guidelines for radon concentrations and emissions in the atmosphere above facility surfaces or openings. It defines environmental radiological protection requirements and guidelines for cleanup of residual radioactive material, the management of resulting wastes and residues, and the radiological release of property. These requirements and guidelines are applicable at the time the property is released and state that environmental radon levels must not exceed the following limits when added to background levels:

A. 100 pCi/L at any given point,

B. Annual average concentration of 30 pCi/L over any facility site,

C. Annual average concentration of 3 pCi/L at or above any location outside the facility site, or

D. Flux rates greater than 20 pCi/m^2-sec from the storage of radon-producing wastes.

Federal regulations (40 CFR 61 and 192) also impose flux limits on the emission of radon gas from a variety of sources either owned or operated by DOE. Flux monitoring has only been conducted in association with specific EPA-related projects, because the wastes may only be potential radon sources when excavation begins.

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The FEMP routinely uses two types of radon detectors to measure radon concentrations in the environment: long-term time-integrating alpha track-etch detectors and continuous-reading alpha scintillation monitors.

6.4.2.1 Long-Term Environmental Radon Monitoring. Alpha track-etch detectors are used when monitoring requirements pertain to annual limits Since these detectors collect data over longer periods of time (6 months), they are used to generate an average annual concentration. The detectors are placed onsite and offsite to gather information regarding the dispersion of radon from FEMP sources. Currently, there are approximately 55 locations, with each location containing two or three detectors. Multiple detectors are used for Quality Control purposes. At the site boundary, approximately 20 locations are evaluated using alpha track-etch detectors. Additionally, data is collected from area residences, background locations, locations adjacent to the K-65 silos, and at locations in the path of the prevalent wind direction from the silos.

An alpha track-etch detector consists of a filtered canister containing a special plastic chip. The canister is placed inside a plastic cup that is mounted in an environmental housing. Radon in the atmosphere penetrates the filter and concentrates within the canister. As radon and radon progeny decay, the released alpha particles react with the plastic chip, leaving a damaged track in the material. The tracks are later made visible by chemical etching. The number of tracks is proportional to the average concentration of radon in the canister.

Each radon measurement contains three components:

A. The local natural background radon component;

B. The etches present in the plastic before field placement (known as detector background); and

C. The potential FEMP radon component.

The second component can be determined by submitting unexposed detectors for counting. Unfortunately, at a specific location, it is impossible to distinguish between the first and third components. To determine a net radon contribution from FEMP sources, the average background value for all background locations can be subtracted from each radon measurement.

Specific requirements and guidelines are stated in Appendix K.6.2.4, including the types of Quality Control samples analyzed with each batch of samples and the acceptance limits for the results.

6.4.2.2 Continuous Environmental Radon Monitoring. Continuous environmental radon monitors reveal important information regarding the dynamics of radon concentrations onsite and offsite. These monitors allow for timely review of radon concentrations and provide the ability to detect short-term changes. However, there are certain restrictions on the use of these monitors. Electrical power is available at a limited number of locations, and extreme cold weather may effect the reliability of the instruments, rendering some data unusable. Data is collected and analyzed from approximately 20 onsite and offsite monitoring locations. Sampling is performed using passive methods, without the aid of a pump.

The monitors use alpha-scintillation detectors, which are hollow cylinders with a foam barrier that prevents airborne material from entering the detector. Radon can pass through the foam barrier to concentrate within the detector. The inside surface of the detector is coated with crystalline zinc sulfide. Alpha particles generated from radon and its progeny produced within the cell interact with the zinc sulfide crystals to produce light pulses. Light pulses are converted into an electronic signal by the photomultiplier tube. Electronic signals of sufficient voltage are recorded as counts. The number of counts detected is ultimately considered proportional to the radon concentration that was present in the air over a given time interval.

The continuous monitor will record a signal in a radon-free environment, falsely indicating a radon concentration. This electronic noise phenomenon is common to all types of electronic instrumentation. Radon data collected at Fernald is corrected for electronic noise.

The equipment used for continuous environmental radon monitoring is calibrated at least annually. Additional requirements and guidelines related to the use of these monitors are found in Appendix K.

6.4.2.3 **Radon Flux Sampling**. Measurement of radon flux density using a passive charcoal collector (40 CFR 61, Method 115) is the method of choice for determining radon emissions from sources such as the Waste Pits. Method 115 references an USEPA document written by Hartley and Freeman that describes the large-area, activated-charcoal collector in detail and gives general field methods for its use. Additional requirements and guidelines for conducting this type of sampling are found in Appendix K.6.2.

6.4.2.4 **Direct-Radiation Monitoring**. The direct-radiation monitoring program is designed to collect measurements of environmental radiation levels resulting from radioactive materials onsite. This is accomplished using a network of environmental thermoluminescent dosimeters (TLD).

The K-65 silos are the single largest source of direct (gamma) radiation at the FEMP. Therefore, TLD locations radiate outward from the silo area with emphasis on the nearby and publicly accessible western boundary of the site. Additional TLDs are located at air monitoring stations along the facility fence line and in the local community. Six TLD locations serve as background measurement points.

The network of TLDs provides a mechanism to measure and track ambient radiation levels at the facility fence line, as gamma emitting radioactive materials (primarily Radium-226, Thorium-232, and their decay products) are handled and processed during remediation.

6.4.2.5 **FFA-Mandated Radon Monitoring**. Federal Facility Agreement (FFA), Control and Abatement of Radon-222 Emissions, signed November 19, 1991, ensures that DOE takes all necessary actions to control and abate radon emissions at the FEMP, under the authority of 40 CFR 61, Subpart Q. This agreement acknowledges that the K-65 silos (Operable Unit 4) exceed the radon emission of 20 pCi/m^2-sec, but allows the FEMP to address this exceedance by implementing a removal action to bring radon emissions from the silos to a level As Low As Reasonably Achievable (ALARA), and to attain the NESHAP Subpart Q standard upon completion of final remediation. The remediation work plan included a radon monitoring system, which was previously monitored under the predecessor EMP, and which has been incorporated into the current IEMP.

This agreement mandated continuous monitoring of the radon concentration within the two K-65 silos, confirmatory headspace grab samples, and continuous environmental radon monitoring at designated locations. The equipment used for the headspace monitoring is essentially the same as the alpha-scintillation detectors used in continuous environmental radon monitoring. However, the method of sample collection differs in that in headspace monitoring, air is pumped from the silos through a filter and desiccant column before entering the alpha-scintillation cell.

6.4.3 General Area Air Samples

Routine air sampling is performed to measure occupational levels of airborne radioactive material in order to properly characterize areas in accordance with 10 CFR, Part 835. These data are also used to measure ambient levels of airborne radioactive in the workplace, assess worker intakes, dictate posting requirements, and evaluate the adequacy of engineered and administrative process controls such as containment and ventilation. Sampling is accomplished as specified in Appendix K.6.3.

Continuous air monitors are used to provide real-time air monitoring as required by 10 CFR, Part 835. These monitors are operated in accordance with applicable documented procedures.

6.4.4 Monitoring for Organic and Inorganic Contaminants in the Field

Air is monitored to screen for organic contaminants in the field and to protect the health and safety of workers and surrounding populations from organic and inorganic contaminants. Requirements for this type of air monitoring are provided in Appendix K.6.4.

6.4.5 Radiological Air Particulate Monitoring

The FEMP radiological air particulate monitoring program is designed to provide a continual assessment of the collective emissions accompanying multiple concurrent remediation projects at the FEMP and provide necessary "early warning" feedback regarding the cumulative sitewide effectiveness of project-specific emission controls relative to the health protective NESHAP standard of 10 mrem.

Environmental high volume air monitoring, at a minimum, shall be adequate to provide a direct measure of the environmental conditions resulting from the full range of planned remedial activities at the FEMP and therefore provide a reliable, accurate assessment of dose received by off-site receptors via the air pathway. Additionally, this program will demonstrate compliance with DOE Order 5400.5 and the provisions of the Clean Air Act, 40 CFR 61, Subpart H (NESHAP).

The program design is based on taking direct measurements of airborne radionuclide concentrations in the environment at or near potential receptor locations. A network of high-volume air monitors has been established based on the location of potential off-site receptors and in consideration of the 16 primary wind rose sectors. The monitoring network encompasses all the current and expected diffuse and point sources at the FEMP. Since the point of compliance under NESHAP Subpart H is the receptor location, monitoring locations are designated at the FEMP property boundary in wind rose sectors where potential receptors are located immediately adjacent to the property boundary. DOE guidance (DOE 1991c) and EPA siting criteria (40 CFR 58, Appendix E) were considered when selecting these locations.

The potential exists for exposure to air particulates from past and present releases directly from the facility and from resuspension of materials following deposition. Since particulate activity is primarily due to uranium, thorium and their progeny, particulate air sampling is important to the environmental surveillance program at FEMP for monitoring compliance with dose limits. Performance requirements for the design of air monitoring systems are included in Appendix K.6.5.

6.4.6 Meteorological Monitoring Program

The FEMP meteorological monitoring program is designed to provide data on the atmospheric conditions which influence the dispersion and transport of contaminants in the air pathway. This program provides critical data for the evaluation and interpretation of air monitoring data, and the support of the design and conduct of the air monitoring programs.

Monitoring instruments record wind speed, wind direction, temperature, barometric pressure, precipitation and relative humidity and store 1-minute and 15-minute average data on the meteorological database. The system has been developed based on the requirements of DOE Order 5400.5 and DOE guidance (DOE 1991c) and complies with industry standards for calibration and data recovery.

Meteorological data is used in the evaluation and interpretation of environmental data collected from the air, radon, and project-specific monitoring data. Short-term meteorological data will be used to relate air monitoring results to specific projects, when necessary. In addition to supplying data necessary to support monitoring and surveillance, the meteorological monitoring system serves to support the day-to-day operations for construction, emergency preparedness, and engineering design.

6.5 BIOLOGICAL SAMPLING

Biological sampling is conducted at the FEMP to evaluate radiological parameters (e.g., uranium) in farm and garden produce. Similar sampling for milk, fish, game, meat, and grass have been discontinued. Basic requirements for collecting samples of farm and garden produce are provided in Appendix K.7. Target analytes have been identified based on onsite contaminants of concern and are specified in the FEMP IEMP. Analytical methodologies shall be adapted from current USEPA procedures.

6.6 MISCELLANEOUS SAMPLES

A variety of media samples are collected at the FEMP to characterize radionuclide and chemical contaminants to determine handling and disposal requirements. Other sampling conducted for health and safety monitoring and personnel exposure calculations are covered in detail in health and safety plans and procedures and are not discussed in detail here.

6.6.1 Sample Requests and Collection Requirements

Sampling of miscellaneous media (soil, water, sediment, construction rubble, waste streams) is performed for various purposes including the following:

A. Pre- or post-construction and demolition projects;

B. Characterization of onsite conditions;

C. Renovation projects;

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D. Site emergency response activities;

E. Support of site regulatory programs;

F. Support of site remediation programs;

G. Offsite routine monitoring for soil, water and sediment;

H. Onsite routine environmental media sampling;

I. RCRA characterization of drummed wastes.

Media samples shall be collected at sample point locations identified in PSPs. Each sample shall be placed in appropriate sample containers as identified in Table 6-1 (Appendix A) and labeled as specified in Section 7. Specific parameters for analysis shall be determined from process knowledge, DQO requirements, and regulatory guidance.

6.6.2 Debris Sample Collection Requirements

Requirements for collecting solid debris samples from construction, renovation, and demolition (paint chip, fabric, plastic, wood, concrete, and dust) for radiological and chemical analyses are provided in Appendix K.8.

6.6.3 Asbestos-Containing Building Materials

Most FEMP buildings were constructed prior to 1970, when asbestos-containing building materials (ACBM) were commonly used in the construction industry. Asbestos was used for items such as pipe insulation, duct work, fire proofing, sound insulation, boiler insulation, interior cement board, vinyl tile, acoustical ceiling tile coverings, and outer building coverings. Prior to remodeling, renovation, or demolition, samples of potential ACBM shall be collected for analysis and the results used to determine if ACBM is present. Sampling for ACBM shall be in accordance with 29 CFR Part 1926.110, 40 CFR Part 763 subpart e, 40 CFR Part 61 subpart m, and with FEMP health and safety, disposal, and handling requirements. Analytical results are used to determine disposition of ACBM (remove or fix in place).

6.6.4 Polychlorinated Biphenyl-Contaminated Materials

Materials contaminated with Polychlorinated Biphenyls (PCBs) are regulated under the Toxic Substances Control Act (TSCA) program at the FEMP consistent with 40 CFR, Part 761. TSCA classes materials containing 50 parts per million of PCBs as contaminated. FEMP procedures for managing materials contaminated with PCBs meet or exceed all federal requirements. FEMP-regulated PCB-contaminated materials are separated into four groups as follows:

A. Solid nonradiological;

B. Solid radiological;

C. Liquid radiological;

D. Liquid nonradiological.

There is currently no identified solid nonradiological PCB-contaminated material at FEMP. Other groups of PCB-contaminated material are stored in RCRA warehouses until a disposal option is identified.

Sampling of potential PCB-contaminated materials is not currently planned. However, suspect materials could be identified during future demolition or decommissioning of facilities. Should sampling and analysis be necessary, a material evaluation process shall be defined in a PSP and implemented at that time. Handling of PCBs must be consistent with the requirements of 29 CFR, Part 1926.

6.6.5 Worker Protection and Area Classification
Sections 6.6.5.1, 6.6.5.2, and 6.6.5.3 are for information only; they discuss sampling and analysis programs not covered by the SCQ. Data gathered from the samples discussed are for personnel monitoring. Samples are obtained in accordance with written procedures and access is controlled as appropriate.

6.6.5.1 **Personal Radiological Contamination Survey**. Radiological contamination surveys at FEMP are conducted to determine personnel protection requirements in accordance with DOE Notification N 441.1. The regulatory driver or other reason for sampling and knowledge of types of radiation emitted by contaminants most likely to be encountered shall be considered when scoping radiological contaminant surveys. Material and equipment shall be capable of providing the type and quality of data required to comply with requirements.

Personal radiological contamination surveys are generally self surveys. Instruments used and the extent of the survey depend on monitoring location and type of contaminant most likely to be present. Personal radiological contamination surveys include frisking with hand-held instruments and monitoring with automated equipment. Data are recorded only when contamination is found or when personnel injury is involved.

A frisking survey is used when contamination limits of interest are readily detected by available instruments. Depending on the situation, personnel are required to survey either their hands and feet or their whole body. These requirements are spelled out in applicable site procedures.

Methods for use of automated contamination monitoring equipment are dependent on the type of instrument. Instructions for use are described in applicable procedures and taught in FEMP radiation worker training. This type of instrumentation is configured to automatically alarm at contamination exceeding administrative action levels.

6.6.5.2 **Radiation Survey Techniques**. Radiation surveys measure intensity and type of radiation field emitted from radioactive material. These surveys differ from radioactive contamination surveys in that dose or exposure rates in the area of interest are measured rather than the amount of radioactive material present. This information is used to determine worker safety and shielding requirements, area classification, and radioactive shipment classification. Area radiation surveys are performed with portable instruments and stationary detectors.

Information required prior to performing radiation surveys is similar to that required for radiological contamination surveys including a regulatory driver or other reason for the survey and knowledge of contaminants most likely to be present.

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Stationary area radiation detectors are used to detect relatively high radiation fields and serve to indicate possible criticality accidents. These instruments are maintained as specified by FEMP procedures and are not expected to generate data for the FEMP CERCLA program.

The internal dosimetry program has been developed to comply with the requirements of 10 CFR, Part 835. Results of internal dosimetry surveys are not expected to be used to support closure certifications. Basic requirements for these programs are included for information purposes only. Additional details may be obtained upon request to the DOE-FEMP.

Any worker who has the potential of receiving an internal exposure of 100 mrem Committed Effective Dose Equivalent (CEDE) shall be monitored for internal contamination. Monitoring methods used to evaluate internal exposure are designed for each potential exposure condition and may include urine sampling, in vivo measurements, fecal sampling, and/or breathing zone air sampling.

FDF is currently responsible for administering the internal dosimetry program. Detailed program procedures are documented in standard operating procedures. A brief description of the internal dosimetry program follows.

A. **Routine Urinalysis** - The routine urinalysis program is the largest part of the internal dosimetry program and includes workers with a potential for receiving greater than 100 mrem CEDE from exposure to compounds of uranium isotopes. Workers submit bimonthly urine samples for analysis at the FEMP bioassay laboratory, which uses a kinetic phosphorescence technique. Assuming a worker is exposed to two percent enriched class W uranium, a detection limit for uranium of 0.8 micrograms/L allows assessment of doses less than 100 mrem CEDE. In addition to bimonthly samples, workers are required to submit baseline, incident, annual, and termination urine samples.

B. **In Vivo Monitoring** - A routine in vivo monitoring program has been implemented for radiation workers. A worker who is Radiological Worker II qualified is scheduled for an annual in vivo examination designed to detect uranium or thorium deposited in the lungs. The detection limit for the lung exam is dependent upon the individual's anthropometric characteristics. For an average-sized person at the 95 percent confidence interval for a 1200-second exam, the limit is approximately 2.5 nanocuries (nCi) for U-238, 0:18 nCi for U-235, and 1.0 nCi for Th-232. In addition to the annual exam, workers undergo an in vivo exam when they become qualified as a Radiological Worker II, after an incident, and upon termination.

C. **Special Internal Dosimetry Programs** - Special monitoring programs are developed on a case-by-case basis and are included in project-specific plans and health and safety plans. An example of a special monitoring program is the thorium overpack project. Available data from the expected source term and the potential for exposure to the workers involved in an operation are used to determine the frequency and extent of special sampling. When mixtures of radionuclides are present, the dose from all radionuclides in the mixture as well as daughter product activity are considered. The required detection limit for a particular analysis is calculated based on these considerations.

External dosimetry programs are in place to monitor external personnel radiation exposure. The external dosimetry program is currently run by FDF. Standard operating procedures for specific parts of the program are available upon request from DOE-FEMP.

Thermoluminescent Dosimeters (TLDs) are used to measure exposure to the whole-body, skin and extremities, and environmental exposures. Self-reading pocket dosimeters are used to monitor worker exposure on a real-time basis. Dosimetry results are used to calculate whole-body, skin and extremity response to beta and gamma radiation. These devices are used as follows.

D. **Thermoluminescent Dosimeters** - TLDs are used to monitor whole-body, skin, and extremity exposures. Extremity TLDs, such as ring badges, may be used to monitor exposure to the most exposed body part. TLD badges can be used to differentiate between the types and amounts of radiation to which they were exposed. A special insert in the FEMP TLD badge holder also can determine whether a worker was exposed to a criticality event. Following are basic requirements for TLD use at FEMP.

1. Personnel entering a radiologically controlled area at FEMP shall wear a personal TLD.

2. Radiological safety may require additional personal TLDs for purposes such as job-dose tracking.

3. Extremity TLDs capable of detecting exposures greater than 30 mrem may be required by radiological safety when a dose to the extremities is a prime concern.

4. Whole body TLDs shall be capable of detecting exposures greater than five mrem.

5. TLDs shall be stored in their designated racks when not being worn.

E. **Self-Reading Pocket Dosimeters** - These dosimeters continuously monitor whole body exposure on a real-time basis. They are specified when work is conducted in areas where the possibility of acquiring a large dose in a short period of time exists.

6.6.5.3 **Medical Services**. The FEMP medical department provides services to plant personnel that include, but are not limited to, entry examinations, annual examinations, special assessments, emergency medical services, drug screening (FDF and DOE), and medical surveillance.

The department is staffed by trained professionals and is equipped to handle daily activities and critical medical emergencies. Except for drug screening, most human specimens (blood, urine, fecal) are analyzed onsite. Rarely are human specimens sent to an offsite laboratory; but, if this is necessary, the specimens are packaged, marked, and shipped according to applicable laboratory and U.S. Postal Service requirements.

As specified by the National Institute on Drug Abuse, drug screening specimens are obtained, handled, stored, and shipped to an approved laboratory in accordance with strict protocols for

chain of custody procedure and patient privacy and confidentiality of medical records. The laboratory is responsible for specimen pickup and disposal.

Human specimens are handled, stored, transported, and disposed of in such a manner as to protect specimen integrity, medical care workers, and the general public and in accordance with Federal, State, and local laws. FEMP standard operating procedures provide guidance to personnel on specimen handling.

6.7 FIELD STORAGE AND SHIPMENT OF SAMPLES

Samples collected in response to programs onsite shall be classified as either environmental or hazardous substances samples prior to shipment. Classification shall be made by the responsible department or division identified in the PSP. In general, environmental samples include the following:

A. Drinking water;

B. Surface water;

C. Groundwater;

D. Sediment;

E. Air;

F. Soils;

G. Treated municipal and industrial wastewater effluent;

H. Biological specimens or samples not expected to be contaminated with high levels of hazardous materials;

I. Geotechnical.

Shipment of samples designated as environmental samples may be regulated by the U.S. Department of Transportation (DOT). These samples shall be transported in a manner to preserve their integrity and, if there is any doubt as to the sample classification, it shall be considered a hazardous substance and shipped accordingly.

Materials or samples shipped by FEMP personnel to a laboratory that must have the hazard class determined by laboratory testing and analysis shall be assigned a tentative shipping name, hazard class, and identification number. The materials or samples shall be packaged and labeled based on the FEMP tentative determination of hazard class. The class shall be based on process knowledge of the material and previously acquired information on related materials or samples. It may require classification of samples as hazardous until validated documentation is received verifying that the material is not hazardous.

DOT has regulatory responsibility for the security of hazardous materials transported off site by any means. Regulations for packaging, marking, labeling, and shipping of hazardous substances are issued by DOT and described in 49 CFR, Parts 171 through 177.

Radioactive material samples are, by definition, hazardous and are subject to specific stringent regulations governing their transportation. Radioactive material transportation is regulated by DOT under the Transportation Safety Act of 1974.

Samples collected from process wastewater streams, drums, bulk storage tanks, soil, sediment, or water samples from areas suspected of being highly contaminated may require a hazardous material classification for shipment.

The Nuclear Regulatory Commission is responsible for governing the transportation of radioactive source material. Specifically included in Nuclear Regulatory Commission responsibilities is approval of certain types of packages (type B and fissile). DOE Orders require shipment in compliance with applicable DOT and Nuclear Regulatory Commission rules or provision for equivalent public safety. Chain of custody requirements are discussed in Section 7.

6.7.1 Field Storage

In the field, samples shall be handled in a way to preserve sample integrity and maintain chain of custody security. As soon as samples requiring refrigeration are collected, filtered as necessary, and preserved, they shall be stored in chests packed with artificial icing material to obtain a temperature range of 2°- 6°C if refrigerators are unavailable. Care should be exercised to avoid breakage of containers due to rapid extreme temperature changes. Field personnel shall be responsible for ensuring that sample container lids are secure before placing samples in the storage chest.

Samples shall be shipped promptly to the laboratory in accordance with chain of custody requirements in Section 7 so that holding times are not exceeded. Samples shipped off site shall be shipped to ensure laboratory receipt within 24 hours of shipment time when required. Sample containers and shipping containers shall be custody-sealed as specified in Section 7.

6.7.2 Sample Container Preparation

All sample containers shall be purchased precleaned in accordance with *U.S. EPA Specifications and Guidance for Obtaining Contaminant-Free Sample Containers* (U.S. Environmental Protection Agency, 1992).

6.7.3 Sample Preservation

Certain samples must be preserved to minimize the degradation of the constituents of concern prior to analysis. The required preservatives for various constituents are given in Table 6-1 (Appendix A). If requested, sample bottles may be prepared in a sample preparation area with premeasured amounts of appropriate chemical preservatives and sent to the field.

Methods of preservation are relatively limited and intended to:

A. Retard biological action;

B. Retard hydrolysis of chemical compounds and complexes;

C. Reduce volatility of constituents; and

D. Reduce absorption effects.

Preservation methods are generally limited to pH control, chemical addition, refrigeration, and freezing. Some samples collected to support treatability analyses may require special onsite storage conditions (e.g., nonfreezing, special refrigeration). Special preservation requirements shall be specified in the applicable PSP.

6.7.4 Sample Classification

6.7.4.1 **RCRA and CERCLA Initial Sampling Programs**. RCRA and CERCLA programs that require initial sampling of unknown substances specify that samples be shipped in accordance with hazardous materials regulations if process knowledge suggests the presence of a substance classified as hazardous.

If process knowledge does not indicate presence of a hazardous substance or if initial tests are negative for spectrum testing for hazard identification, the samples may be shipped as environmental samples.

6.7.4.2 **Routine Sampling**. For routine sampling programs, past test results shall be compared with the requirements of 49 CFR to establish the sample classification as environmental or hazardous for shipping purposes.

Detailed requirements for handling, packaging, labeling, and transportation of samples are provided in Appendix K.10 *et seq.*

6.7.5 Environmental Samples

Samples collected and designated as environmental samples shall be packaged and shipped to maintain sample integrity and chain of custody requirements. However, if a hazardous material preservative is added to a sample, the amount of preservative shall not exceed limits specified in Appendix K.10.3.

When samples are dispatched to the laboratory for analysis, a chain of custody record shall accompany each set of samples. Requirements for processing sample sets for shipment are provided in Appendix K.10.4.

6.7.6 Hazardous Substance Samples

NOTE

The following requirements are based upon DOT regulations in effect at the time this section was revised. Consult with the FEMP transportation group to confirm that these requirements have not been amended.

6.7.6.1 **Known, Suspected, or Routine Hazardous Substance Samples**. If a sample contains a known or a suspected substance listed in the Hazardous Materials Table in 49 CFR, Part 172.101 or meets the definition of a hazardous substance, but not the exceptions for small quantities criteria, the sample shall be handled, packaged, marked, labeled, and shipped according to DOT specifications for that material. A hazardous substance, for shipping purposes, is a material, including its mixtures and solutions, that meets the following criteria:

A. Is listed in 49 CFR, Part 172, Appendix A;

B. Is in a quantity in one package that equals or exceeds the reportable quantity listed in 49 CFR, Part 172, Appendix A;

C. Meets other criteria defined in 49 CFR, Part 171.8.

This definition does not apply to petroleum products that are lubricants or fuels.

6.7.6.2 **Exceptions-for-Small-Quantities Criteria**. This substance category includes flammable liquids; flammable solids; oxidizers; organic peroxides; corrosive materials; poison B and other Class 9 regulated materials A, B, and C; and radioactive materials that are normally classified as hazardous. However, if hazardous materials are present in known or suspected quantities that are less than the following limits, a hazardous classification is not required and they are not subject to the requirements of 49 CFR, Part 173.4. However the substance-specific guidelines of 49 CFR, Part 173.4 do apply. Maximum limits for inner receptacle quantities to meet criteria for exceptions for small quantities are as follows:

A. Thirty milliliters for authorized liquids other than Division 6.1 Packaging Group 1 materials;

B. Thirty grams for authorized solids other than Division 6.1 Packaging Group 1 materials;

C. One gram for authorized materials classed as Division 6.1 Packaging Group 1 materials;

D. Activity level less than that specified in 49 CFR, Parts 173.421, 173.424, 173.425, and 173.426 as appropriate for packages containing radioactive material.

6.7.6.3 **Exemptions for Treatability Studies**. If an offsite treatability study is planned, the Federal Treatability Study Sample Exception Rule (40 CFR, Part 261) shall be used to collect, store, and transport samples to an offsite laboratory or testing facility provided that the following conditions exist:

A. The generator or sample collector uses no more than 1000 kg of any nonacute hazardous waste; 1 kg of acute hazardous waste; or 250 kg of soils, water, or debris contaminated with acute hazardous waste per waste stream per treatment process. However, if additional samples are required, the regional administrator or state director may, on a case-by-case basis, grant requests for waste stream limits up to an additional 500 kg of nonacute hazardous waste; 1 kg of acute hazardous waste; and 250 kg of soils, water, or debris contaminated with acute hazardous waste.

B. The quantity of each sample shipment does not exceed the above listed quantity limitations.

C. The sample is packaged so that it will not leak, spill, or vaporize from its packaging during shipment, and the transportation of each sample shipment complies with regulations for shipping hazardous material as specified in Appendix K.10.

D. The sample is shipped to a laboratory or testing facility that is exempt under 40 CFR, Part 261, or that has an appropriate RCRA permit or interim status.

E. For three years after completion of the study, the generator or sample collector maintains copies of shipping documents, the contract with the facility conducting the treatability study, and records showing compliance with shipping limits.

F. The data generator provides all the documentation in its biennial report.

The Federal Treatability Study Sample Exemption Rule is only applicable in states that do not have final authorization (i.e., USEPA authorization to manage Superfund sites) or in authorized states that have revised their program to adopt the equivalent regulations under state law. Thus, the states through which these materials pass and the location of the offsite treatability laboratory or testing facility need to be evaluated relative to the regulations prior to selection/implementation of the study (U.S. Environmental Protection Agency, 1989d).

6.7.7 Packing and Transporting Hazardous Substance Samples
Requirements for handling, packaging, labeling, and shipping hazardous substance samples are provided in Appendix K.10.5.

6.7.8 Radioactive Samples

6.7.8.1 **Screening Samples for Total Radioactivity**. Laboratories receiving radioactive samples shall be licensed to handle them. Licensing requirements may be based on the total mass or activity of specific radioactive isotopes or on activity by type of radiation.

Samples suspected of containing radioactive materials shall be screened prior to acceptance for analysis at an offsite laboratory. Radioactive samples exceeding the limits of a laboratory license shall not be accepted. Screening may be conducted at the offsite laboratory if the laboratory license covers the sample, or screening may be conducted at the FEMP analytical laboratory prior to shipment using radiometric screening to determine total radioactivity in various matrices (see Section K.10.6).

6.7.8.2 **Transporting Radioactive Samples**. Samples collected from the former production area or Hazardous Waste Management Units (HWMUs), or samples that yield above background radiation levels, are classified for transport purposes as radioactive samples, for which special packaging and shipping restrictions are mandated.

Regulations limit the total radioactivity (i.e., specific activity times the weight of the package) contained within a package of radioactive material. With respect to DOT type A packages, limits are expressed as two quantities: A1, which refers to the maximum permissible activity for radionuclides in special form, and A2, which refers to normal form radioactive materials. The samples from FEMP fall into the A2 category so the A2 value sets activity limits for sample packages. In cases where contaminated material shipments are designated "Low Specific Activity" (LSA), "Surface Contaminated Object" (SCO), or "Limited Quantity," some fraction of the A2 value will normally apply (see Section K.10.6).

6.7.9 Low Specific Activity Materials
LSA materials include the following:

A. Uranium and thorium ores;

B. Physical and chemical concentrates of these ores (e.g., yellow cake);

C. Unirradiated natural or depleted uranium or thorium;

D. Nonradioactive material externally contaminated with radioactivity that is not readily dispersible;

E. Material in which radioactivity is essentially uniformly distributed and does not exceed certain prescribed concentration limits.

Details for shipping LSA materials are described in 49 CFR, Part 173. The chief advantage of shipping under the LSA category is that shipments are consigned as "Exclusive Use"; that is, under the supervision or direction of a single consignor from point of origin to final destination (49 CFR, Part 173). When packaged shipments of LSA materials are consigned as "Exclusive Use," the shipment is exempt from specification packaging, labeling, and marking. Requirements for these shipments are provided in Appendix K.10.

6.7.10 Limited Quantities of Radioactive Material
Limited quantity shipments of radioactive material shall not exceed the materials package limits specified in 49 CFR, Part 173.425 and must meet the requirements specified in 49 CFR, Part 173.421.

6.7.11 General Requirements for Packaging Radioactive Materials
The type of packaging for a radioactive material shipment depends upon general and specific requirements for the shipping category (type A or type B) in 49 CFR, Part 173. Unless otherwise specified, shipments of radioactive materials shall comply with requirements listed in Appendix K.10.9 for types A and B packages.

6.7.12 Marking and Labeling Radioactive Samples
Requirements for marking and labeling packages containing radioactive material are provided in Appendix K. General requirements for shipping documentation and radioactive requirements for shipping papers are specified in 49 CFR, Part 172 and listed in Appendix K.10.10.

6.7.13 Radiation and Contamination Control
Measurements of radiation level (dose rate) and of nonfixed (removable) radioactive contamination shall be conducted on radioactive material shipments to control exposure to radioactivity. The radiation level is the radiation-dose-equivalent rate expressed in millirem per hour as specified in 49 CFR, Part 173. Permissible radiation levels are provided in Appendix K for the shipping categories of limited quantity packages, LSA packages, and other packages. Maximum permissible limits for removable radioactive contamination allowed on a package are specified in 49 CFR, Part 173 and are summarized in Appendix K.10.11.

6.7.14 Transportation of Samples on Public Highways
FEMP contractors and subcontractors that transport samples classified as a hazardous substance over public highways shall comply with applicable Federal and state of Ohio regulations pertaining to transportation of hazardous materials. The only exception to this requirement is when a shipment of radioactive materials is made under DOE auspices and is

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escorted by personnel specially designated by or under the authority of DOE for the purpose of national security. The shipment then is exempt from the regulations in 49 CFR, Part 170 through 189.

6.8 DECONTAMINATION REQUIREMENTS

Equipment shall be decontaminated for the following reasons:

A. To prevent transfer of contaminants from equipment to sampled media;

B. To limit cross-contamination between sampling points;

C. To protect worker health and safety.

Decontamination requirements in Appendix K.11 are designed to maintain the integrity of collected samples and minimize generation of hazardous waste and excessive volumes of waste solutions. Use of improperly decontaminated equipment is prohibited. Nondedicated sampling equipment shall be cleaned between each use and each sampling point except as described in Appendix K. Dedicated equipment shall be cleaned as necessary.

The cleaning requirements shall be followed by field personnel unless variations have received prior approval as specified in Section 15.3. The reason for the variation, its nature, the affected sample identification numbers, and the subsequent procedure shall be described in detail in the daily field log.

Equipment shall be decontaminated at a central decontamination area where a water source and a means of containing decontamination solutions is available. If decontamination must be conducted in the field, the circumstances dictating this action shall be documented as specified in Appendix K.11.

Requirements for decontamination materials are based on those specified in the U.S. Environmental Protection Agency Region IV Standard Operating Procedure. A similar guidance document is not yet available for Region V. Variations from use of specified materials shall be recorded on the daily field log and the samples potentially affected shall be identified.

Section 7

Section 7

SAMPLE CUSTODY

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Sample custody procedures at the FEMP are conducted in accordance with guidelines in the USEPA Region V Model Superfund Quality Assurance Project Plan (U.S. Environmental Protection Agency, 1996a), which are derived from EPA sample custody protocols described in ***NEIC Policies and Procedures***, EPA-330/9-78-001-R (revised May 1986). Custody requirements are addressed in three parts: (1) sample custody and handling in the field; (2) custody during laboratory receipt, analysis, and disposition; and (3) evidence files.

A sample or evidence file is considered in the custody of a person if any of the following rules of custody are met:

A. The person has physical possession of the sample or file;

B. The sample or file is in view of the person after being in possession;

C. The sample or file is placed in a secure location by the custody holder; or

D. The sample or file is in a designated secure area.

All samples collected within the scope of the SCQ require complete custody documentation.

Compliance with sample packaging and shipment requirements in Section 6 and the custody requirements in this section will provide adequate documentation of sample custody from the time of sample collection to final disposition.

FDF accepts full responsibility for ensuring that all subcontracted offsite laboratories' chain of custody procedures will be contained in written Quality Assurance Plans or SOPs, and that those procedures are fully consistent with the FEMP chain of custody requirements and the SCQ.

Managers of projects which require the collection of samples are responsible for the implementation of sample custody procedures. The designated FEMP QA organization is responsible for verifying through audits, independent surveillance, and inspections that sample custody requirements are implemented and followed.

7.1 FIELD SAMPLE CUSTODY REQUIREMENTS

The sampling team leader is responsible for the care and custody of the samples collected until they are transferred to a sample receiving group, a transporter, an analytical laboratory, or a processing facility. The sampling team member who has maintained custody of the samples must sign the Chain of Custody Record/ Request for Analysis (COC), FS-F-3361 (Form 7-1, Appendix B), when the samples are transferred to a sample receiving, a transporter, an analytical laboratory, or a processing facility. The appropriate sample relinquishment signatures and sample receipt signatures must be documented on the COC.

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Field requirements are as follows:

A. The COC shall be generated in accordance with the FEMP COC procedure either prior to or at the point of sample generation.

B. Prepare sample labels containing sampling information for each individual sample as specified in Section 7.1.3. Sample labels may be preprinted or handwritten using indelible ink. The label shall be permanently affixed to the sample container. Information on the label must be consistent with the information recorded on the COC.

C. Collect samples as specified in the Project-Specific Plan (PSP) (see Section 3). The number of persons having sample custody shall be minimized.

D. Record the information concerning the sample collection in a field log as specified in Section 7.1.2. Record the date and time of collection on the COC once a sample has been collected. All samplers involved in the sample collection shall sign the COC.

E. Seal the sample immediately upon sample collection using custody tape around the lid of the sample container in such a manner that when the container is opened, the tape would be destroyed. Custody tape will be initialed and dated by the sampler.

F. Samples that require refrigeration shall then be placed immediately in a refrigerator and/or in a cooler with cooling media and kept under the rules of custody.

G. When sample collection has been completed, deliver the samples directly to a processing facility, a sample receiving group, a transporter, an analytical laboratory, or store the samples in a secure area. For field personnel shipping samples directly to an offsite laboratory, see Section 7.1.5. If the samples are not transferred immediately, the COC shall contain the name of the storage area (including the room number, if applicable) and shall state how custody was maintained (e.g., locked room or sealed cooler).

H. If analysis is completed in the field, the rules of custody shall apply.

I. The FEMP project manager shall review activities to determine whether proper custody procedures were followed during field work.

7.1.1 Sample Tracking and Control Documentation

Sample custody shall be documented from the time of collection through final disposition. The following minimum sample records shall be maintained:

A. Bound field log books with sequentially numbered pages, or uniquely numbered daily field activity log forms;

B. Sample identification number and labeling;

C. Chain of custody form.

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The first two items shall be completed for all samples regardless of ASL. The COC is required for samples shipped offsite or for samples analyzed onsite by a party other than the sample collector (i.e., whenever a sample is transferred to the custody of another party).

7.1.2 Daily Logs

Data collection activities shall be recorded in a bound field log or on daily field log forms as described in Section 5.1. Entries shall describe activities sufficiently for the sampling team to reconstruct a particular situation without reliance on memory.

As specified in Section 5.1, field logs shall be bound field log books with sequentially numbered pages, or uniquely and sequentially numbered daily field activity log forms, preferably with water-resistant paper (standard engineering field book). Field logbooks shall be assigned to field personnel. Field logs shall be stored in a secure area when not in use. Each log shall be identified by a unique control number.

Use of daily log forms was approved by the EPA for the Remedial Investigation/Feasibility Study program (U.S. Department of Energy, 1988c). Similar forms are used by other programs at the FEMP. Each form shall be sequentially and uniquely numbered and controlled.

7.1.3 Sample Identification and Labeling

Sample labels shall be used to identify individual samples from the time of collection and packaging through final disposition. Sample labels shall be preprinted or handwritten using indelible black ink and attached to the sample container. The sample label shall include the following information:

A. Sample identification number;

B. Date of collection;

C. Time of collection;

D. Sample matrix (e.g., groundwater);

E. Preservation method(s) used;

F. Container type;

G. Sample collector's initials.

Duplicate barcode labels shall be attached to the original sample label by a perforation. The backing shall also be perforated at the point of the barcode label. The duplicate barcode labels are not removed from the sample containers until the samples are received in the laboratory.

Preprinted sample labels are generated by the Laboratory Information Management System (LIMS). An established numbering system is used by LIMS to automatically generate a unique nine-digit number for each sample (e.g., 200312345). The generated sample number appears on the sample label as the Sample Identification Number and is also printed in a barcode format.

7.1.4 Request for Analysis

Prior to any sampling event, analyses must be coordinated through the FEMP sample management organization. Analysis requests shall be prepared to specify the testing or analysis required for collected samples using the COC (Form 7-1, Appendix B). As much advanced notice as possible should be given to secure analytical services either from the FEMP onsite laboratory or from FEMP-approved contract laboratories. Analysis requests must be confirmed prior to sample collection.

If the laboratory initially contacted cannot perform the analysis, an alternate FEMP-audited and approved laboratory shall perform the requested analyses.

The following information shall be provided to the onsite and offsite laboratories when scheduling analytical services:

A. Project name and number;

B. Number of samples;

C. Required report date and turnaround times for testing or analysis;

D. Sample matrix;

E. Types of analyses required;

F. ASL required for the data.

Information on the COC shall be consistent with that on the sample labels and with the scheduling information. When discrepancies occur, the sample receiving group or laboratory project manager shall contact the designated project contact and/or the analytical project manager to resolve the discrepancies. The written discrepancy resolution shall be transmitted to the appropriate parties (e.g., sample receiving group or laboratory project manager) within one working day of notification (see Section 7.2.1.2 for resolution of discrepancies after samples are received by the laboratory).

7.1.5 Shipment of Samples to a Laboratory

Samples collected at the FEMP within the scope of this SCQ shall be accompanied by a COC. The COC shall follow the samples from sample collection to sample disposal. The time frame between the collection of samples and their delivery to the analytical laboratories shall be minimized to ensure that all holding times can be achieved by the laboratory.

Samples shipped to offsite laboratories shall be managed as follows:

A. The onsite sample receiving group shall check the sample containers to verify that the custody tape is intact and ensure that the information on the sample labels agrees with the information recorded on the COC.

B. Errors and discrepancies discovered on the COC while all pages of the form are present can be corrected by drawing a single line through the error and entering the correct

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information. Each error discovered must be corrected by the individual who made the original entry, and each correction must be initialed and dated.

C. When the sample receiving group discovers errors or discrepancies on the COC after the sampler has transferred possession, they shall record them on a Change Request Record (CRR) form. If the discrepancy affects sample analysis (e.g., sample collected in the wrong container or improperly preserved), the sample receiving group shall also record the discrepancy on a nonconformance form. Notify the FEMP project contact immediately and store the sample(s) until a resolution is received from the FEMP project contact.

D. The duplicate barcode labels are not removed from the sample containers until the samples are received in the laboratory.

E. Maintain sample preservation (e.g., refrigeration) from receipt of samples until sample shipment. It is the responsibility of the sample receiving group to ship samples in a manner as to maintain sample preservation requirements during shipment, and ensure that holding times can be achieved by the laboratories.

F. Package the samples properly for offsite shipment as specified in Section 6.7 and in accordance with all applicable DOT regulations. The signed COC shall be enclosed in a watertight container (e.g., a zipper lock plastic bag) and shall accompany each shipment.

G. Secure the shipping containers with custody tape and/or FEMP custody seals so that access to the container can be gained only by breaking a seal. Lock the container if appropriate. If a numbered custody seal is used, document the number on the COC. If the shipping container is secured with custody tape, the packager shall initial and date the custody tape.

H. If samples are sent by commercial carrier, a bill of lading (waybill) may be used. Receipts for bills of lading and all other documentation of shipment shall be maintained as part of permanent custody documentation. Commercial carriers are not required to sign the COC as long as the COC is enclosed in the shipping container and the custody seals remain intact.

7.2 ANALYTICAL LABORATORY

7.2.1 Laboratory Sample Receipt

Laboratory personnel are responsible for the care and custody of samples from the time of receipt until the sample is exhausted, disposed, or returned to the FEMP. Within eight business hours of sample receipt by the laboratory, the designated sample custodian, laboratory project manager, or representative shall examine the samples as specified in Section 7.2.1.1. The laboratory project manager or representative shall notify the FEMP analytical project manager of discrepancies noted during sample receipt by telephone or facsimile transmission immediately as specified in Section 7.2.1.2. Within eight business hours of receipt of notification, the FEMP analytical project manager shall provide the laboratory with directions for sample disposition.

7.2.1.1 Sample Examination and Management.

NOTE

Failure to follow the procedures outlined below can adversely affect the legal documentation of the FEMP remediation efforts.

A. Examine the shipping container custody tape on seals for breakage and tampering. Open the shipping container and remove the COC. Record the condition of custody seals on the COC. Sample containers received by onsite laboratory may lack container custody seals.

B. Compare the custody seal number on the COC form to the number on the custody seal that is used to secure the container. Ensure that they are the same. Indicate the results of this comparison on the COC.

C. Use a calibrated, standard laboratory thermometer to measure the temperature of shipping containers holding samples that require refrigeration, and record the temperature on the COC. If the samples were collected at least twenty-four hours earlier (check the COC for sample collection time) and the temperature is outside the range of 2 to 6 degrees centigrade, document this information on the COC and on a laboratory nonconformance form and notify the FEMP analytical project manager. Store the samples until directions for disposition are received. If the samples were collected less than 24 hours earlier and cooling agents had been added to the shipping container, but the temperature has not yet reached the range of 2 to 6 degrees centigrade, document this information on the COC but do not notify the FEMP analytical project manager or suspend sample processing.

D. Examine the custody tape on the sample containers for breakage and tampering. Record the condition of custody seals on the COC and the sample receiving checklist. Check the sample identification numbers on the sample containers against those listed on the COC.

E. When applicable, enter the bill of lading number (waybill) on the COC.

F. Sign and date the COC and attach the waybill to it (when applicable). For offsite laboratories, remove the temporary duplicate barcode labels from the sample containers and affix them permanently to the back of appropriate copy of the COC . This is to verify the identification of the samples that were sent for analysis. Offsite laboratories return the appropriate signed copy of the COC to the FEMP analytical project manager as instructed on the form. Onsite laboratories shall place the original signed copy in the release file and distribute the remaining copies as instructed on the form.

G. If the FEMP sample number is not used for internal laboratory tracking purposes, assign a unique laboratory tracking number to each sample and affix a label with that number onto the appropriate sample container.

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H. Enter the following sample receipt information into the laboratory tracking system:

1. Project identification number;
2. Sample identification number;
3. Laboratory tracking number, if different from FEMP identification number;
4. Type of sample, including matrix;
5. Date received in the laboratory;
6. Test assignments;
7. Anticipated reporting date.

I. If sample holding time has been exceeded or cannot be met, notify FEMP analytical project manager and complete a laboratory nonconformance form.

J. Store samples as required in the laboratory facility to maintain preservation requirements. Custody rules shall be followed throughout the life of the sample in the laboratory.

K. Each laboratory must follow its established system for ensuring that sample custody is documented for all movements of both the sample and its extracts/digestates. Each laboratory shall have an approved, controlled SOP that gives stepwise intralaboratory custody procedures complete with copies of documentation to be used. This SOP shall be approved by the FEMP before use. Any changes to the SOP shall also be approved by the FEMP subcontract technical representative (STR) before being implemented. Transfers that shall be documented include the following, as applicable:

1. From sample receiving to sample preparation;
2. Return of original sample to sample receiving;
3. From sample extraction to digestion;
4. From digestion to analysis;
5. From analysis to storage of both original sample and extract;
6. From sample storage to disposal.

L. For offsite laboratories, all documentation of sample custody within the laboratory shall become a permanent part of the laboratory project files.

M. The original (white) copy of the COC is to be held in the release files. Release files, including the original copy of the COC, will become part of the FEMP project files.

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7.2.1.2 Discrepancy Resolution.

If sample shipments arrive at the laboratory with errors on the COC (including missing transfer signatures), incorrect number of samples, improper preservation, broken sample containers, broken or tampered custody seals, or with any other apparent discrepancy, the sample receiving group must notify the FEMP analytical project manager as soon as possible and before sample analysis is performed. This notification may be made by telephone or facsimile transmission. The samples must be stored in accordance with specified preservation requirements until the situation is resolved.

The FEMP analytical project manager must resolve all discrepancies. A nonconformance letter or other written explanation must be distributed to the original COC authors and recipients in order to correct errors as directed in the FEMP COC procedure. For discrepancies in the COC, a CRR must be initiated. Upon resolution, the analytical project manager will notify the sample receiving group or laboratory of the discrepancy resolution. Discrepancies and errors must be documented in writing as soon as they are discovered. Discrepancy resolution shall be documented in project file and must be traceable to field paperwork or responsible personnel. The nonconformance letter will serve as traceability documentation.

The FEMP analytical project manager must write and distribute a nonconformance letter to document the resolution of errors or discrepancies on the COC that were discovered after the samples were shipped to the laboratory. This is a letter of explanation addressed to the laboratory sample custodian defining and correcting the error or discrepancy. A separate nonconformance letter must be written for each separate release, project, and laboratory and shall include all pertinent release information. At a minimum, the carrier used, the bill of lading (waybill) number for the sample shipment, the date of shipment, the FERMCO sample numbers, the time and date of sample collection and the document number, which is found on the upper right-hand corner of the chain of custody record, must be included.

An "amended" or "second" COC cannot be submitted to the laboratory in conjunction with, or in lieu of, the original COC. A photocopy of the original COC may be sent to the laboratory if the original record has become illegible or destroyed as a result of leaking sample containers, melting ice, or other causes. In this instance, the laboratory can request a photocopy of the document from the analytical project manager. The photocopy must be accompanied by a cover letter, which describes the reason the photocopy was requested. The authorized request must be signed by the FEMP analytical project manager.

7.2.2 Assignment of Processing Priorities

The laboratory manager is responsible for assigning priorities to samples to ensure that holding times will not be exceeded during the time needed to process the samples.

7.2.3 Sample Holding and Disposal

It is essential to track the final disposition of each sample because of potential liabilities incurred through improper sample disposal. Sample disposition shall be traceable to the original COC either electronically (via the FACTS database) or through hard copy records. Analysis will confirm if the sample contains hazardous waste and/or radioactive material as defined by the DOT, the Atomic Energy Act, Department of Energy (DOE), and Nuclear Regulatory Commission (NRC). Nonhazardous and nonradioactive samples shall be disposed in accordance with standard laboratory practices or returned to the FEMP as specified by the FEMP analytical project manager.

When environmental samples are held for reanalysis, proper environmental storage control and holding times shall be maintained. When reanalysis is not anticipated but samples must be held for a specific time, environmental storage controls are not required.

When hazardous waste samples are held, they shall be stored according to their hazard classification under RCRA.

When radiological samples are held, they shall be stored in accordance with DOE regulations and individual laboratory license requirements.

When mixed waste samples are held, they shall be stored in accordance with DOE regulations, individual laboratory license requirements, and their hazard classification under RCRA.

Special arrangements may be necessary for samples stored longer than six months.

Wastes generated by the laboratory during analysis of FEMP samples, including but not limited to contact waste, equipment wash waters, and rinsates, shall be managed and disposed by the laboratory. These wastes must be properly stored and disposed in accordance with applicable NRC (or Agreement State) license and/or USEPA regulations. Care should be taken to minimize the generation of mixed waste through selection of appropriate reagents and methods.

Only by prior agreement will unused sample fractions or laboratory-generated wastes be returned to the FEMP for archiving, storage and/or disposal (see Section 7.2.3.1).

The preparation and shipment of unused sample fractions and laboratory-generated waste shall be in accordance with the FEMP Waste Acceptance Criteria document, which provides guidance to facilitate transfer of waste from offsite generators to the FEMP in accordance with applicable federal and state regulations.

A. FEMP personnel shall maintain a sample disposal log defining methods for disposal of FEMP-generated samples. Contract laboratories shall provide information identifying sample disposal methods. The following are examples of sample disposition:

   1. Consumed in analysis;

   2. Returned to FEMP;

   3. Storage;

   4. Nonhazardous/nonradioactive samples disposed in accordance with standard laboratory disposal practices.

B. The disposal of samples analyzed at the FEMP shall be documented in the FACTS database. The following information shall be recorded:

   1. Sample identification number;

   2. Date of disposal;

3. Method of disposal;

4. Location of disposed sample (if applicable).

7.2.3.1 **Management of Bulk Wastes to be Returned.** When the FEMP agrees to accept from a contract laboratory any waste streams generated from analysis of FEMP samples, those wastes shall be segregated by waste type. Each waste stream authorized to be returned shall be accumulated in the appropriate DOT containers as specified in 49 CFR Part 173. The FEMP analytical project manager may be contacted for advice in selecting appropriate containers.

An inventory shall be maintained for each container including, at a minimum, the following information for each addition of waste to the container:

A. FEMP sample identification number and release number;

B. Waste type (e.g., acid digestate of soil);

C. Estimated (within ± 10%) volume of waste added;

D. Date the waste was added;

E. Name of the person making the addition.

The laboratory shall provide the required documentation in accordance with the FEMP Waste Acceptance Criteria document. After this documentation is received, the FEMP will schedule a pickup date with an authorized trucking company for return of the waste.

7.2.3.2 **Management of Unused Samples.** If the laboratory contract specifies that unused portions of FEMP samples may be returned to the FEMP, those samples shall be managed as follows:

A. Unused sample portions shall be packaged for return to the FEMP in the same standard of packaging in which they were sent to the laboratory;

B. Samples shall be returned under the exclusion to the definition of hazardous waste specified in 40 CFR 261.4(d);

C. All required shipping papers (including a copy of the inventory of all samples in each shipping container) shall be completed by the laboratory and sent to the FEMP prior to shipment.

When the required shipping papers are received, the FEMP will schedule a pickup date with an authorized trucking company for return of the unused samples.

Unused samples from onsite laboratories are sent to the KC-2 Warehouse where they are packaged and stored in accordance with applicable FEMP requirements and other regulations pending final disposal.

7.2.3.3 **Archive Samples**. Archive samples shall be maintained in accordance with applicable regulations and FEMP procedures.

7.3 EVIDENCE FILES

Evidence files for sampling and analysis data are maintained at the FEMP and contain relevant records, reports, correspondence, logs, field logs, original laboratory data packages, pictures, subcontractor reports, SAR/CRs, COCs, RFAs, and data validation reports. All information supporting FEMP CERCLA decisions shall be included in the final evidence file as support for the CERCLA Administrative Record and the Post Record of Decision files in accordance with the 1991 Amended Consent Agreement.

Evidence files shall be in the custody of the FEMP Administrative Record Coordinator, who controls the Central Data files for environmental sampling and analysis at the FEMP in addition to managing the CERCLA Administrative Record and the Post Record of Decision files in accordance with the 1991 Amended Consent Agreement. The final evidence file shall be maintained for at least ten years after the termination of the Amended Consent Agreement. If DOE decides to discard the files after this time, the 1991 Amended Consent Agreement specifies that the files be offered to EPA.

FDF must consult the DOE record retention policy prior to destroying any environmental documents. DOE's record retention requirements may exceed those established by USEPA or the Amended Consent Agreement.

Data generated by subcontractors for the FEMP are the property of DOE and shall be maintained temporarily under contract at the facility where they were generated, prior to being returned to the FEMP. No files shall be discarded without written consent of the DOE project director. Offsite record storage (e.g., at analytical laboratories prior to return to the FEMP) shall be as secure as and similar to the storage of onsite project files. If a storage, security, or other problem is discovered at the facility, files shall immediately be transferred to the FEMP. Upon completion of the project phase, offsite files shall be transferred to and integrated with onsite files.

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Section 8

Section 8

CALIBRATION PROCEDURES AND FREQUENCY

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Measuring and testing equipment used in the field and the laboratory shall comply with formally prescribed calibration requirements. Equipment shall be of the type, range, accuracy, and precision necessary to provide data compatible with the Analytical Support Level (ASL) specified in applicable Data Quality Objectives (DQOs) or Project-Specific Plans (PSPs). Calibration of measuring and testing equipment shall be performed using documented and approved procedures. When available, accepted procedures published by the American Society for Testing and Materials (ASTM), the U.S. Environmental Protection Agency (USEPA), the National Institute of Standards and Technology (NIST), or manufacturer equipment manuals shall be used.

8.1 RESPONSIBILITIES

Responsibility for calibration requirements and documentation is as follows.

8.1.1 Analytical Laboratory Equipment and Instrumentation

The laboratory manager is responsible for ensuring that calibration requirements are met. Individual laboratory analysts responsible for performing analytical procedures shall maintain required calibration logs. Laboratory analysts who perform calibration procedures shall have received appropriate training and be qualified in the calibration and use of the equipment.

8.1.2 Field Equipment and Instrumentation

Each FEMP project manager is responsible for ensuring that field equipment and instrumentation calibration requirements are met as specified in Section 8.3, Appendix G, Appendix I, or the applicable SOP.

Field users of calibrated instruments are responsible for inspecting calibration status before using the equipment and documenting the inspection in the calibration log. Field personnel who perform calibration procedures shall have received appropriate training and be qualified in the calibration and use of the equipment.

8.2 CALIBRATION PROCEDURES

Calibration procedures for measurement and test equipment used in the field shall be specified in Appendix I or the applicable SOP. After identifying the appropriate procedure for calibrating the subject instrument, the source of the procedure shall be recorded and implementation shall be documented in the instrument-specific calibration log. When available, accepted procedures published by ASTM, USEPA, or the equipment manufacturer shall be used.

8.2.1 Procedure Requirements

The following shall be included in procedures for the calibration of measurement and test equipment:

A. A list of field measurement and test equipment to be used, including the manufacturer and type;

B. Source of the calibration procedure;

C. Provision for recording unique identification numbers for equipment requiring calibration on appropriate logs. The number assigned may be the manufacturer's serial number, a calibration system identification number, or other equipment-unique identifier;

D. Specified reference standards with known relationships to nationally recognized standards (e.g., National Institute of Standards and Technology) or accepted values of natural physical constants. If national standards do not exist, reference and document the basis for calibration;

E. Prescribed frequencies for the calibration of measurement and test equipment (see Section 8.2.2);

F. Specification for a log to document each calibration, including the applicable criteria and minimum information required.

8.2.2 Calibration Frequency

Frequency of calibration and calibration verification shall be determined based on the following applicable criteria:

A. Type of equipment;

B. Inherent stability;

C. Manufacturer recommendations;

D. Guidance given in national standards;

E. Intended use;

F. Results of QC sample analysis or checks with standards;

G. Instrument response time;

H. Experience using the instrument in similar conditions.

8.2.3 Calibration Documentation Requirements

Documentation shall be maintained for each piece of calibrated measurement and test equipment to indicate that established calibration procedures have been followed. Calibration records for field equipment shall be retained in project files. Records for laboratory equipment shall be maintained by the laboratory. At a minimum, the following information shall be recorded and available for project use:

A. Equipment identification number;

B. Type and manufacturer of equipment;

C. Calibration frequency and acceptable tolerances;

D. Calibration dates, results, and any problems encountered during calibration;

E. Identification of calibration procedures employed;

F. Identification of personnel performing calibration;

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G. Dates of maintenance and inspections;

H. Certification or statement of calibration provided by manufacturer or external agency, if applicable;

I. Statement of calibration acceptance or failure;

J. Disposition of equipment that fails calibration.

8.2.4 Equipment Failure

Equipment that cannot be calibrated or becomes inoperable during use shall be tagged and removed from service until it can be repaired and/or recalibrated to the acceptance criteria specified in the applicable procedure. Equipment that cannot be repaired shall be permanently removed from service.

8.3 FIELD MEASUREMENT AND TEST EQUIPMENT FOR ASLs A AND B

Calibration checks shall be performed on all field instruments before use each day. If the instrument does not meet the criteria specified in Appendix G, Appendix I, the SOP, or instrument calibration procedure, use of the instrument shall be discontinued until the appropriate corrective action has been taken.

The responsible FEMP project manager shall maintain a list of field measurement and test equipment used for the collection of project data. The list shall include the following information:

A. Identification number;

B. Description of equipment;

C. Manufacturer of equipment;

D. Required calibration frequency;

E. Number and title of applicable calibration procedure;

F. Source of procedure.

The FEMP project manager shall validate the list for adequacy and review the calibration procedures periodically to ensure adequacy for the specified ASL. Procedures for calibration of commonly used field equipment are provided in Appendix I.

8.4 ANALYTICAL LABORATORY INSTRUMENTATION AND EQUIPMENT FOR ASLs B, C, D, AND E

Method-specific calibration requirements are specified in Table G-2. These include concentration of standards, frequency for initial and continuing calibration requirements, and quality control acceptance criteria.

If initial calibrations do not meet acceptance criteria, analyses shall not be performed, corrective action shall be taken, and the calibration standards shall be reanalyzed. If continuing calibration check samples do not meet acceptance criteria, corrective action shall be taken and the instrument shall be recalibrated. Samples analyzed since the last calibration that met specified criteria shall be reanalyzed.

If deviations from procedures are necessary, the FEMP project contact shall be notified immediately. Documentation and explanation of the deviation shall be presented in the final analytical report.

Calibration information shall be documented in the applicable calibration log.

8.4.1 Laboratory Equipment Calibration Schedules

The calibration of laboratory equipment shall be verified at least annually or at the time of a repair that affects the function of the equipment. The laboratory manager shall maintain a written calibration verification schedule for all commonly used laboratory equipment including, but not limited to, the following:

A. Ovens;

B. Automatic/manual pipettors;

C. Laboratory balances;

D. Thermometers.

NOTE

The following requirements apply to thermometers directly used to verify compliance with the requirements of this document (e.g., to monitor sample preservation) or monitor analytical methods that produce data in accordance with this document. Thermometers used for ancillary purposes (e.g., to monitor glassware drying ovens) shall have their calibration verified according to laboratory SOPs.

1. Check the calibration of working thermometers annually against a NIST-traceable thermometer.

2. Replace thermometers that differ by more than ± 1 degree Centigrade or ± 2 degrees Fahrenheit.

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8.4.2 Laboratory Instruments

The laboratory manager shall maintain a written calibration schedule for all laboratory instruments. Laboratory instruments must be calibrated at least as frequently as the shortest of the following:

A. The frequency specified in Appendix G;

B. The frequency specified in the applicable SOP;

C. The frequency specified in the laboratory contract (for offsite laboratories);

D. The frequency specified by the manufacturer.

In addition, laboratory instruments must be calibrated before use and after a repair that affects the function of the equipment. The minimum instrument calibration and performance evaluation requirements for radiochemistry instrumentation are listed in Appendix A, Table 8-1.

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Section 9

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Section 9

ANALYTICAL METHODS

The objectives of the analytical procedures and quality control elements are to ensure quality data at each Analytical Support Level (ASL); to promote comparability of past, current, and future data; to ensure completeness and validatability; to ensure compliance with performance criteria and specifications; to promote cost effectiveness; and to promote efficient throughput and turnaround times. Analytical methods and associated laboratory quality control elements are identified in Appendix G. The methods included in Appendix G are those either commonly used for FEMP analyses (by both offsite and onsite laboratories), or those projected to be used in the near future. As new analytical requirements are identified, additional methods will be added.

9.1 CHEMICAL ANALYSES

Organic, inorganic, and various wet chemical analyses are performed on FEMP samples for a wide variety of programs encompassing the entire range of Analytical Support Levels. Such analyses are performed for CAA, CWA, SDWA, NPDES, RCRA and CERCLA programs at the FEMP. Additionally, such analyses are performed for treatability studies, for monitoring various operating plant processes, for environmental monitoring, for QC programs, and for routine investigations.

The inorganic, organic, and wet chemical methods listed in Appendix G are USEPA methods or other standard methods commonly used at CERCLA and RCRA sites and readily performed by commercial analytical laboratories. USEPA methods include 200 and 500 Series methods (40 CFR 141), 600 Series methods (40 CFR 136), SW-846 methods (40 CFR 261) and CLP-SOW methods (latest version). Other standard methods include those listed in Standard Methods for the Analysis of Wastewater (latest edition) and those listed in American Society for Testing and Materials (ASTM) publications (latest revision).

9.2 RADIOCHEMICAL ANALYSES

Unlike organic and inorganic chemical analytical methods, few standard methods are available for the radiochemical analysis of environmental samples. Standard established quality assurance/quality control requirements and acceptance criteria are not available for environmental radiochemical methods, so different USEPA, DOE, and commercial environmental laboratories may have different sample preparation and analytical techniques for specific radiochemical analytes. For this reason, laboratory-reported detection limits may vary. Nonetheless, multilab validation studies and interlaboratory comparison studies have demonstrated that accurate, comparable radiochemical data are obtainable even though different procedures are used.

The FEMP has adopted the approach of utilizing performance-based methods for radiochemical analyses. These methods specify quality control frequencies and acceptance criteria for quality control performance parameters. Table G-4 in Appendix G presents performance specifications for radiochemical analyses as a function of radionuclides and a matrix for the analytes of interest at the FEMP. The specifications represent a consensus from six commercial laboratories and from radiochemists at the Fernald site. Ability to meet these performance criteria will ensure consistent and comparable radiochemical data.

9.3 HISTORICAL DOE METHODS

Because of the presence of radionuclides at the FEMP and other DOE sites, methods have been developed at those sites for the radiochemical and chemical analysis of certain elements (uranium and thorium, for example). Although these methods have a long history of use, they have not been promulgated, nor have they been compiled as "standard" methods due to limited applicability. Tables G-1 and G-2 in Appendix G list five such methods. Because of their historically routine use at the FEMP for a variety of programs, these methods are more appropriately treated as ASL B than as ASL E.

9.4 USE OF CHEMICAL, RADIOCHEMICAL, AND HISTORICAL DOE METHODS

To ensure consistency and comparability of analytical data, the requirements governing the use of analytical procedures in Appendix G are delineated below and shall be followed.

9.4.1 Chemical and Historical DOE Methods

All organic, inorganic, and wet chemical methods to be used under the jurisdiction of the SCQ shall be listed in the Method Selection Table (Appendix G, Table G-1). As discussed in Section 9.1, these must be standard methods or historical, routine DOE methods as discussed in Section 9.3. The Method Selection Table relates standard analytical methods to analyte group, ASL, and matrix. Where appropriate, standard sample preparation methods are also included. Analytical methods not listed in the Method Selection Table must be added at a later date via a Document Change Request or described in a DQO/PSP and may be treated as ASL E methods.

Methods to be used for ASL B analyses will be standard methods or DOE historic methods as discussed above. Utilization of the Method Selection Table will ensure uniformity of analytical method application across the FEMP and at subcontractor laboratories.

Each analytical method listed in the Method Selection Table (Table G-1) for an ASL B must be accompanied by a Performance Criteria Specification Table in Appendix G (Table G-2 or G-4 for radiological analytes). Where concentrations, frequencies, and acceptance criteria of QC elements are delineated in the referenced methods, they will be adopted without modification into the appropriate Performance Criteria Specification table. Where concentrations, frequencies, and acceptance criteria of QC elements are **not** delineated in a referenced method but are required as per SCQ Section 10, such performance criteria will be specified in the appropriate Performance Criteria Specification table.

Methods to be used for ASL C and D analyses shall be those specified in the most recent CLP-SOW. Most of these methods do not have a Performance Criteria Specification Table in Appendix G. Such analytical methods are sufficiently rigorous that all necessary performance criteria are spelled out within them.

9.4.2 Radiochemical Methods

All radiochemical analyses to be performed under the auspices of the SCQ shall be represented by Radiochemical Performance Criteria Tables in Table G-4 of Appendix G.

The Radiochemical Performance Criteria Tables present performance criteria for QC elements relative to radionuclide species and matrix types. It is not practical to list every matrix in the table because the full extent of the matrices that may be encountered is not

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known. The matrices listed in Table G-4 are intended to be representative of the broad spectrum of matrices that may be encountered. It is anticipated that the performance specifications given in Table G-4 will meet the needs of most projects. Professional judgement will be exercised in deciding if a given matrix resembles a listed matrix closely enough to warrant application of the tabulated specifications to the matrix in question. If the performance specifications listed do not meet the analytical requirements of the project, then analytical performance specifications for the project must be provided in the DQO/PSP.

The performance criteria for ASLs C and D are identical. However, data reporting requirements differ for ASLs C and D as specified in Section 11.3. ASL B QC levels differ from those of ASLs C and D by having shorter counting times in order to reduce analysis times. Performance parameters affected by shorter count times have different acceptance criteria as delineated in the ASL B Radiochemical Performance Criteria Tables.

Analyses not listed in the Radiochemical Performance Criteria Tables must either be added at a later date via a Document Change Request or justified in the DQO/PSP and may be treated as ASL E methods.

9.5 COMPLIANCE WITH PERFORMANCE REQUIREMENT

To insure that subcontractor analytical laboratories can perform the analyses in Appendix G, meet chemical and radiochemical performance specifications, and report the data in a format that facilitates data validation, the laboratories will be rigorously evaluated prior to contract award and during contract performance. The guidelines for evaluating laboratory capability to provide analytical services for the FEMP are delineated in numerous sections of the SCQ, including the following:

- 3.1.5.2 Analytical Laboratory Subcontractors' Requirements
- 3.4 Analytical Laboratory Responsibilities
- 12.4 Laboratory Qualification and System Audits
- 12.4.1 Laboratory Capacity
- 12.4.2 Hazardous Materials Handling Ability, License, Permits
- 12.4.3 Quality Requirements
- 12.4.3.1 Administrative (Items)
- 12.4.3.2 Technical (Items)
- 12.4.4 Performance Evaluation Samples
- 12.4.5 Continuing Satisfactory Performance
- 12.4.6 Quality Assurance Plan
- Appendix E Analytical Laboratory Performance Requirements

Radiochemistry, historical DOE methods, and ASL E methods shall be validated prior to use. Method validation data must include information demonstrating that the method can meet all identified data quality objectives and performance criteria. The method and method validation data must receive independent verification that they will meet the accuracy and precision requirements of the DQO/PSP as specified by project management prior to analysis of any FEMP samples.

9.6 CALIBRATION STANDARDS FOR CHEMICAL ANALYSES

In some standard analytical procedures for chemical analyses (e.g., SW-846), exact concentrations and/or range of calibration standards are not given. The following guidelines shall apply to procedures in the Method Selection Table (Table G-1) for which ranges/concentrations of calibration standards are not specified.

The calibration range should span the expected concentration range of analytes in a sample. If analyte concentrations fall outside the calibration range, the measuring instrument shall be recalibrated or the sample diluted (if applicable).

The lowest point of the calibration curve shall be at or near the Practical Quantitation Limit (PQL) or Instrument Detection Limit (IDL) for nonorganic analyses, and the reporting level for CLP organic analyses. An additional concentration point shall be at the midpoint of the range.

The highest concentration of calibration standard shall not exceed the linear dynamic range of the detector.

The concentrations of all standards used in any calibration should be recorded in a laboratory notebook or documented by other hard copy records. Similarly, any sample dilutions must be recorded in a laboratory notebook or documented by other hard copy records.

Laboratories will not be routinely required to report working range or calibration concentrations/ranges unless specified as part of the data validation package or in a contract laboratory Statement of Work (SOW). All records must be maintained for audit purposes.

9.7 NATURAL WATERS ANALYSIS

The following field methods for determining properties of natural waters at ASL A are provided in Appendix K :

A. Temperature (K.4.1.1)
B. pH (K.4.1.2)
C. Specific conductance (K.4.1.3)
D. Dissolved oxygen (K.4.1.4)
E. Redox potential (Eh) (K.4.1.5)
F. Turbidity (K.4.1.6).

9.8 ASBESTOS ANALYSIS

Bulk materials and filters will be analyzed for asbestos to identify presence and to monitor airborne concentrations. Analyses shall be performed as specified in 40 CFR, Part 763.

9.9 GEOTECHNICAL TESTING AND ANALYSIS

Geotechnical tests and analyses performed at the FEMP for treatability studies and other environmental decision making are bound to the requirements of the SCQ (Section 1.2.1). Geotechnical methods to be used at the FEMP are not listed in Appendix G, but shall be

selected from ASTM methods. All geotechnical testing methods performed must be identified in the project-specific plan (see Section 5.3.3).

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Section 10

INTERNAL QUALITY CONTROL CHECKS AND FREQUENCY

Quality Control (QC) checks are performed to verify the quality of field measurements and of laboratory investigations and associated tasks. Required frequencies for QC checks are specified in Tables 2-2 and 2-3 (Appendix A).

10.1 QUALITY CONTROL CHECKS AND PROCEDURES

QC operations performed to satisfy requirements for Analytical Support Levels (ASLs) are defined in specific methods or performance specifications identified in Appendix G. Additional QC measurements may be specified in project Data Quality Objectives and Project-Specific Plans. Common QC samples are defined in Section 4.1.2.

10.2 INORGANIC QUALITY CONTROL

Types and required frequencies of laboratory QC samples for inorganic analyses performed for ASLs B, C, and D are summarized in Table 2-2 (Appendix A). QC samples for inorganic analyses may include some or all of the following:

A. Preparation and method blanks;

B. Inductively Coupled Plasma (ICP) interference check;

C. ICP serial dilution;

D. Matrix spike analysis;

E. Laboratory replicate sample analysis;

F. Graphite furnace analytical (instrument) spike;

G. Use of Method of Standard Additions;

H. Laboratory control standard;

I. Calibration verifications.

Laboratory QC requirements vary according to the target analyte, the method used, and the desired ASL for the data. Acceptance criteria for each QC sample type and required corrective actions are specified in Table G-2 (Appendix G). Data reporting requirements are specified in Section 11.3. Data validation requirements are described in Section 11.2 and detailed in Appendix D. Additional QC requirements may be specified in the PSP or DQO.

10.3 ORGANIC QUALITY CONTROL

Types and required frequencies of laboratory QC samples for organic analyses performed for ASLs B, C, and D are summarized in Table 2-2 (Appendix A). Different types of QC samples are defined in Section 4.1.2. QC samples for organic analyses may include some or all of the following:

A. Preparation and method blanks;

B. Surrogate spike analysis;

C. Laboratory replicate sample analysis;

D. Matrix spike/matrix spike duplicate analysis;

E. Retention-time window establishment and retention-time shift evaluation;

F. Method linear range determination;

G. Endrin/DDT breakdown product evaluation;

H. Laboratory control standards;

I. Calibration verifications.

Laboratory QC requirements vary according to the target analyte, the method used, and the desired ASL for the data. Acceptance criteria for each QC sample type and required corrective actions are specified in Table G-2 (Appendix G). Data reporting requirements are specified in Section 11.3. Data validation requirements are described in Section 11.2 and detailed in Appendix D. Additional QC requirements may be specified in the PSP or DQO.

10.4 RADIOMETRIC SAMPLE ANALYSIS QUALITY CONTROL

Types and required frequencies of laboratory QC samples for radiological analyses performed for ASLs B, C, and D are summarized in Table 2-2 (Appendix A). Different types of QC samples are defined in Section 4.1.2. QC samples for radiometric analyses may include some or all of the following:

A. Preparation and method blanks;

B. Matrix spike/matrix spike duplicate analysis;

C. Tracer analysis;

D. Laboratory control standards (check-source samples);

E. Laboratory replicate sample analysis;

F. Calibration verifications.

Laboratory QC requirements vary according to the target analyte, the method used, and the desired ASL for the data. Acceptance criteria for each QC sample type and required corrective actions are specified in Table G-4 (Appendix G). Data reporting requirements are specified in Section 11.3. Data validation requirements are described in Section 11.2 and detailed in Appendix D. Additional QC requirements may be specified in the PSP or DQO.

Laboratory check-source results for radiometric analyses must fall within the method-required range. Check-source results will also be examined for high or low bias, or for regular fluctuations within the specified range. If data are biased high or low, or if they exhibit fluctuations according to a regular trend, the cause of the bias or trend shall be identified and corrected.

10.5 INORGANIC-NONMETALS QUALITY CONTROL

Types and required frequencies of laboratory QC samples for inorganic-nonmetals (conventional or wet chemistry) analyses performed for ASLs B, C, and D are summarized in Table 2-2 (Appendix A). Different types of QC samples are defined in Section 4.1.2.

Laboratory QC requirements vary according to the target analyte, the method used, and the desired ASL for the data. Acceptance criteria for each QC sample type and the required corrective actions are specified in Table G-2 (Appendix G). Data reporting requirements are specified in Section 11.3. Data validation requirements are described in Section 11.2 and detailed in Appendix D. Additional QC requirements may be specified in the PSP or DQO.

10.6 FIELD QUALITY CONTROL

The type of field QC samples collected and the frequency of collection vary according to the target analyte and the desired ASL of the data. Each FEMP project manager is responsible for ensuring that field QC samples are collected in accordance with the approved DQOs. Specific requirements and justification for the collection of field QC samples for each sampling event shall be documented in PSPs.

The types of field QC samples collected at the FEMP and general QC requirements for field samples are described in Section 4.1.1. Sample frequencies, which vary according to the desired ASL for the data, are listed in Table 2-3 of Appendix A. Acceptance criteria and corrective actions for field QC samples are specified in Appendix D.

Reporting requirements for field data are specified in Sections 5.1, 6.1, 7.1, 11.3, and K.9. Data validation requirements for field activities are described in Section 11.2 and detailed in Appendix D.5.

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Section 11

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Section 11

DATA REDUCTION, VALIDATION, AND REPORTING

The following procedures shall be used by FEMP personnel, the FEMP laboratory, and subcontractor laboratories for data reduction, validation, and reporting as applicable for each Analytical Support Level (ASL) (Section 2). The Data Validation Plan is described in Appendix D.

11.1 DATA REDUCTION

Data reduction is the process of converting raw data to a useable format beginning with data processing and continuing through review and reporting of results. Data reduction can be performed either by the analyst who obtained the data or by another analyst. Data review begins with the laboratory manager or field supervisor who verifies that the data reduction has been correctly performed. In general, data shall be reduced in one of the following ways:

A. Manual computation of results directly on the data sheet or on attached calculation pages;

B. Input of raw data for computer processing;

C. Direct acquisition and processing of raw data by a computer.

11.1.1 Responsibilities

Data reduction shall be performed by the laboratories analyzing samples or by field personnel responsible for obtaining field measurements. The individual analyst shall review the appropriate forms to verify completeness and correctness of data acquisition and reduction. The certificate of analysis provided with sample results shall ensure that data reduction has been performed properly and that the reported results are correct. All calculations and results, including field measurements, shall be independently reviewed. The reviewer shall initial and date the applicable reporting forms (see Sections 5.1 & 6.1 and Appendices J.4.1 & K.9).

11.1.2 Data Reduction Procedures

Analysis-specific calculations and statistical methods are dependent on the methods identified in the project-specific plan. Analytical procedures will contain the equation(s) used to calculate results. It may be acceptable to reference applicable section(s) of analytical standard operating procedures where the equations may be found. Reduction procedures, as well as the analytical procedures, must include the equations applicable for each matrix to be analyzed.

Reduction of field data, such as field geotechnical data, shall be performed as described in the associated methods. Data reduction shall be done on data sheets specified for the field method or in the field notebook. Equations and other information required to reduce field data shall be specified in the individual field methods.

Records management shall be in accordance with guidelines in Section 4. Sections 5 & 6 and Appendices J & K provide discussions of reporting and data reduction requirements for field measurements.

11.2 DATA VALIDATION

Data validation is a process performed independently of the laboratory or field personnel generating analytical data. The Data Validation Plan (Appendix D) describes the validation process requirements, responsibilities for performing data validation, and detailed technical requirements for review and qualification (flagging) of the analytical data.

Data will be validated according to the ASL specified by the appropriate DQO or PSP. However, data cannot be validated at an ASL more restrictive than the ASL at which it was analyzed. Data used to calculate upper confidence limits (UCLs) for risk assessment by any new method requires full validation to ASL D criteria until completeness requirements for the initial stage or phase of use have been met. Continued use of the method in generating data for quantitative risk assessment requires a minimum of ten percent of the data to be validated to ASL D.

Requirements for validation of ASL A field data are listed in Appendix D (Sections D.2.5.1 and D.5). Requirements for validation of ASL B (including user-selected QA/QC) and ASL E (non-standardized QA/QC) are specifically selected/defined in the PSP. Validation requirements for ASLs C and D are routine and fully defined in this document; the PSP need only reference ASL C and D protocols, not select or define them.

Data qualifiers, or flags, are defined in Appendix D (Section D.2.4), along with the procedures on how they are assigned to the validated data. Data validation criteria are based on the method performance and QC acceptance criteria specified for each method in Appendix G.

Data validation procedures presented in Appendix D are applicable only to data collected under the Sitewide CERCLA Quality Assurance Project Plan (SCQ). Data collected prior to implementation of the SCQ shall be considered historical data and its validation will be handled on a project-specific basis as outlined in Section 11.4.

11.3 DATA REPORTING

Certificates of analysis and summary sheets shall be generated by the analytical laboratory. The sheets shall contain information about analytical tests performed, date and condition of samples received, results, methodology, and quality of data reported. Field measurements shall be reported on applicable forms specified in Sections 5 and 6 and Appendices J and K. Electronic data transfer information shall be generated from a certificate of analysis. Data shall be verified for accuracy by a person other than the one responsible for entering the data. Each FEMP project manager shall be responsible for checking and approving the final presentation of reported data to ensure that project-specific requirements are met.

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11.3.1 ASL A Data Reporting

Field-generated data reports for ASL A shall include field logs, report forms, and chain of custody records.

11.3.2 ASL B Data Reporting

NOTE

If requested, the FEMP laboratory may issue an abbreviated data report to the project manager. However, the complete data package must be produced and managed in accordance with the requirements of this section and Appendix F.

For ASL B analyses, the deliverable data package shall include, at a minimum, reports of the following analysis results, as applicable:

A. A complete copy of the chain of custody records;

B. Analyst name;

C. Sample and dilution results;

D. Method blank results;

E. Laboratory control sample results;

F. Matrix spike/matrix spike duplicate results;

G. Laboratory replicate results;

H. Surrogate recoveries;

I. Calibration standards and/or curve;

J. Initial calibration standard and continuing calibration standard results;

K. Analytical sequence check for pesticides;

L. Compound quantitation and reporting detection limits;

M. Graphite furnace atomic absorption (GFAA) - post digest spike results;

N. Duplicate injection results for GFAA;

O. Method of Standard Additions (MSA) results.

11.3.3 ASL C Data Reporting

The deliverable data package for ASL C analyses shall include, but not be limited to, the following items for the analytical methods to which they apply. Note that further requirements

are given in the individual laboratory statements of work, especially for radiological analyses, due to their performance based nature.

A. All laboratory analyses:

1. A complete copy of the chain of custody records;
2. Case narrative;
3. Sample and dilution results;
4. Laboratory control sample results;
5. Matrix spike/matrix spike duplicate results;
6. Blank results;
7. Laboratory replicate results;
8. Injection logs of instruments used;
9. Initial and continuing calibration results;
10. Internal standards;
11. Analyst bench notes;
12. Analysis run logs;
13. Preparation logs.

B. Organic analyses:

1. Reports of compounds detected in gas chromatography and gas chromatography/mass spectrometry (GC/MS) analyses including reported retention times, integrated area counts, and compound identification,
2. Library search results to tentatively identify non-target analytes in GC/MS analyses;
3. Surrogate recoveries;
4. Results of GC/MS tuning samples for instruments used;
5. Instrument performance results for pesticide/polychlorinated biphenyls degradation check samples;
6. Compound quantitation and reported detection limits;

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7. Analytical sequence check for pesticides;

8. Instrument performance check results;

9. Identification summary for single or multi component analytes (pesticides);

10. USEPA Contract Laboratory Program (CLP) forms for data reporting;

11. Method blank summary;

12. Pesticide analyte resolution summary;

13. Identification summary for single or multi component analytes (pesticides only).

C. Inorganic analyses:

1. Inorganic analysis data sheet;

2. Required detection limit standards;

3. Analysis reports of spike and post-digestion spike;

4. Inductively coupled plasma (ICP) interference check sample results;

5. ICP inter-element correction factors;

6. Serial dilution results;

7. Method of standard additions if required;

8. Percent solids calculation (when applicable);

9. GFAA duplicate injection results;

10. CLP forms for data reporting.

D. Radiological analyses:

1. Radiological requirements specified in Appendix G;

2. Tracer results;

3. Calibration curve calculations;

4. Other deliverables as specified in laboratory statements of work.

Laboratories performing ASL C analyses will be required to maintain all documentation and supporting information required to generate an ASL D data package for all ASL C analyses they

perform. Should the FEMP at some future date request an ASL D deliverable data package, the laboratory shall generate a complete new data package containing the information required in this section and in Section 11.3.4 below.

11.3.4 ASL D Data Reporting

ASL D data packages shall contain the requirements specified in Section 11.3.3, as well as copies of raw instrument output for those deliverables including, but not limited to, the following, as applicable:

A. Chromatograms;

B. Total and reconstructed ion chromatograms;

C. Raw calibration files;

D. Mass spectra of identified constituents and the library-reference mass spectrum for the compound;

E. Mass spectra for library-search compounds and the closest spectral matches from the reference library;

F. Channel-by-channel output for multi-channel radiochemical analyses when specifically requested;

G. Instrument-specific calibration and performance information if applicable;

H. Other output files or printouts from instruments used to perform the analyses;

I. Calibration verification (pesticides only);

J. Florisil check (pesticides only);

K. Gel permeation chromatography calibration (pesticides only);

L. Internal standard error and retention time summary for volatile and/or semivolatile organic analyses.

Site-specific summary sheets shall be developed for reporting specified deliverable items. The summary sheets shall contain information similar to that specified for report forms in SW-846 (Third Edition, Chapter One) and the USEPA CLP report forms.

11.3.5 ASL E Data Reporting

ASL E analysis is nonstandard, so it is not possible to predetermine report requirements. Requirements for ASL E analyses shall be specified in the PSP, DQO, and statement of work.

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11.4 VALIDATION OF HISTORICAL DATA

Data collected prior to sitewide implementation of the SCQ shall be considered historical data and may include, but not be limited to, data collected under the following projects or programs:

A. Remedial Investigation/Feasibility Study (RI/FS) Quality Assurance Project Plan;

B. RI/FS Data Validation Plan (U.S. Department of Energy, 1988b);

C. RI/FS Data Management Plan (U.S. Department of Energy 1988a);

D. Resource Conservation and Recovery Act interim status monitoring;

E. Wastewater monitoring related to the National Pollutant Discharge Elimination System;

F. Routine environmental monitoring for radionuclides.

Some historical data were not gathered under an approved quality assurance program plan, or full QA/QC documentation may not be available for all samples and procedures. However, the data may be good for some uses and should not be automatically discounted prior to evaluation.

The following general approach shall be used to validate and assess the useability of historical data:

A. Gather available field sampling protocols, data management protocols, analytical results, including supporting QA/QC analysis results, data packages, supporting field records, chain of custody documentation, and associated audit and surveillance reports.

B. Obtain available copies of analytical protocols and performance criteria used to perform analyses, including quality assurance project plans and data validation plans in effect at the time of data generation.

C. Compare results for samples and QA/QC analyses to protocol and method performance criteria in effect at the time data were generated or to data validation criteria of this SCQ if no such protocols are readily available.

D. Review field records, audit and surveillance reports, and training records for personnel performing sampling and analysis.

E. Assign the data set a level of useability that indicates uses for which the data are suitable, based on the level of performance achieved and the quality of the supporting data package.

If sufficient supporting QA/QC documentation is not available or if the raw data package is not available, a data set may be assigned a more restrictive level of useability than was originally intended, or it may be classified as unusable.

Validation procedures for historical data shall be included in the PSP and a summary report of data validation shall be prepared. The report shall discuss validation findings and assigned useability of the historical data.

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Section 12

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Section 12

PERFORMANCE AND SYSTEM AUDITS

Self-assessments and independent assessments of work processes and operations shall be undertaken to assure quality of performance. Such assessments may include but are not limited to, surveillances, audits, inspections, tests, data verification and validation, and peer reviews. Assessments shall include evaluation of compliance with both technical and procedural requirements and may be conducted at any point in the life of a project.

Self-assessment shall be performed by each FEMP organization responsible for conducting environmental sampling and analysis, specifically including subcontractor laboratories.

Independent assessment is the responsibility of the FEMP Quality Assurance (QA) organization (Section 3.2.1).

Performance and system audits of field and laboratory activities shall be conducted to verify that sampling and analysis are performed in accordance with requirements established in this document (SCQ). Performance audits are spot checks of program implementation and are referred to as surveillances or inspections. System audits and analytical laboratory performance evaluations are in-depth reviews of an entire program.

When appropriate, the FEMP QA organization may accept third party audits of contracted laboratories.

To verify compliance with the SCQ and project-specific requirements, the FEMP project manager and FEMP QA organization shall be responsible for scheduling and conducting surveillances and inspections. Audit results of activities covered by the SCQ are available to the USEPA upon request to DOE-FEMP. USEPA may conduct external audits of FEMP activities covered by the 1991 Amended Consent Agreement as required.

As a minimum, surveillances and inspections shall consist of an evaluation of the QA program and procedures, a verification that they have been effectively implemented, and a review of associated project documentation. They shall monitor ongoing project activities and work areas to verify conformance to specified requirements. Audits shall cover applicable laboratory activities, field operations and documentation, and final reports.

Potential subcontractor laboratories shall be audited by the FEMP QA organization (Section 3.1.5.2 and Appendix E). The FEMP laboratories and subcontracted laboratories shall be audited annually at a minimum and may only perform services for the FEMP in the areas audited at the facility. Before a laboratory may handle samples from the FEMP, documentation is required specifying that performance in areas related to analysis of FEMP samples is within pre-established specifications.

Laboratory internal audits (self assessments) shall be performed in accordance with established laboratory manuals. For subcontractor laboratories, the audit may also include specific attachments as amended by contract with the FEMP. System audits shall be performed to evaluate components of the measurement systems to determine their proper selection and use.

Performance audits shall be conducted periodically to determine accuracy of the total measurement system or component parts thereof.

Audit, surveillance, and inspection results of 1991 Amended Consent Agreement activities are available to USEPA upon request to DOE-FEMP. External field and laboratory audits may be conducted by the USEPA, the Ohio Environmental Protection Agency (OEPA), or their respective subcontractors. USEPA and DOE may coordinate laboratory audits to streamline manpower requirements and improve response time. External field audits may be conducted by the USEPA Region V Central District Office or OEPA as required.

Upon notification to the DOE-FEMP, arrangements will be made with the FEMP security department to grant regulatory agency personnel access to field activities for external audits.

12.1 AUDIT AND SURVEILLANCE PERSONNEL

Qualified personnel working under a qualified lead auditor shall perform project and laboratory audits. Technical specialists may be assigned to the audit team at the discretion of the lead auditor.

The designated FEMP QA organization shall ensure that authorized personnel perform independent project surveillances. Personnel shall be qualified by education or experience to perform the surveillances and shall be technically knowledgeable of the activity being monitored.

Qualification of personnel conducting audits and surveillances shall be documented. Audit and surveillance personnel shall be independent of activities being audited or surveilled.

12.2 SYSTEM AUDITS

12.2.1 Pre-Audit Activities

Pre-audit activities shall consist of definition of audit purpose, scheduling, identification of subject and scope, selection of audit team and lead auditor, development of audit plan and checklists, and notification of organization to be audited.

Audits shall be scheduled to provide coverage and coordination with ongoing activities and at a frequency commensurate with the status and importance of the activity. Schedules may be revised as necessary and may be supplemented by additional audits as necessary.

As with scheduling, when determining activities to be audited, consideration shall be given to ensure adequate coverage of pertinent activities. Scope definition of each audit shall consider the activity status and importance of required validity/acceptability of its product and supporting documentation (e.g., records, reports).

The lead auditor shall develop plans for each audit, assisted as required by team members. Plans shall identify audit scope, applicable requirements, auditing personnel, activities to be audited, organizations to be audited, schedule, and checklist items.

Checklists are audit-specific and based on audit requirements and goals. They are designed to document results of the audit. Items requiring review shall be listed on the checklist and checked off as they are audited. Preparation of checklists is the responsibility of the audit team

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prior to the audit. This preparation not only helps the team decide what the important points of the audit are, it also helps familiarize the team with the audited organization prior to conducting the audit.

The audited group or organization shall be formally notified in advance of the scheduled audit. The notification, as a minimum, shall include the audit date and length, associated meetings, auditing organization, identity of auditors, audit subject, and intended scope. Additional items to be covered in laboratory audits are specified in Section 12.4.

12.2.2 Audit Conduct

Audits shall be conducted in accordance with written checklists. If portions of the proposed scope as identified on the checklist are not addressed during the audit, this shall be discussed at the closeout meeting and documentation shall be recorded in the audit report.

Pre-audit and post-audit meetings between auditors and audited organization management and personnel shall be held to review the purpose and scope of the audit, establish personnel contacts, and present audit results.

During an audit and at completion, auditors shall discuss results and findings with individuals audited. Nonconformances shall be recorded on checklists and included in audit reports (see Section 15 for explanation of nonconformances, responsibilities, and reporting requirements).

12.2.3 Post-Audit Activities

Upon completion of an audit, auditors shall prepare and submit a formal report to DOE, to the management of the audited organization, and to the responsible FEMP organization. The report may also be sent to other FEMP project managers, individuals contacted during the audit, and management of applicable FEMP subcontractors. The report shall be prepared as soon as possible after the audit (within 30 days) and contain the following information as applicable:

A. Dates of audit;

B. Identification of participants;

C. Identification of activities audited;

D. Audit results;

E. Description of items requiring corrective action and, if possible, the means of correction;

F. Directions for audit response in writing.

Auditors shall verify completion of required corrective actions by written communication, re-audit, or other appropriate means. After verification and acceptance of corrective actions, the lead auditor shall issue an audit closure report to the same individuals receiving the audit report.

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12.3 SURVEILLANCES (PERFORMANCE AUDITS)

12.3.1 Pre-Surveillance Activities

Surveillance shall be scheduled by selecting project activities based on the program schedule defined in the project-specific plan. Scheduling may occur on a daily or weekly basis in order to provide adequate activity coverage in response to project task assignments. Actual date and time of a surveillance shall be coordinated with applicable project personnel by surveillance personnel. Field activities, sample preparation, handling and shipping, document completion, laboratory analysis, data management, and security items shall be subject to surveillance. Activity procedures or surveillance checklists shall be prepared by surveillance personnel if applicable.

12.3.2 Surveillance Conduct

Personnel conducting surveillance shall follow applicable procedures or surveillance checklists. Surveillance personnel may communicate directly with project personnel during conduct of the surveillance to expedite corrective actions.

12.3.3 Post-Surveillance Activities

Surveillance personnel shall prepare a report documenting surveillance results. Observations identified during the surveillance do not require a response by the cognizant manager. Recommendations are provided for information only as potential areas for improvement. Other nonconformances identified during the surveillance shall constitute cause to initiate a nonconformance in accordance with the established FEMP QA programs. Nonconformance numbers shall be identified and documented in the surveillance report. The surveillance report, when completed and approved, shall be distributed to applicable project personnel.

A surveillance will be considered closed when all nonconformances have been answered, corrective actions implemented and verified, and no further action associated with the surveillance is required.

Each FEMP project manager is responsible for ensuring that corrective action required by audit or surveillance reports is implemented and completed on schedule. If required, DOE or the FEMP QA organization is authorized to stop project work until corrective actions have been implemented.

12.4 LABORATORY QUALIFICATION AND SYSTEM AUDITS

An analytical laboratory qualification program has been instituted to provide assurance that sample analyses, quality control (QC) samples, and analytical data reports are in accordance with requirements specified in the SCQ for the analytical support level (ASL) designated for samples being submitted (Appendix E). Survey and external audit checklists shall be developed prior to laboratory acceptance for sample analyses to reflect ASL requirements as specified in the SCQ. Specific checklists will depend on the intended use of the laboratory and the availability of previous audit results.

Certified lead auditors shall conduct pre-acceptance surveys and audits at laboratories, assisted by qualified auditors or technical representatives.

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The laboratory qualification audit shall include, but not be limited to, the following:

A. QC verification samples shall be sent to potential suppliers of analytical services and sample analyses shall be evaluated and compared to known values. Use of independent QA program results may be used in lieu of FEMP-supplied QA samples (e.g., USEPA Contract Laboratory Program performance evaluation samples).

B. Prior to award of analytical subcontracts, acceptance to perform analyses, surveys shall be conducted at laboratories. Checklists shall be completed, supplier acceptability determined, and summary reports issued.

During performance, periodic audits shall be conducted at each facility to assure continued acceptable performance (annually, at a minimum). Audit summary reports shall be issued. Follow-up audits may be performed to determine whether the laboratory has adequately corrected all problems listed in the audit summary report. The FEMP may suspend all shipments to any laboratory which fails to perform according to the required standards and/or fails to correct all deficiencies discovered during periodic audits.

12.4.1 Laboratory Capacity

A laboratory shall demonstrate its ability to perform analysis at a specified capacity. Overall capacity of a laboratory shall be based on equipment and personnel available. The laboratory shall supply references demonstrating successful past performance of analyses similar to those required.

12.4.2 Hazardous Materials Handling Ability, Licenses, and Permits

A laboratory shall be qualified to handle samples containing hazardous materials in a safe, efficient manner. Applicable licenses and permits shall be required. Additionally, laboratories receiving samples containing radioactive materials shall be licensed by the Nuclear Regulatory Commission or applicable state agency as required.

Samples shall not be sent to a laboratory if the receipt of those samples will cause the laboratory to exceed its radioactive materials license limits for isotopic or total activity.

12.4.3 Quality Requirements

Laboratories shall have an acceptable quality assurance plan that is in accordance with the requirements of the SCQ (Section 12.4.6). Laboratories shall be audited prior to receiving FEMP samples as follows.

12.4.3.1 <u>Administrative</u>. The following administrative items shall be addressed during audits:

A. Documentation of laboratory organizational hierarchy;

B. QA program;

C. Assignment of responsibility for establishing, maintaining, and verifying an appropriate QA program;

D. Facility design for applicable analytical work meeting USEPA requirements, as applicable;

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E. A training and certification program for laboratory analysts;

F. Tracking system for documents, equipment, parts, and supplies;

G. Use of current, controlled copies of operating procedures;

H. Use of current, labeled, and dated standards;

I. Internal chain of custody process meeting requirements of Section 7;

J. Procedures and records for equipment calibration, maintenance, and evaluation;

K. Facilities for receiving, checking, and storing samples prior to analysis and a routine that ensures compliance with preservation requirements;

L. Tracking system for samples that ensures holding-time requirements are met;

M. Process for documenting, reporting, and recording nonconforming items or actions, including corrective actions;

N. Process for storage that ensures record security, including a records tracking system;

O. System for scheduling and documenting internal audits of the analysis system and its components, using checklists and reports and a means of addressing audit findings in a timely manner;

P. Laboratory copies of the SCQ that are properly controlled and updated.

12.4.3.2 Technical. The following technical items shall be addressed during audits:

A. Demonstration that analyses are performed in accordance with written procedural requirements, including calibration and use of proper standards, blanks, and other QC checks;

B. Demonstration that technical expertise and equipment meet FEMP methods requirements;

C. Verification and reporting of analytical results as required.

12.4.4 Performance Evaluation Samples

Laboratories shall provide documentation of successful analyses of performance evaluation samples prior to approval for FEMP sample analyses.

Laboratories that perform ASL D analyses shall document successful analyses of the USEPA Contract Laboratory Program performance evaluation samples, or equivalent, covering the four previous quarters.

For analyses at other ASLs, performance evaluation samples supplied by the FEMP or the USEPA Contract Laboratory Program shall be successfully analyzed and documented using FEMP-approved methods, such as those identified in Appendix G.

12.4.5 Continuing Satisfactory Performance

Implementation of quality requirements shall be continually verified through onsite audits conducted by FEMP personnel annually at a minimum (see Appendix E). Follow-up audits may be performed to determine whether the laboratory has adequately corrected all problems listed in the audit summary report. The FEMP may suspend all shipments to any laboratory which fails to perform according to the required standards and/or fails to correct all deficiencies discovered during periodic audits.

Laboratory performance shall be evaluated through data validation (Appendix D), audits, and/or performance evaluation sample analysis.

12.4.6 Quality Assurance Plan

Analytical laboratories shall be required to have a written internal QA plan and applicable standard operating procedures in place that include the following items. Adherence to the elements of the plan shall be documented in audits:

A. Laboratory management structure including individual responsibilities;

B. Documentation of laboratory personnel qualifications;

C. Documentation of training;

D. Audit procedures, schedule, and log;

E. Instrument calibration schedule and log;

F. Internal chain of custody procedures meeting requirements in Section 7;

G. Schedule and log of routine equipment maintenance;

H. Procedure for documenting and reporting deviation from laboratory or project requirements;

I. Records control system;

J. Document revision and control system.

The SCQ shall be a contract-specified attachment to the laboratory-specific QA plan. Compliance with the SCQ shall be verified through project surveillances.

FEMP audit and performance evaluation data relevant to the laboratory shall be provided to USEPA upon request. USEPA may choose to conduct its own audit of the laboratory or conduct an audit in conjunction with FEMP personnel.

Section 13

PREVENTIVE MAINTENANCE

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13.1 PURPOSE

Preventive maintenance is an organized program developed to maintain proper instrument and equipment performance and to prevent instruments and equipment from failing during use. An adequate preventive maintenance program increases reliability of a measurement system.

The requirements of a preventive maintenance program are dependent upon the instruments and equipment used within a laboratory or field program. This section does not attempt to specify instrument or equipment requirements, but rather sets minimum guidelines for maintenance practices. Each field project and laboratory shall develop and implement a preventive maintenance program that complies with the guidelines presented in this section. Preventive maintenance requirements may be documented in SOPs or in separate preventive maintenance documents. If necessary, additional preventive maintenance requirements may be stipulated in project-specific plans.

13.2 SCOPE

A. The following factors are addressed in the FEMP preventive maintenance programs:

1. Instruments, equipment, and parts thereof that are subject to wear, deterioration, or other change in operational characteristics in the absence of routine maintenance;

2. Spare parts necessary to minimize down time;

3. Optimum frequency of maintenance.

B. Analytical laboratories approved for analysis of FEMP samples are required to have SOP's for preventive maintenance of each measurement system (including analytical instruments) and necessary support equipment (e.g., refrigerators, ovens). Maintenance activities shall be documented in logs.

C. Preventive maintenance programs shall include the following at a minimum:

1. List of instruments and equipment that require preventive maintenance;

2. Frequency of maintenance (generally stated in terms of daily, weekly, monthly) considering manufacturer recommendations (which shall be documented in the form of operating manuals) and experience with the particular piece of equipment;

3. Spare parts list and an up-to-date inventory of spare parts for each instrument or piece of equipment necessary to preclude long down time;

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4. Service contracts as necessary;

5. Items to be checked or serviced during maintenance and directions for performing maintenance.

13.3 RESPONSIBILITIES

The laboratory manager is responsible for preparation, implementation, and documentation of the laboratory preventive maintenance program. Specific individuals within the laboratories shall be responsible for implementation of the program, and quality assurance personnel shall be responsible for surveillance to verify compliance.

For field projects, each FEMP project manager or designee is responsible for preparation, implementation, and documentation of the preventive maintenance program. DOE-FEMP and the designated FEMP QA organization shall approve the field program and review its implementation to verify compliance. Table 13-1 (Appendix A) lists preventive maintenance requirements for commonly used field equipment.

13.4 PREVENTIVE MAINTENANCE PROGRAM DEVELOPMENT

Preventive maintenance activities shall be performed in accordance with approved SOPs or other written requirements for each type of equipment or instrument. The specified schedules for the performance of preventive maintenance shall be at least as frequent as the manufacturer's recommendation. These activities shall be documented in individual instrument files, which shall include the following:

A. Spare parts inventory and use, as appropriate;

B. External service contracts, if applicable;

C. Records of periodic maintenance performed.

Records of maintenance shall be documented in maintenance logs maintained with the instrument or at an instrument storage and service area.

Section 14

SPECIFIC ROUTINE PROCEDURES TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS

14.1 FIELD DATA

Field data shall be assessed for accuracy, precision, and completeness taking into account overall project objectives, background data points, and field QC samples as defined in Section 4.1.1. Requirements for field documentation are included in the following sections of this document:

5.1 Daily logs;

6.1 Sample collection forms;

7.1 Sample labeling and chain of custody forms;

J.4.1 Field documentation;

K.9 Sample collection forms.

If additional requirements are required for a specific project, they shall be defined in project-specific plans (PSPs).

14.2 ANALYTICAL LABORATORY

Analysts, in consultation with the laboratory project manager, are responsible for evaluating the acceptability of quality control (QC) analyses, such as surrogate and matrix spike recoveries and duplicate precision. Quality control acceptance criteria for recoveries and relative percent difference are included in the applicable method in Appendix G.

QC criteria that are found to be "out-of-control" shall be evaluated using all pertinent information, such as method, instrumentation, preparation blanks, laboratory control samples, any matrix interferences present, concentration of the spiking compound present in the original sample, sample homogeneity, and sample matrix.

Assessment of data precision and accuracy is an integral part of the laboratory data verification process. After data have been generated by an analyst or instrument, they shall be submitted to a qualified peer (another analyst, group supervisor or equivalent) for review. This initial review is for procedural errors, transcription errors, calculation errors, holding times, and a check for completeness, which shall include the following elements:

A. Required samples and analyses have been processed;

B. Complete records exist for each analyte and associated QC samples;

C. Specified procedures have been implemented;

D. Electronic data packages have been checked for completeness.

A secondary review is conducted by the laboratory group supervisor (or equivalent), laboratory project manager, or laboratory quality control personnel or equivalent.

A tertiary review is a quality function that is performed on a minimum of five percent of analytical data, including technical and editorial reviews. All data shall be reviewed by laboratory project manager for accuracy, precision, and completeness prior to transmittal to the data requestor. These reviews shall be documented in the analytical data package.

14.3 PRECISION

A routine program of duplicate analyses shall be performed to determine precision of the method (Section 4). The results of the duplicate analyses are used to calculate the relative percent difference (RPD), which is the governing QC parameter for precision.

$$RPD\ \% = 100 \times \frac{(D_1 - D_2)}{(D_1 + D_2)\ /\ 2}$$

Where:

D_1 = the larger of the two observed values
D_2 = the smaller of the two observed values

Additional determiners of precision may be specified by methods, such as the 20 percent multiple injection criterion for ASL C and D graphite furnace atomic absorption analyses or the relative error ratio (RER) for radiochemical analyses.

14.4 ACCURACY

Accuracy shall be estimated based on results of laboratory control sample (LCS) analyses and/or matrix spike recoveries (Section 4) and/or the use of other performance evaluation samples or standards as specified by the methods. Accuracy is expressed in terms of percent recovery as expressed in the following formulas:

A. For LCS:

$$Percent\ Recovery = 100 \times \frac{measured\ value}{true\ value}$$

B. For matrix spikes:

$$Percent\ Recovery = 100 \times \frac{C_i - C_0}{C_t}$$

Where:

C_o = value of unspiked aliquot
C_i = value of spiked aliquot
C_t = value of spike added

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14.5 COMPLETENESS

Completeness shall be reported as the percentage of all measurements made with results judged to be valid following FEMP data validation (Appendix D). The following formula will be used to estimate completeness.

$$\textit{Percent Completeness} = 100 \times \frac{V}{T}$$

Where:

V = number of required measurements judged useable for their intended purpose
T = total number of required measurements

Completeness shall be evaluated relative to the length of the project and the specified holding time. If the completeness is less than 90 percent, explanatory documentation shall be provided that (1) states why this completeness percentage is acceptable for the project and (2) evaluates the impact of this completeness percentage on the project.

14.6 METHOD DETECTION LIMITS

For organic and inorganic analyses, method detection limits (MDLs) represent the minimum concentration of a substance that can be measured and reported (with 99 percent confidence) to be present at a level above zero. Method detection limits shall be determined according to procedures specified in The Code of Federal Regulations, 40 CFR Part 136, Appendix B and modified by the following:

A. Appropriate dilution/concentration factors dictated by sample preparation methods used;

B. Extract/digestate dilutions necessary to adjust analyte concentrations to linear calibration range of the specific instrument;

C. Analytical method used.

ASL C & D organic and inorganic detection limit criteria are defined by the CLP Statement of Work.

For radiochemical analyses, the minimum detectable activity (MDA) is the amount of a radionuclide which would be detected in a sample with a 95 percent probability. The minimum detectable concentration (MDC) is the MDA expressed in concentration units relative to sample weight and volume. The FEMP has defined highest allowable minimum detectable concentrations (HAMDCs) for various matrices in Appendix G.3.

Section 15

CORRECTIVE ACTIONS

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Corrective action is required whenever a nonconformance is noticed. Corrective action is defined to be not only those actions taken to correct the immediately identified nonconformance, but also any and all actions taken to evaluate the extent and impact of the identified nonconformance and to correct these as well. Actions taken to prevent recurrence of the identified nonconformance represent corrective action on the root cause, and may include re-evaluation of the process or procedure, retraining, or replacement of process equipment or instruments.

Interim corrective actions to mitigate hazards to human health or the environment may be implemented as necessary by the FEMP project manager or representative, FEMP health and safety personnel, the designated FEMP QA organization, DOE, Ohio EPA, or USEPA. Corrective actions shall be prioritized to address the most serious conditions first.

15.1 NONCONFORMANCES

A nonconformance is a deficiency in characteristics, documentation, procedures, or a departure from a requirement that renders the quality of an item, datum, or activity unacceptable or indeterminate. Types of nonconformances to be reported are:

A. Observation - an assessment conclusion that identifies a condition that is not a deviation to a written requirement. An observation, if resolved, could lead to excellence in operations.

B. Finding - an individual item that does not meet written requirements.

C. Concern - a determination of a programmatic breakdown or widespread problem supported by one or more findings.

15.1.1 Responsibility

All FEMP staff are responsible for reporting nonconformances. The following personnel shall be especially aware of the possibility of nonconformances:

A. **Project Staff** - During performance of field investigation and testing, supervision of subcontractors, performance of field inspection, and preparation and verification of numerical analyses;

B. **Laboratory Staff** - During preparation for and performance of laboratory testing, audits, calibration of equipment, sample receipt, and quality control activities;

C. **Assessment Personnel** - During audits, surveillances, and other QA or QC activities.

Upon identification of a nonconformance, all employees must notify the responsible project manager, team leader, or QA personnel, and, if they are not qualified to draft a

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Nonconformance Report (NCR), immediately notify a person who is qualified to do so (an NCR originator).

The NCR originator or qualified assessor is responsible for determining whether a nonconforming condition exists and, if confirmed, the severity of the identified nonconforming condition. If the nonconforming condition represents a significant condition adverse to quality, the FEMP QA organization may issue a STOP WORK authorization, which would remain in effect until such time as adequate corrective actions are established and implemented.

15.1.2 Nonconformance Reporting

15.1.2.1 Nonconformances at the FEMP.

A. When a condition appears to be a nonconformance, the NCR originator or qualified assessor shall document the violation in a nonconformance report (Appendix B, Form 15-2) and describe the nonconformance as follows, as applicable:

1. Type of nonconformance;
2. Date discovered;
3. Responsible organization;
4. Responsible manager;
5. Location;
6. Assessment activity;
7. Requirements (identify and quote the requirement directly from the document that best describes the acceptance criteria for the item or activity);
8. Nonconformance (fully describe the nonconformance as it relates to the requirements).

NOTE

If a written FEMP requirement has been violated (such as those specified in site procedures, department procedures, specifications, drawings, work plans, project-specific plans, or contracts describing how work shall be performed), cite that specific requirement. Regulatory requirements may be cited as support documents only. If an activity not covered by a written FEMP requirement is in violation of a regulatory requirement, a concern shall be issued to the responsible project manager.

B. The NCR originator or qualified assessor shall forward the nonconformance report to the designated FEMP project manager for resolution.

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C. The FEMP project manager shall provide the information specified on the nonconformance report form within 20 working days, unless an extension has been requested. This information will include the following, as applicable:

1. Proposed disposition and corrective action;

2. Disposition results in design change;

3. Unresolved Safety Question/Document Change Notice number;

4. Investigation of similar item and/or processes for presence of the identified nonconformance;

5. Measures taken to prevent recurrence;

6. Root cause (concerns only).

D. The NCR originator or qualified assessor shall determine whether the response is acceptable and shall complete the applicable section of the nonconformance report form.

E. If the response is found to be satisfactory, the NCR originator or qualified assessor shall notify the responsible FEMP project manager.

F. If the response is in some way deficient, the quality representative shall notify the FEMP project manager and document the deficiency. Steps B through F shall be repeated, and the nonconformance report form shall be revised to indicate the deficiency, and it shall be returned to the responsible FEMP project manager for further resolution until satisfactory resolution is reached.

G. Upon agreement of the nonconformance report resolution, the NCR originator or qualified assessor shall verify completion of actions.

H. The NCR originator or qualified assessor shall send copies of reports to managers whose projects may be affected by the outcome.

15.1.2.2 **<u>Subcontractor Nonconformances.</u>** Nonconformances identified by subcontractors (including subcontractor laboratories) shall be reported and processed as follows.

A. Nonconformances identified during subcontractor laboratory operations shall be documented in nonconformance reports or as specified in procedures approved by the specific contract with the FEMP.

B. The subcontractor project manager shall enclose copies of documents that identify nonconformances that occurred during activities in support of the FEMP, together with records of corrective actions, in the associated laboratory data packages submitted to the FEMP. These nonconformance reports shall become part of the sample documentation.

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C. The FEMP QA organization shall review the subcontractor laboratory's logs of nonconformances and resolutions during laboratory audits.

D. If a sample is potentially affected by the deviation, the laboratory must contact the FEMP analytical project manager for review and approval of the nonconformance resolution.

15.2 EVALUATION OF RECURRING NONCONFORMANCES

When a nonconformance report or its equivalent is received, the designated FEMP QA organization shall determine if it describes a recurring deviation. If so, the root cause shall be evaluated to determine actions required to prevent further recurrences.

The designated FEMP QA organization shall notify the appropriate FEMP project manager of recurring nonconformances that can impact results of work and shall indicate the corrective action that will be taken.

15.3 VARIANCE

A variance is a preapproved action performed in a manner different than that specified by the requirements of an approved plan, procedure, or drawing. The impact of changes on the quality of work performed shall be evaluated, documented, and approved by the FEMP organizations that approved the original document prior to implementation.

A variance is not a nonconformance. A variance is a means of accomplishing changes to project-specific plans. If it is necessary to deviate from procedures or drawings when implementing PSP requirements, a variance may be written to identify those changes necessary for work to proceed. The variance is a change approved only for the specific activity described in the variance documentation. Proposed changes must be in accordance with the approved DQO. Any changes outside the scope of the DQO must be accomplished through a revision of the PSP and DQO.

A. The person identifying the need for the variance (the initiator) shall process a variance request as follows:

1. Notify the project manager of the need to vary from the plan and determine the appropriate action.

2. Initiate a Variance/Field Change Notice, FS-F-4162 (Appendix B, Form 15-1). The original planning document (e.g., PSP or work plan) for which the variance is being sought must be identified.

3. Describe the variance in writing, including the justification for the variance, and the potential impact on the project.

4. Indicate the intended time and date of variance implementation and the time allotted for comments and resolution (if applicable).

5. Distribute the variance request to all organizations affected by the variance for their review.

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B. The reviewers shall proceed as follows:

1. Evaluate the variance request and approve or disapprove the document.

2. If approved, sign and date (including time approval was granted) the request.

3. If disapproved, return document to the initiator indicating reason for disapproval.

C. If approval was not obtained, the initiator shall evaluate reasons for disapproval and the need for a revision to the requested variance. Revisions to the variance shall be processed as indicated in steps A and B above.

D. When approvals have been obtained, project personnel may implement the described variance. Under no condition shall an unapproved variance be implemented.

E. The FEMP project manager shall ensure that controlled copies of the approved variance are distributed for inclusion with the applicable controlled PSP or work plan. The original signed variance shall be stamped "original" in red ink and shall become part of the project file.

F. Approved variances shall be incorporated into subsequent revisions of the PSP.

15.3.1 Time-Critical Variance

A time-critical variance may be obtained in cases where expedited approval is needed to avoid costly project delays.

A. Like a regular variance, each time-critical variance shall identify the change to an approved project-specific plan, procedure, or drawing that is necessary for work to proceed. The time-critical variance is approved only for the specific activity described in the written documentation, and all changes must be in accordance with the approved DQO or work plan.

B. When a field project team leader (the initiator) identifies the immediate and critical need for a variance to an approved project-specific plan, procedure, or drawing, he or she shall notify the project manager and request a time-critical variance. The scope and justification for the change requested shall be clearly conveyed to the project manager in writing via hard copy, fax, or electronic mail.

C. When the project manager has approved the time-critical variance, it shall be sent via hard copy, fax, or electronic mail to the designated QA organization for approval. If necessary, a telephone conference or other meeting may be required to resolve unanswered questions. QA approval of the time-critical variance may be transmitted via hard copy, fax, or electronic mail.

D. Upon receipt of approval from the project manager and the QA organization, the field project team leader may implement the time-critical variance.

E. The field project team leader shall complete a Variance/Field Change Notice (Appendix B, Form 15-1) and submit it to the project manager and QA organization for approval. Copies of the initial request and time-critical variance approvals shall be attached to the Variance/Field Change Notice. The completed approved Variance/Field Change Notice form and all accompanying documentation will be submitted to the project file within 5 working days after the time-critical variance is approved.

15.4 EXPEDITED SAMPLING AND ANALYSIS AUTHORIZATION

In order to rapidly respond to unforeseen conditions that arise during the course of construction or excavation activities, a level 2 project manager may authorize a limited sampling event with the concurrence of the project QA representative and the manager of Environmental Monitoring. This request will not be used to take the place of the DQO and PSP process for routine work as described in sections 1.5 and 3.3 of the SCQ. This authorization will only be applicable for unanticipated situations when a single sampling event of limited scope and duration is required to provide information to support a field decision to affect further action (i.e., determining handling and dispositioning requirements for an unknown material). Sampling and analysis activities conducted under this authorization must not exceed ASL B. Decisions based on the data collected under this authorization must be commensurate with the limited (primarily screening level) nature of the sampling activities. If decisions requiring higher data quality are necessary, then a DQO and PSP must be developed for the sampling event.

The authorized sampling and analysis methods, as well as all other related activities (e.g., sample preservation, sample custody, field documentation, data management), must be performed in accordance with the requirements listed in the SCQ. No other field activities (e.g., the installation, development, or maintenance of monitoring wells) will be authorized by means of this request.

The written authorization must be documented in the project files and include the information identified in the DQO summary form (Appendix B, Form C-1). This information in conjunction with the established standard operating procedures for the sampling and analysis activities will serve as the sampling and analysis plan. The written authorization for expedited sampling and analysis must be approved by the initiating level 2 project manager, the project QA representative, and the manager of Environmental Monitoring before the requested samples are collected.

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Section 16

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Section 16

QUALITY ASSURANCE REPORTS TO MANAGEMENT

16.1 CONSENT AGREEMENT QUARTERLY REPORTS

The 1991 Amended Consent Agreement required DOE to submit monthly reports to the USEPA that summarize activities of the preceding month and projected activities. USEPA approved the change to a quarterly reporting schedule on January 31, 1996 and February 28, 1996 respectively. Milestones shall be indicated along with their status. If a milestone is not met, the quarterly report shall include justification for missing the commitment and a new schedule for completion. Significant problems and steps taken towards resolution shall also be recorded.

16.2 SUMMARY REPORTS OF QUALITY ASSURANCE ACTIVITIES

The designated FEMP Quality Assurance (QA) organization shall notify project management of field audit and surveillance results, performance of measurement systems, data quality, results of QA activities, and, if applicable, repetitive and significant QA problems through routine distribution of surveillance and audit reports (Section 12), nonconformance documentation (Section 15), and weekly and monthly activity reports. Records of QA activities within the project shall become part of project files.

The FEMP project managers shall be responsible for variance requests and implementation (Section 15) as well as assessment of the variance effect on final project results. The effects shall be reported on a timely basis to other potentially affected parties.

QA reports shall be distributed to the responsible FEMP project manager and applicable project personnel. When requested, the DOE-FEMP QA officer shall receive QA reports pertaining to 1991 Amended Consent Agreement activities. Required reports of activities that affect 1991 Amended Consent Agreement requirements shall be distributed by DOE to the USEPA Remedial Project Manager (EPA-RPM). The EPA-RPM is responsible for distributing reports to appropriate USEPA personnel.

16.3 LABORATORY MANAGEMENT REPORTS

Laboratory managers and quality control coordinators, or equivalent, shall provide periodic reports to FEMP project managers as required for specific projects. The types and frequencies shall be addressed in the PSP. The reports shall include the following as a minimum:

A. Assessment of measurement data accuracy and precision;

B. Results of performance and system audits of laboratory activities;

C. Laboratory intercomparison study of proficiency of sample results (e.g., quality control checks for effectiveness);

D. Significant quality problems and their resolutions.

Data quality shall be assessed in terms of precision, accuracy, representativeness and method and matrix detection limits. The status of objectives shall be recorded. If they are not met, an

explanation of problems, why they were not resolved, and limitations on data use shall be included.

16.4 FINAL PROJECT REPORTS

The final report for each phase of a program or project, including remedial investigation and feasibility studies reports, shall include a separate QA section that summarizes data quality information collected during the project. A brief description of QA elements implemented within the project, surveillances and audits, significant audit and surveillance findings (findings that could affect data interpretation), and implemented corrective actions shall also be provided. Limitations on data use shall be identified by data users based on results of data validation and specific project requirements. A summary of the applicability of QA elements to data quality objectives and achieved data quality shall be included.

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Appendix A

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APPENDIX A

FIGURES AND TABLES

APPENDIX A FIGURES AND TABLES

A.1 FIGURES

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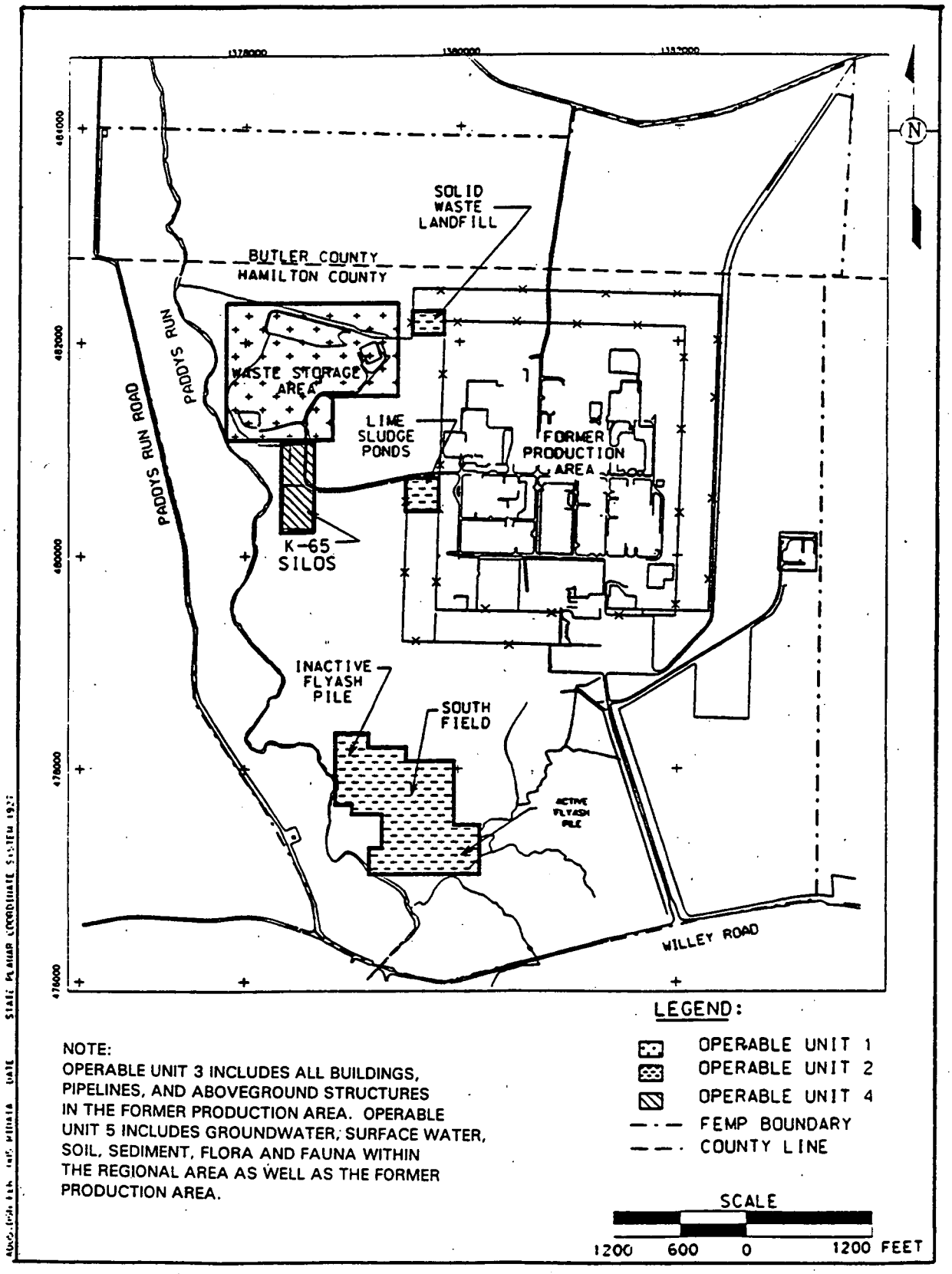

NOTE:
OPERABLE UNIT 3 INCLUDES ALL BUILDINGS, PIPELINES, AND ABOVEGROUND STRUCTURES IN THE FORMER PRODUCTION AREA. OPERABLE UNIT 5 INCLUDES GROUNDWATER, SURFACE WATER, SOIL, SEDIMENT, FLORA AND FAUNA WITHIN THE REGIONAL AREA AS WELL AS THE FORMER PRODUCTION AREA.

Figure 2-1. Major Features of Fernald Environmental Management Project

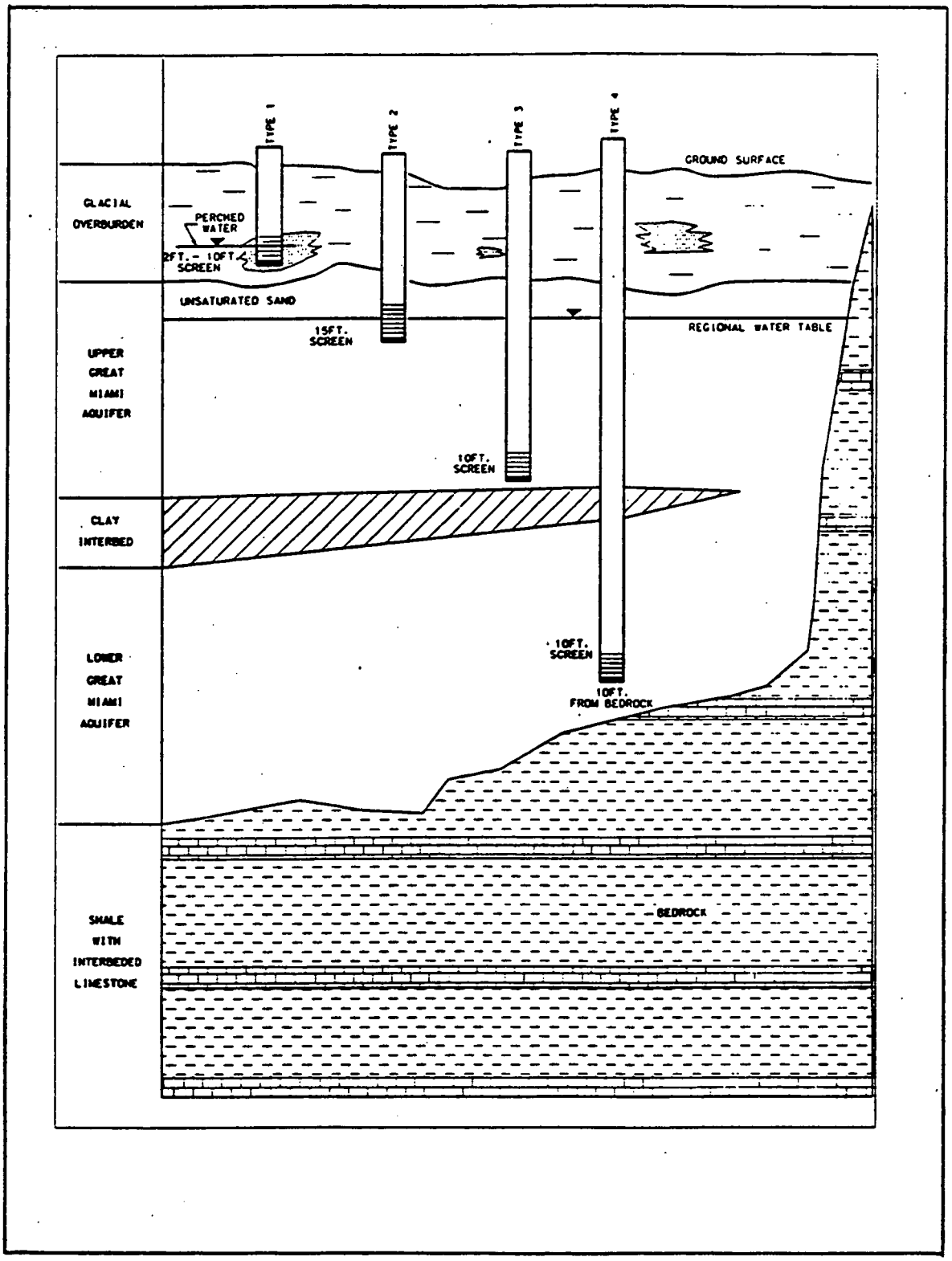

Figure 2-2. Generalized Cross Section of Site Hydrogeology and Monitoring Well Placement

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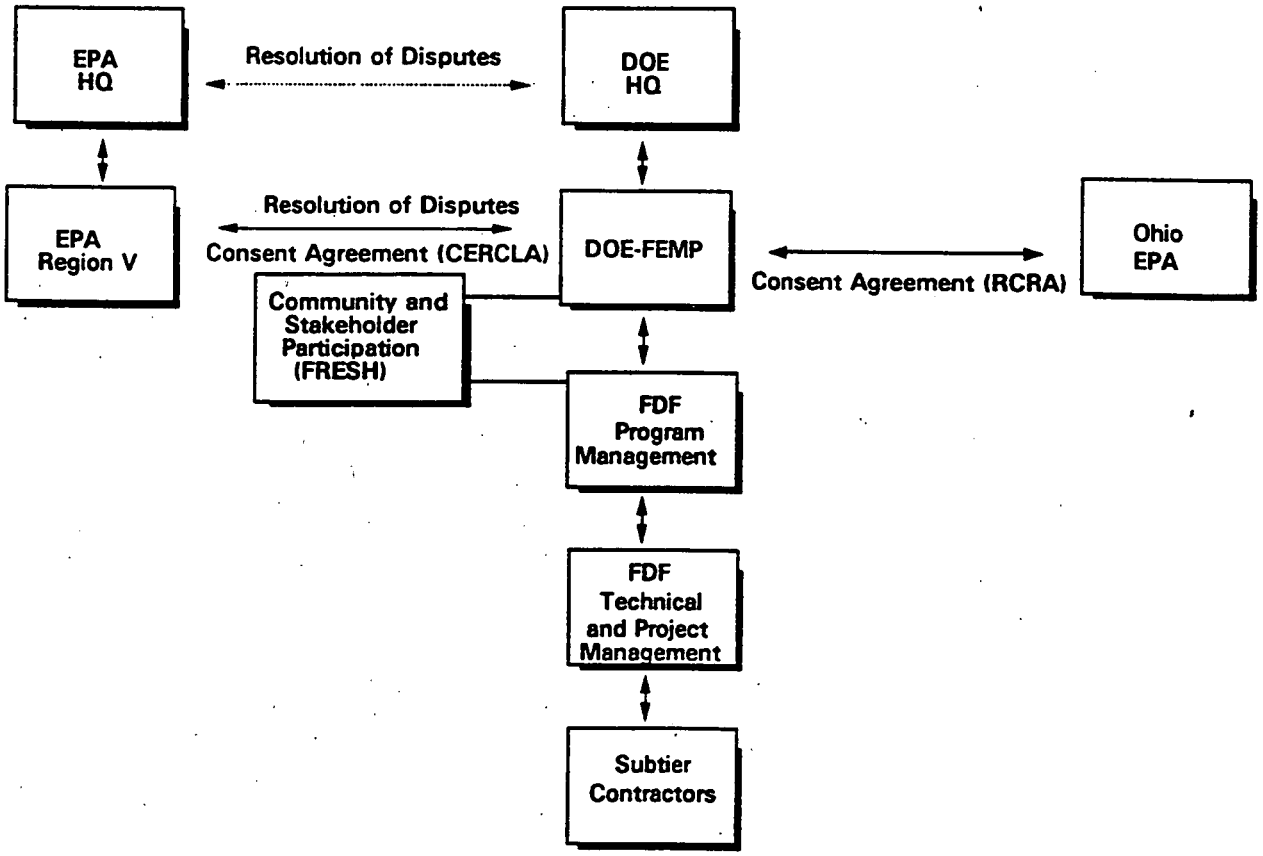

Figure 3-1. Fernald Environmental Management Project Organizations 000211

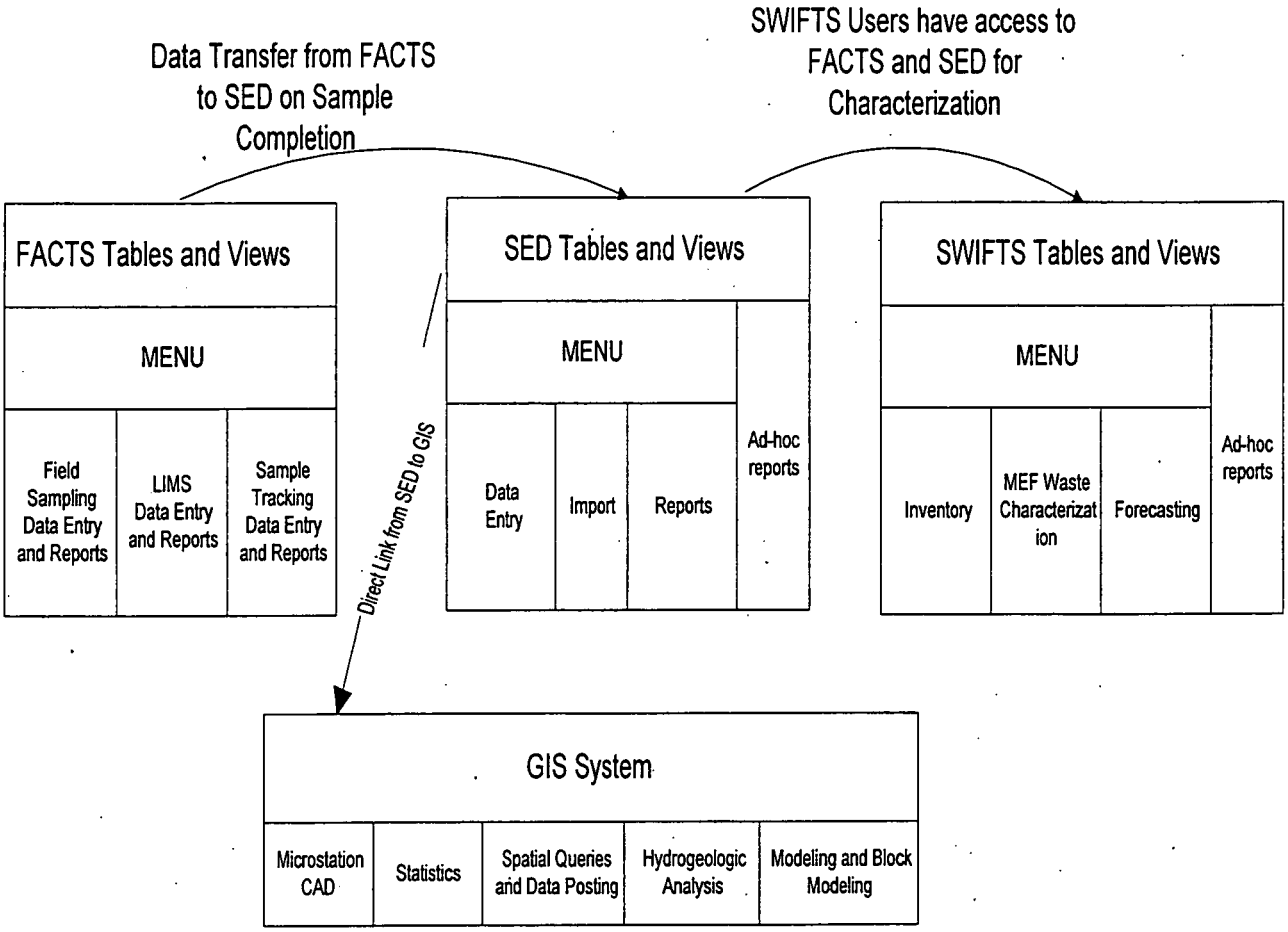

Figure F-1. Relationship of FEMP Databases

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TABLE 1-1 EXAMPLE SAMPLE SUMMARY TABLE

ASL	Analyte(s)	Decision (Action) Level	Matrix	Method[1]
A	pH	8 or higher	Water	pH meter
B	1,1,1-trichloroethane; 1,1,2-trichloroethane	5 ppb	Water	SW 846-8260
C	Arochlor-1242; Arochlor-1254; Arochlor-1260	10 ppb	Water	US EPA CLP Statement of Work
D	Uranium-238	35 pCi/g	Soils	Thermal Ionization Mass Spectrometry

[1]Referenced analytical methods are to be used as specified in Section 9 and Appendix G. For ASL A, identify the field instrument being used in this column.

TABLE 2-1
FEMP OPERABLE UNIT REMEDIES AND ASSOCIATED PROJECT RESPONSIBILITIES[a]

OU Description	Remedy Overview[b]	Project Organization/Responsibilities	Planning Documents
Operable Unit 1 • Waste pits 1-6 • Clearwell • Burn pit • Berms, liners, caps and soil within the operable unit boundary	ROD Approved: March 1995 • Excavation of materials within the waste pits, caps, liners, and surrounding contaminated soils; off-site transportation for disposal at the permitted commercial disposal facility, or disposal at NTS if the waste fails to meet the PCDF WAC; the disposition of contaminated soils; and the D&D of the remediation facility • Waste processing and treatment by thermal drying (as necessary) • Off-site disposal of waste materials at a permitted facility • Restoration	Primary Project: Waste Pits Remedial Action Project responsible for rail upgrade, excavation of Operable Unit 1 waste units, waste processing and drying, loading, rail transport, off-site disposal of contaminated soil and debris that exceed the waste acceptance criteria for the on-site disposal facility, OU1 D&D implementation plan and implementation. (Note: This project will be performed by the WPRAP, SCEP and the ARASA subcontractor.) Related Projects: Soil Characterization and Excavation Project responsible for sampling, excavation, and disposition of impacted soil beneath the rail construction area and the waste pits, as well as at- and below-grade remediation facilities, including the railroad. Soil excavation will be coordinated by SCEP and the ARASA subcontractor. AWWT and Wastewater Project responsible for treating contaminated runoff and perched water collected during waste pit excavation; each project is responsible for containing and transporting remediation wastewater to the AWWT facility for treatment.	Operable Unit 1 RA Work Plan SEP and Area 6 IRDP for underlying soil excavation and certification IEMP for sitewide environmental monitoring

TABLE 2-1
(Continued)

OU Description	Remedy Overview[b]	Project Organization/Responsibilities	Planning Documents
Operable Unit 2 • Solid waste landfill • Inactive flyash pile • Active flyash pile (now inactive) • North and south lime sludge ponds • Other south field disposal areas • Berms, liners and soil within the operable unit boundary	ROD Approved: May 1995 • Excavation of all materials with COCs above FRLs • Treatment for size reduction and moisture control as required • Establishment of OSDF WAC • OSDF construction • WAC attainment certification • FRL certification • Collection and treatment of Operable Unit 2 subunit and OSDF construction water • On-site disposal in the OSDF • Off-site disposal of a small fraction of excavated material that exceeds the WAC for the OSDF and lead-contaminated soil from the South Field Firing Range. • Restoration	Primary Project: Soil Characterization and Excavation Project responsible for excavation and disposition of waste from all Operable Unit 2 subunits. Related Projects: On-Site Disposal Facility Design Project responsible for design, installation, and closure of the OSDF that will contain Operable Unit 2 subunit wastes, Operable Unit 5 soil and debris, and Operable Unit 3 debris; responsible for monitoring leachate within the OSDF and perched groundwater in the till beneath the OSDF. AWWT and Wastewater Project responsible for treating contaminated runoff and perched water collected during excavation of Operable Unit 2 subunit wastes; each project is responsible for containing and conveying remediation wastewater to the AWWT facility for treatment.	Operable Unit 2 RD and RAWP for OSDF construction, management, and closure SEP, Area 2, Phase I IRDP and Area 2, Phase 2 IRDP for waste unit contents removal and soil excavation and certification, respectively IEMP for sitewide environmental monitoring

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TABLE 2-1
(Continued)

OU Description	Remedy Overview[b]	Project Organization/Responsibilities	Planning Documents
Operable Unit 3 • Former production area and associated facilities and equipment (includes all above-, at-, and below-grade improvements) including, but not limited to: • All structures, equipment, utilities, effluent lines, K-65 transfer line • Wastewater treatment facilities • Fire training facilities • Coal pile • Scrap metals piles • Drums, tanks, solid waste, waste product, feedstocks, thorium	ROD Approved: September 1996 • Incorporates decisions provided in Operable Unit 3 IROD • Alternatives to disposal through the unrestricted or restricted release of materials, as economically feasible for recycling, reuse, or disposal • Treatment of material for on-site or offsite disposal • Required off-site disposal for process residues, product materials, process-related metals, acid brick, concreted from specific locations, and any other material exceeding the OSDF WAC • On-site disposal for material that meets the OSDF WAC • Restoration	Primary Project: Facilities D&D Project responsible for D&D of all above-grade buildings and facilities at the FEMP. Related Projects: Soil Characterization and Excavation Project responsible for removal of at- and below-grade facilities. Responsible for certification sampling beneath excavated facilities. AWWT and Wastewater Project responsible for treating contaminated and other waste waters during D&D activities; each project is responsible for containing and conveying remediation wastewater to the AWWT facility for treatment. On-Site Disposal Facility Design Project responsible for design, installation, and closure of the OSDF that will contain Operable Unit 3 debris, Operable Unit 2 subunit wastes, and Operable Unit 5 soil.	SEP and Areas 3, 4, and 5 IRDPs under SCEP: Removal of all Operable Unit 3 at- and below-grade structures (building foundations, roadways, underground utilities, in-ground basins within former production area, sewage treatment plant, and the fire training facility) and WAC attainment and debris management. Facilities D&D Project Operable Unit 3 Integrated RD/RA Work Plan for D&D of above-grade facilities and applicable Implementation Plans. IEMP for sitewide environmental monitoring.

TABLE 2-1
(Continued)

OU Description	Remedy Overview[b]	Project Organization/Responsibilities	Planning Documents
Operable Unit 4 • Silos 1 and 2 (containing K-65 residues) • Silo 3 (containing cold metal oxides) • Silo 4 (empty and never used) • Decant tank system • Berms and soil within the operable unit boundary	ROD Approved: December 1994 • Removal of silo residues and decant sump tank sludges with on site treatment of residues and sludges followed by off-site disposal • Demolition and decontamination, to the extent possible, of silos and vitrification facilities • Excavation of contaminated soil above the FRLs with on site disposal for contaminated soil and debris that meet the OSDF WAC • Contaminated soil and debris that exceed the OSDF WAC will be disposed of off-site • Restoration	Primary Project: Silos Project responsible for silo content removal, treatment, and transport off-site. Related Projects: Soil Characterization and Excavation Project responsible for certification, excavation and disposition of contaminated soil beneath the silos that exceed to on-site WAC, and for removal of subsurface structures (i.e., sub-grade silo decant system). AWWT and Wastewater Project responsible for treating decontamination and other waste waters during D&D activities; each project is responsible for capturing and transporting remediation wastewater to the AWWT facility for treatment. Facilities D&D Project responsible for D&D of all Operable Unit 4 remediation facilities.	Operable Unit 4 RD documents - planning for removal of silo contents and their transport for off-site disposal SEP and Area 7 IRDP - planning for excavating remaining contaminated soil, attainment of FRLs, final site restoration of Operable Unit 4. IEMP for sitewide environmental monitoring Implementation Plans for above-grade D&D

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TABLE 2-1
(Continued)

OU Description	Remedy Overview[b]	Project Organization/Responsibilities	Planning Documents
Operable Unit 5 • Groundwater • Surface water and sediments • Soil not included in the definitions of Operable Units 1-4 • Flora and fauna	ROD Approved: January 1996 • Extraction of contaminated groundwater from the Great Miami Aquifer to meet FRLs at all affected areas of the aquifer • Treatment of contaminated groundwater, stormwater, and wastewater to attain mass-based discharge limits and FRLs in the Great Miami River • Excavation of contaminated soil, rubble, and sediment to meet FRLs • Excavation of contaminated soil containing perched water that presents an unacceptable threat, through contaminant migration, to the underlying aquifer • On-site disposal of contaminated soil and sediment that meet the OSDF WAC • Soil and sediment that exceed the WAC for the OSDF will be treated, where possible, to meet the OSDF WAC or will be disposed of at an off-site facility • Site restoration, institutional controls, and post-remediation maintenance.	Primary Projects: Soil Characterization and Excavation Project responsible for precertification and certification of sitewide soil; excavation and disposition of contaminated soil, sediment, impacted perched groundwater and at- and below-grade facilities; and final site restoration. Aquifer Restoration Project is responsible for designing, installing, and operating the pumping systems for the Great Miami Aquifer groundwater restoration; responsible for groundwater monitoring in the Great Miami Aquifer, including the groundwater monitoring program for the on-site disposal facility. AWWT and Wastewater Project responsible for designing, constructing, and operating all treated effluent discharge systems, and for treating and discharging contaminated groundwater, stormwater, runoff water, and remedial action waste waters at the FEMP. Related Projects: Facilities D&D Project responsible for D&D of all Operable Unit 5 remediation facilities. On-Site Disposal Facility Design Project responsible for design, installation, and closure of the on-site disposal facility that will contain Operable Unit 3 debris, Operable Unit 2 subunit wastes, and Operable Unit 5 soil.	SEP, all IRDPs, and ERDs. Groundwater Monitoring and Sitewide Environmental Monitoring: Integrated Environmental Monitoring Plan.

[a]Source of information is from each operable unit's ROD and RD work plan.
[b]Each remedy includes institutional controls that will be managed for the site through the NRRP.

TABLE 2-2
LABORATORY QUALITY CONTROL REQUIREMENTS

	ANALYTICAL SUPPORT LEVELS	
	B	C & D
Inorganic Analytical QC Samples		
Laboratory control samples	1 per analytical batch if applicable	1 per analytical batch if applicable
Method blanks	1 per analytical batch of samples	1 per analytical batch of samples
Matrix spikes	1 per 20 samples or 1 per analytical batch, whichever is more frequent (per matrix) if applicable to the method	1 per 20 samples or 1 per analytical batch, whichever is more frequent (per matrix) if applicable to the method
Laboratory replicate samples	1 per 20 samples or 1 per analytical batch, whichever is more frequent (per matrix) if applicable to the method	1 per 20 samples or 1 per analytical batch, whichever is more frequent (per matrix) if applicable to the method
Interference check	A/S	1 per analytical batch per matrix
Dilution check	A/S	1 per analytical batch per matrix
Initial Calibration/Verification	As required by method	A/S
Continuing Calibration/Verification	As required by method	A/S
Organic Analytical QC Samples		
Method (reagent) blanks	1 per 20 samples or 1 per analytical batch, whichever is more frequent (per matrix) if applicable to the method	1 per 20 samples or 1 per analytical batch, whichever is more frequent (per matrix) if applicable to the method

TABLE 2-2
LABORATORY QUALITY CONTROL REQUIREMENTS (Continued)

	ANALYTICAL SUPPORT LEVELS	
	B	C & D
Organic Analytical QC Samples - (Continued)		
Matrix spikes	1 per 20 samples or 1 per analytical batch, whichever is more frequent (per matrix) if applicable to the method	1 per 20 samples or 1 per analytical batch, whichever is more frequent (per matrix) if applicable to the method
Matrix spike duplicates	1 per 20 samples or 1 per analytical batch, whichever is more frequent (per matrix) if applicable to the method	1 per 20 samples or 1 per analytical batch, whichever is more frequent (per matrix) if applicable to the method
Surrogates	Present in every determination	Present in every determination
DFTPP and BFB performance results (GC/MS)	Daily	Once every 12 hours
Internal standard (GC/MS)	A/S	In every determination
Performance evaluation standard (pesticides/PCBs)	A/S	1 per 10 samples
Initial calibration	A/S	A/S
Continuing calibration	A/S	A/S
Second column confirmation (GC analyses)	A/S	For all positive hits
Review of compound identification for target analytes	A/S	For all positive hits by GC/MS methods
Review tentatively identified compounds	A/S	For GC/MS methods

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TABLE 2-2
LABORATORY QUALITY CONTROL REQUIREMENTS (Continued)

	ANALYTICAL SUPPORT LEVELS	
	B	C & D
Radiochemical Analytical QC Samples		
Reagent Blank	1/20 or 1/batch[1]	1/20 or 1/batch[1]
Laboratory control samples[2]	1/20 or 1/batch[1]	1/20 or 1/batch[1]
Duplicate	N/A	1/20 or 1/batch[1] per matrix
Matrix Spike	N/A	1/20 or 1/batch[1]
Tracer, carrier or spike[3]	each sample	each sample

Notes:

A/S - As specified in method or project-specific plan.

N/A - Not applicable.

ASL - Analytical Support Level.

(1) - One per 20 or 1 per batch, whichever is more frequent.

(2) - The LCS shall include at least one radioisotope from those being analyzed when using alpha and gamma counting techniques.

(3) - When a tracer or carrier is not used to determine chemical recovery, a spiked duplicate must be analyzed concurrently with each sample. A sample specific chemical recovery monitor (either a tracer, carrier, or spike) must be used for each sample being analyzed by a method which involves chemical separation. The use of batch efficiency or batch recovery factors is not acceptable. The only exceptions to this requirement are gross alpha, gross beta, direct gamma spectrometry methods that do not involve chemical separations, and chemical uranium (U-Total) measurements.

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TABLE 2-3
FIELD QUALITY CONTROL SAMPLES

	ANALYTICAL SUPPORT LEVELS		
	B	C	D
INORGANICS, ORGANICS, and RADIONUCLIDES			
Field QC Samples			
Field blanks	A/S	1 per 20 samples or 1 per sampling round, whichever is more frequent	1 per 20 samples or 1 per sampling round, whichever is more frequent
Equipment rinsate* blanks	A/S	1 per 20 samples or 1 per sampling round, whichever is more frequent	1 per 20 samples or 1 per sampling round, whichever is more frequent
Field duplicates	A/S	1 per 20 samples or 1 per sampling round, whichever is more frequent	1 per 20 samples or 1 per sampling round, whichever is more frequent
Preservative blanks	A/S	A/S	A/S
Container blanks	A/S	1 per QC lot of containers, if necessary	1 per QC lot of containers, if necessary
Trip blanks (VOAs only)	A/S	1 per shipping container containing VOAs	1 per shipping container containing VOAs
Split samples	A/S	A/S	A/S
Field spikes	A/S	1 per sampling round, if specified	1 per sampling round, if specified
Material blanks	A/S	1 per sampling round, if specified	1 per sampling round, if specified

*A rinsate sample is not required for dedicated equipment.

Notes:

A/S - As specified in project-specific plan

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TABLE 3-1
EXAMPLE LIST OF LABORATORIES APPROVED FOR FERNALD ENVIRONMENTAL MANAGEMENT PROJECT ANALYSES

Laboratory Name	Analytical Support Level	CLP Contract (Y/N)	Type of Service	Period of Performance	Date Last Audited	Auditing Organization	Audit Results	Audit Frequency	Type of Analyses	Remarks
ABC Laboratories, Inc. Anytown, TN	B,E	N/A	Radiological	2/87 to 2/97	2/97	FDF	Pass	Annual	Radiological	Approved for ASL B and E
DEF Enviro Labs Ourtown, OH	B,C,D	Yes	Chemical	3/91 to 3/97	3/97	FDF	Pass	Annual	Organics Inorganics	
Samples R Us Theirtown, NM	B,C,D	Yes	Chemical	5/96 to 5/97	4/96	FDF	Pass	Annual	Volatiles Semivolatiles Pesticides	Approved for ASL B only

Column Definitions:

Laboratory Name - Complete laboratory name and affiliated organizations. Street address (no P.O. box numbers), telephone number, and name of laboratory contact shall be kept on file by FDF.

Analytical Support Level - Analytical Support Level (ASL) (A, B, C, D, or E) for which laboratory is qualified. See Section 2 for ASL definitions.

CLP Contract - Y (yes) indicates that laboratory currently performs analyses under the EPA Contract Laboratory Program (CLP).

Type of Services - Type of services laboratory is qualified to perform for the FEMP (e.g., chemical, radiochemical, pesticides).

Period of Performance - Interval during which laboratory has been approved to perform type of analysis listed.

Date Last Audited - Date (month, year) when laboratory was last audited.

Auditing Organization - Organization that performed last audit indicated in preceding column. Include a separate line for each auditing organization (e.g., EPA, DOE, or private laboratory auditors).

Audit Frequency - Frequency of audits per year (minimum required - once per year).

Type of Analyses - Specific types of analyses laboratory is qualified to perform (e.g., Volatile Organic Analyses (VOA), Semivolatile Analyses (SVOA), inorganics).

Remarks - Comments relating to activities within the laboratory that may affect its ability to perform to its qualifications (e.g., probation periods because of failed audits, current EPA investigations).

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TABLE 3-2
QUALITY ASSURANCE RESPONSIBILITIES

Quality Assurance (QA) Task	Responsible Organization/Personnel
Overall management	DOE-FEMP Project Director EPA Region V Remedial Project Manager (RPM) FDF
Preparation of SCQ and supporting documents	FDF
Review of SCQ and supporting documents	DOE-FEMP Project Director EPA Region V RPM EPA Region V QA Section Ohio EPA FDF
Approval of SCQ and supporting documents	DOE-FEMP Project Director EPA Region V RPM EPA Region V Regional QA Manager FDF
Internal field surveillances and audits	Designated FEMP QA Organization FDF project managers
External field surveillances and performance audits	EPA Region V Ohio EPA DOE-FEMP Project Director
Internal laboratory audits and surveillances	Designated FEMP QA Organization Laboratory managers
External laboratory audits and surveillances	EPA Region V Designated FEMP QA Organization
Internal approval of project-specific plans	FEMP project manager Designated FEMP QA Organization Contract technical monitor (where applicable) FEMP Environmental Safety and Health Organization DOE Operable Unit manager
External approval of project-specific plans	EPA Region V RPM (Consent Agreement activities) Ohio EPA (Consent Decree activities)
Document control of SCQ and supporting documents	FDF

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TABLE 6-1
SAMPLE CONTAINER AND PRESERVATION REQUIREMENTS

Analyte	Container[7]	Preservative	Holding Time[1]	Permissible Sample Type
Radiological Samples in Water				
All analytes in App G, Table G-4	glass or plastic	HNO_3, pH < 2	6 months	G or C
Radiological Samples in Acid Solution				
All analytes in App G, Table G-4	glass or plastic	In final conc. of 3 M HNO_3	one year	C
Radiological Samples in Soil/Sediment				
All analytes in App. G, Table G-4	8-oz. widemouth glass	None	one year	G or C
Radiological Samples - Other Materials				
Radium - 228 in air Radium - 226 in air Isotopic uranium in air Uranium in air Gamma scan in air	Sampling jig	None	6 months	G or C
Radium - 226 in milk Isotopic thorium in milk Isotopic uranium in milk Gamma scan in milk	100-mL plastic or glass	5 mL/liter H_3CCHO	3 months	G or C
Isotopic thorium in vegetation Isotopic uranium in tissue/vegetation	Sealed plastic bag	Freeze (< 0°C)	6 months	G or C
Concentrated Waste Samples				
EP toxicity[B]	8-oz. widemouth glass with Teflon liner	None, but recommend cool[6]	6 months	G or C
Flash point and/or heat content [B]	8-oz. widemouth glass with Teflon liner	None, but recommend cool[6]	28 days	G
Metals and other inorganic compounds[A]	8-oz. widemouth glass with Teflon liner	None, but recommend cool[6]	6 months	G or C
Organic compounds[A]	8-oz. widemouth glass with Teflon liner	None, but recommend cool[6]	6 months	G or C
TCLP metals, except Hg	500-mL amber glass with Teflon-lined lid	Cool[6]	180/180	G or C
TCLP Hg	500-mL amber glass with Teflon-lined lid	Cool[6]	28/28	G or C
TCLP semi-volatile organics	500-mL amber glass with Teflon-lined lid	Cool[6]	14/14	G or C
TCLP volatile organics	500-mL amber glass with Teflon-lined lid	Cool[6]	14/40	G or C
Fish Samples				
Metals[A] and other inorganic compounds except Hg	Place in plastic ziplock bag	Freeze	6 months[8]	G or C
Mercury	Place in plastic ziplock bag	Freeze	28 days	G or C
Semi volatile compounds[A], organo-chlorine pesticides/ PCBs, herbicides, organo-phosphate pesticides	Wrap in aluminum foil	Freeze	14/40 days	G or C

TABLE 6-1
SAMPLE CONTAINER AND PRESERVATION REQUIREMENTS (Continued)

Analyte	Container[7]	Preservative	Holding Time[1]	Permissible Sample Type
Liquid - Low to Medium Concentration Samples				
Acidity[C,F]	500-mL or 1-liter polyethylene[2] with polyethylene or polyethylene-lined closure	Cool[6]	Immediate (in field)	G or C
Acrolein and acrylonitrile[C,F]	2 40-mL vials with teflon-lined septum closure	Cool[6], 0.008% $Na_2S_2O_3$, pH 4-5	14 days	G or C
Alkalinity[C,F]	1-liter polyethylene[2] with polyethylene or polyethylene-lined closure	Cool[6]	14 days	G or C
Ammonia	1-liter polyethylene[2] with polyethylene or polyethylene-lined closure	Cool[6] H_2SO_4 to pH <2	28 days	G or C
Bacteriological[C]	250-mL glass with glass closure or plastic capable of being autoclaved	Cool[6]	24 hours	
Bioassay, static[D]	1-gal. amber glass (not solvent rinsed)	Cool[6]	36 hours	G or C
Biochemical oxygen demand (BOD)[C]	½-gal. polyethylene[2] with polyethylene closure	Cool[6]	48 hours	G or C
Chloride[C,F]	500-mL or 1-liter polyethylene[2] with polyethylene or polyethylene-lined closure	None	28 days	G or C
Chlorine residual[C,F]	*In situ* (beaker or bucket)	None	24 hours	G
Chromium, hexavalent[C]	1-liter polyethylene with polyethylene closure	Cool[6]	24 hours	G
Coliform total[C]	250-mL glass with glass closure or plastic capable of being autoclaved	Cool[6], 0.008% $Na_2S_2O_3$	6 hours	G or C
Color[C,F]	500-mL or 1-liter polyethylene[2] with polyethylene or polyethylene-lined closure	Cool[6]	48 hours	G or C
Conductivity[C]	500-mL or 1-liter polyethylene[2] with polyethylene or polyethylene-lined closure	Cool[6]	28 days	G or C
Cyanide[C,F]	1-liter or ½-gallon polyethylene with polyethylene or polyethylene-lined closure	Ascorbic acid[3,5] 10 N NaOH pH >12	14 days	G
Dioxins and Furans	1- or 2.5-gal. Amber glass with Teflon liner	Cool[6]	7/40 days	G of C
Dissolved oxygen[C] (probe)	*In situ* (beaker or bucket)	None	Immediate (in field)	G
Dissolved oxygen[C] (Winkler)	300-mL glass (BOD bottle)	Fix on site, store in dark	24 hours	G
EP toxicity[B]	1-gal. glass (amber) with Teflon liner	Cool[6]	6 months	G or C
Fluoride[C,F]	500-mL or 1-liter polyethylene[2] with polyethylene or polyethylene-lined closure	None	28 days	G or C

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TABLE 6-1
SAMPLE CONTAINER AND PRESERVATION REQUIREMENTS (Continued)

Analyte	Container[7]	Preservative	Holding Time[1]	Permissible Sample Type
Liquid - Low to Medium Concentration Sample (Continued)				
Hardness[C,F]	500-mL or 1-liter polyethylene[2] with polyethylene or polyethylene-lined closure	50% nitric acid[3] pH <2	6 months	G or C
Kjeldahl and organic nitrogen[C,F]	500-mL or 1-liter polyethylene[2] with polyethylene or polyethylene-lined closure	Cool[6] H_2SO_4 to pH <2	28 days	G or C
Metals[C,F] except Hg and hexavalent chromium	1-liter polyethylene with polyethylene-lined closure	50% nitric acid[3] pH <2	6 months[8]	G or C
Metals, dissolved[C,F] except Hg	1-liter polyethylene with polyethylene-lined closure	Filter-on-site 50% nitric acid[3] pH <2	6 months[8]	G
Mercury[C,F]	1-liter polyethylene with polyethylene-lined closure	50% nitric acid[3] pH <2	28 days	G or C
Mercury, dissolved	1-liter polyethylene with polyethylene-lined closure	Filter-on-site, 50% nitric acid[3] pH <2	28 days	G
Methylene Blue Active Substances (MBAS)[C]	500-mL or 1-liter polyethylene[2] with polyethylene or polyethylene-lined closure	Cool[6]	48 hours	G or C
Nitrate[C,]	100 mL polyethylene with polyethylene-lined closure	Cool[6]	48 hours	G or C
Nitrate/nitrite[C,F]	200 mL polyethylene with polyethylene-lined closure	Cool[6] H_2SO_4 to pH <2	28 days	G or C
Nitrite[C,F]	100 mL polyethylene with polyethylene-lined closure	Cool[6]	48 hours	G or C
Oil and grease[C,F]	1-liter widemouth glass with Teflon liner	Cool[6] HCl or H_2SO_4 to pH <2	28 days	G
Organic carbon, Total (TOC)	250-mL amber glass with Teflon lined septum closure [10]	Cool[6], H_2SO_4 or HCl to pH < 2	28 days	G
Organic halogens[E, 9], purgeable (POX)	2 40-mL glass vials with Teflon-lined septum caps	Cool[6], HCl, or solid $NaHSO_4$ to pH < 2 [8]	14 days	G
Organic halogens, total (TOX)[E,F]	250-mL amber glass with Teflon lined septum closure [10]	Cool[6] H_2SO_4 to pH <2	28 days	G
Petroleum Hydrocarbons, Total	1000-mL glass with Teflon-lined closure	Cool[6] HCl to pH < 2	28 days	G or C
pH, *in situ*[C,F]	Beaker or bucket (plastic or glass)	None	Immediate (in field)	G
pH, laboratory[C,F]	100-mL polyethylene with polyethylene-lined closure	None	Immediate (on receipt)	G or C
Phenols[C,F], Total	1-liter amber glass with Teflon-lined closure	Cool[6] HCl to pH < 2	28 days	G
Phosphate-ortho[C,F]	500-mL or 1-liter polyethylene[2] with polyethylene or polyethylene-lined closure	Filter onsite Cool[6]	48 hours	G

TABLE 6-1
SAMPLE CONTAINER AND PRESERVATION REQUIREMENTS (Continued)

Analyte	Container[7]	Preservative	Holding Time[1]	Permissible Sample Type
Liquid - Low to Medium Concentration Sample (Continued)				
Phosphorous, elemental[C]	1-liter polyethylene[2] with polyethylene or polyethylene-lined closure	Cool[6]	48 hours	G
Phosphorous, total[C,F]	1-liter polyethylene[2] with polyethylene or polyethylene-lined closure	H_2SO_4 to pH <2, or 1 mL conc. HCl/L[12], Cool[6]	28 days	G or C
Phosphorus, total dissolved[C,F]	500-mL or 1-liter polyethylene[2] with polyethylene or polyethylene-lined closure	Filter onsite H_2SO_4 to pH <2	28 days	G
Semi volatile compounds, including organochlorine, pesticides/PCBs, herbicides, organo-phosphate pesticides[C, 9]:				
No residual chlorine present[C]	1-gal. amber glass or 2 ½-gal. amber glass with Teflon liner	Cool[6]	7/40 days	G or C
Residual chlorine present [C]	1-gal. amber glass or 2 ½-gal. amber glass with Teflon liner	Add 3 mL 10% sodium thio-sulfate per gallon, Cool[6]	7/40 days	G or C
Solids, settleable[C,F]	½-gal. polyethylene with polyethylene closure	Cool[6]	7 days	G or C
Solids (total and suspended, etc.)[C,F]	500-mL or 1-liter polyethylene[2] with polyethylene or polyethylene-lined closure	Cool[6]	7 days	G or C
Sulfates[C,F]	500-mL or 1-liter polyethylene[2] with polyethylene or polyethylene-lined closure	Cool[6]	28 days	G or C
Sulfides[C,F]	500-mL or 1-liter polyethylene[2] with polyethylene or polyethylene-lined closure	2 mL zinc acetate[3] conc. NaOH to pH >9, Cool[6]	7 days	G
Sulfite[C,F]	250-mL polyethylene with polyethylene or polyethylene-lined closure	None	Immediate	G or C
Temperature[C,F]	*In situ* (beaker or bucket)	None	Immediate (in field)	G
Total dissolved solids[C,F]	1000-mL polyethylene[2] with polyethylene or polyethylene-lined closure	None	7 days	G or C
Volatile organic compounds[9]:				
No residual chlorine present[C]	2 40-mL glass vials with Teflon lined septum caps	Cool[6], H_2SO_4, HCl, or solid $NaHSO_4$ to pH < 2	14 days	G
No residual chlorine present[C]	2 40-mL glass vials with Teflon lined septum caps	Cool[6]	7 days	G
Residual chlorine present[C] - drinking water	2 40-mL glass vials with	See Note 4	7 days	G
Soil, Sediment, or Sludge Samples - Low to Medium Concentration				
Benzidines	8-oz. widemouth glass with Teflon liner	Cool[6]	14/40 days	G or C

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TABLE 6-1
SAMPLE CONTAINER AND PRESERVATION REQUIREMENTS (Continued)

Analyte	Container[7]	Preservative	Holding Time[1]	Permissible Sample Type
Soil, Sediment, or Sludge Samples - Low to Medium Concentration (Continued)				
Cation exchange capacity	1000-mL polyethylene[2] with polyethylene or polyethylene-lined closure	Cool[6]	6 months	G or C
Chlorinated hydrocarbons	8-oz. widemouth glass with Teflon liner	Cool[6]	14/40 days	G or C
Dioxins and Furans	8-oz. widemouth glass	Cool[6]	14/40 days	G or C
Haloethers	8-oz. widemouth glass with Teflon liner	Cool[6]	14/40 days	G or C
Metals[A] except Hg	8-oz. widemouth glass with Teflon-lined closure	Cool[6]	6 months[8]	G or C
Mercury	8-oz. widemouth glass with Teflon-lined closure	Cool[6]	28 days	G or C
Nitroaromatics and cyclic ketones	8-oz. widemouth glass with Teflon liner	Cool[6]	14/40 days	G or C
Nitrosamines	8-oz. widemouth glass with Teflon liner	Cool[6]	14/40 days	G or C
Nutrients[A] including nitrogen, phosphorus, chemical oxygen demand	500-mL polyethylene with polyethylene closure or 8-oz. widemouth glass with Teflon-lined closure	Cool[6]	28 days	G or C
Other inorganic[A] compounds including cyanide	500-mL polyethylene with polyethylene closure or 8-oz. widemouth glass with Teflon-lined closure	Cool[6]	14/40 days	G or C
Petroleum Hydrocarbons, Total	500-mL glass with Teflon-lined closure	Cool[6]	28 days	G or C
Phthalate esters	8-oz. widemouth glass with Teflon liner	Cool[6]	14/40 days	G or C
Polynuclear aromatic hydrocarbons	8-oz. widemouth glass	Cool[6]	14/40 days	G or C
Semi volatile compounds,[C, 9] organochlorine, pesticides/PCBs, herbicides, organo-phosphate pesticides	8-oz. widemouth glass with Teflon liner	Cool[6]	14/40 days	G or C
TCLP metals, except Hg	500-mL amber glass with Teflon lined closure	Cool[6]	180/180	G or C
TCLP Hg	500-mL amber glass with Teflon lined closure	Cool[6]	28/28	G or C
TCLP semi-organic volatiles	4-oz glass with Teflon-lined closure	Cool[6]	14/14	G or C
Volatile organic compounds[A, 9]	4-oz. (120-mL) widemouth glass with Teflon liner	Cool[6]	14/40	G or C

Notes

1. For holding times listed as xx/yy days, the first number is the allowed holding time for extraction or preparation of the sample for analysis and the second number is the allowed holding time for analysis of the extract.

2. Use indicated container for single parameter requests, ½-gallon polyethylene container for multiple parameter requests except those including BOD, or 1-gallon polyethylene container for multiple parameter request that include BOD.

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TABLE 6-1
SAMPLE CONTAINER AND PRESERVATION REQUIREMENTS (Continued)

3. Preserve the sample in the field at time of collection unless the matrix or buffering capacity of the sample renders this infeasible. In such instances, the reason for infeasibility must be appropriately documented in the field logbook and the sample will be preserved as soon as feasible.

4. Collect the sample in a 4-ounce soil VOA container that has been pre-preserved with four drops of 10-percent sodium thiosulfate solution. Gently mix the sample and transfer to a 40-mL VOA vial that has been pre-preserved with four drops concentrated HCl. Cool to between 2° and 6° C.

5. Use ascorbic acid only if the sample contains residual chlorine. Test a drop of sample with potassium iodide-starch test paper. A blue color indicates need for treatment. Add ascorbic acid, a few crystals at a time, until a drop of sample produces no color on the indicator paper, then add an additional 0.6 grams of ascorbic acid for each liter of sample volume.

6. Cool to the range of 2° to 6° C.

7. Sample volumes listed are suggested only and may vary according to analytical method or QC requirement. Check PSP for specific volume required.

8. Free chlorine must be removed prior to addition of HCl by the appropriate addition of $Na_2S_2O_3$.

9. Samples must have zero headspace.

10. To provide sufficient sample quantity for QA/QC tests, collect three replicate samples for one of every ten samples collected.

11. Table 6-1 specifies sample preservation and container requirements for analytes that are regularly collected, as well as certain analytes that were historically sampled and/or may be sampled in the future. All analytes must be tested with methods identified in Appendix G, unless another the selection of another method has been justified in the PSP.

12. If method 4500-P E is to be used to determine total phosphorus, add 1 mL concentrated HCl or freeze at or below -10°C without any additions.

Abbreviations

G - Grab
C - Composite
VOA - Volatile organic analysis
VOC - Volatile organic compound

References

A U.S. EPA Region IV, Environmental Services Division, ***Analytical Support Branch, Operations and Quality Control Manual***, June 1, 1985, or latest version.

B EPA Method 1310, "Extraction Procedures", 1982, SW 846, U.S. EPA, Office of Solid Wastes, Washington, D.C.

C 40 CFR Part 136.

D U.S. EPA Region IV, Environmental Services Division, ***Ecological Support Branch, Standard Operating Procedures Manual***, latest version.

E EPA Interim Method 450.1, "Total Organic Halide" U.S. EPA, ORD, EMSL, Physical and Chemical Method Branch, Cincinnati, Ohio, November, 1980.

F SW-846, 1997, USEPA, Office of Solid Wastes, Washington, D.C.

TABLE 8-1 MINIMUM INSTRUMENT CALIBRATION AND PERFORMANCE EVALUATION REQUIREMENTS

Instrument	Measurement or Check[1]	Frequency
Gamma Spectroscopy	Efficiency Calibration for All Geometries[2] (Efficiency Check/Verification[3])	Annually (Weekly or PTU[4])
	Energy Calibration[2] (Energy Check/Verification[3])	Monthly or PTU (Daily or PTU)
	Resolution Check [3 keV(FWHM) Max.@1.4 MeV]	Daily or PTU
	Background Measurement (500 min. minimum) Background Check/Verification	Monthly Weekly or PTU
Alpha Spectroscopy	Efficiency Calibration (Efficiency Check/Verification)	Annually (Monthly or PTU)
	Energy Calibration[3] (Energy Check/Verification)	Quarterly or PTU (Weekly or PTU)
	Resolution Check [100 keV(FWHM) Max.]	Weekly or PTU
	Background Measurement	Weekly or PTU
Alpha/Beta Proportional Counters	Efficiencies for Specific Radionuclides	Annually
	Efficiency Check	Daily or PTU
	Self-absorption Curves[5]	Annually
	Plateau (Plateau Check [± ≥ 50 V from operating voltage])	Annually (Every Gas change)
	Background Measurement (150 min. minimum)	Weekly or PTU
Scintillation Counters	Efficiencies for Specific Radionuclides (Efficiency Check/Verification)	Annually (Daily or PTU)
	Quench Curves	Annually
	Interference Corrections[6]	Annually
	Background Measurement	Daily or PTU
Kinetic Phosphorescence Analysis (KPA)	Calibration Curve over Sample Concentration Range	Semi-Annually
	Verification of Calibration (three points, one each, at extremes and center of concentration range.)	Weekly or PTU
	Calibration Check	Each Batch

Notes:

(1) **Energy, Efficiency,** and **Resolution** checks shall have a **minimum of 1000 counts** in each peak/window used.
(2) A minimum of seven peaks shall be used.
(3) A minimum of three peaks shall be used.
(4) Prior To Use.
(5) Self-Absorption curves and cross talk factors shall be determined for specific radionuclides.
(6) Interference corrections shall be determined for liquid scintillation counting.

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TABLE 13-1
MINIMUM PREVENTIVE MAINTENANCE FOR COMMONLY USED FIELD EQUIPMENT

Equipment Type	Maintenance	Spare Parts	Minimum Frequency
Photo-ionization detector	Clean lamp	Lamp	40 hours of operation
	Charge battery		As needed
	Change filter	Filters	240 hours of operation
	Factory service		Yearly
Flame-ionization detector	Charge battery		Daily
	Change filter	Filters	80 hours of use
	Check H_2 connections		Daily
	Clean ignitor		As needed
	Factory service		As needed
pH meter	Check battery	Batteries	With each use
	Clean electrode	Electrode	40 hours of use
	Check connectors		With each use
Specific conductance meter	Check battery	Batteries	With each use
	Clean probe	Probe	40 hour of use
	Check connectors		Daily
	Inspect Cable		With each use
Hand-held Beta-Gamma frisker	Check battery	Batteries	With each use
	Clean probe exterior		As needed
	Check connectors		With each use
	Factory service		As needed
Hand-held Alpha frisker	Check battery	Batteries	With each use
	Clean probe exterior		As needed
	Check connectors		With each use
	Factory service		As needed
Dissolved oxygen meter	Check battery	Batteries	Daily
	Clean probe		40 hours of use
	Check cable and connectors		With each use
Explosimeter	Check battery	Batteries	With each use
	Clean sensor		As needed
	Factory maintenance		As needed
Thermometers	Clean and check for cracks		With each use
Electronic water level indicator	Check battery	Batteries	With each use
	Clean probe		As needed
Pressure transducers	Check cables		With each use
	Clean probe		As needed
Water quality meter	Check battery		With each use
	Clean probe		Weekly
	Recharge sensors		As needed
	Inspect cable		With each use
	Replace sensors		As needed
	Check connections		With each use

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Appendix B

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APPENDIX B

FORMS

APPENDIX B FORMS

The forms in this appendix are for reference only. They are subject to change without prior notification. They MUST NOT be reproduced. Fluor Daniel Fernald, Inc. prohibits the use of noncontrolled forms.

Form 4-1. Document Change Request 1
Form 7-1. Chain of Custody/Request for Analysis Record 2
Form 15-1. Example Variance Request Form 3
Form 15-2. Nonconformance Report Form 4
Form C-1. Example DQO Summary Form 6
Form D-1. Example Request for Additional Information/Resubmittal Format 13

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FEMP DOCUMENT CHANGE REQUEST

This form is used to initiate permanent change to the SCQ and controlled distribution project-pecific procedures.

REQUEST #: _____

Issue Date: _____

Page ___ of ___

Do not write in this block

REQUESTOR: _____ PHONE #: _____ REQUESTED DATE: _____

DCR TITLE: _____ SECTION/PAGE #: _____ REV. DATE: _____

CHANGE JUSTIFICATION:

CONTENT OF CHANGE:

IMPLEMENTATION DATE:

☐ EFFECTIVE DATE: _____

☐ OTHER: _____

REQUIRED APPROVALS:

FEMP PROGRAM/PROJECT MGR - FDF	DATE	OTHERS AS REQUIRED	DATE
QA OFFICER - FDF	DATE	OTHERS AS REQUIRED	DATE
SCQ DCR COORDINATOR	DATE	COTR	DATE

FS-F-5233

EXAMPLE

Form 4-1. Example Document Change Request

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COC/RFA CHANGE REQUEST RECORD

GENERAL INFORMATION		
COC/RFA REFERENCE NO.	RELEASE NO.	DATE
PROJECT NAME	PROJECT NO.	

DISTRIBUTION/MAILING LIST (Contact name must be entered for each area)			
CRR ORIGINATOR:		PROJECT CONTACT:	
ACS REPRESENTATIVE:		DATA VALIDATION:	
SAMPLE TEAM REPRESENTATIVE: *		SPL REPRESENTATIVE:	
ON/OFF SITE DOCUMENT CONTROL:		OTHER (Specify):	

COC/RFA RECORD SECTION REQUIRING MODIFICATION (Place X in all applicable)									
	FACTS ID		RELEASE NO.		CHARGE NO.		ANALYSIS		CONTRACT PURCHASE/TASK ORDER NO.
	CUSTOMER ID		SAMPLE POINT		ASL		MEF NO.		OTHER (Specify)

FACTS ID	CUSTOMER ID/SAMPLE POINT	REQUIRED CORRECTIONS TO COC/RFA RECORD

JUSTIFICATION:

* Noted correction must be transcribed to corresponding Sample Collection Log and other documents (field logs, etc.) If applicable, person maintaining custody of samples must make necessary corrections to sample labels.

000236

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VARIANCE / FIELD CHANGE NOTICE	V/F No. _____
PROJECT NO:	Page ___ of ___
DOCUMENT NO:	Date: _____
DOCUMENT TITLE:	

VARIANCE / FIELD CHANGE NOTICE (Include justification)

Requirement:

Variance:

Justification:

EXAMPLE

REQUESTED BY: _____ Date: _____

X IF REQD	V/FCN APPROVAL	DATE	X IF REQD	V/FCN APPROVAL	DATE
	QUALITY ASSURANCE			PROJECT MANAGER	
	DATA QUALITY MANAGEMENT			FIELD MANAGER	
	ANALYTICAL CUSTOMER SUPPORT			OTHER	
	OTHER			OTHER	

REVISION REQUIRED (Document NO. & Title):
[ ] YES [ ] NO

DISTRIBUTION: ECDC

FS-F-4162

Form 15-1. Example Variance Request Form

000237

FLUOR DANIEL FERNALD

NONCONFORMANCE REPORT FORM

	ORIGINATOR/ASSESSOR	
1	Nonconformance	NCR No.: Revision No.
2	**Dates**	Date Discovered: Date NCR Report Issued:
3	**Type of Nonconformance**	[ ] FINDING [ ] CONCERN
4	**Project/Activity @ Fac/Loc/Bldg**	
5	**Hazard Category**	Nuclear: [ ] 1 [ ] 2 [ ] 3 [ ] Radiological Non-Nuclear: [ ] High Hazard [ ] Moderate Hazard [ ] Low Hazard
6	**Assessment**	[ ] Internal [ ] External (OEPA, DOE) [ ] Supplier/Vendor_____
7	**Assessment Type**	[ ] Audit [ ] Surveillance [ ] Inspection [ ] Other_____
8	**Assessment Number**	
9	**Responsible FDF Division/Vendor**	[ ] S&WP [ ] WMT&SP [ ] FC&DP [ ] O&PI [ ] PS [ ]SUPPLIER/VENDOR
10	**Responsible FDF Department/Vendor**	
11	**Responsible Team Leader/Coach/Vendor (Print Name)**	
12	**Functional Area (NA for Vendors)** (choose any that apply) (Ref. RM-0016)	[ ] CM [ ] ED [ ] RD [ ] MS [ ] QA [ ] AC [ ] PM [ ] PI [ ] FM [ ] EP [ ] EW [ ] MT [ ] OP [ ] PT [ ] SE [ ] TR [ ] CT [ ] HR [ ] PC [ ] EM [ ] FP [ ] NS [ ] SH [ ] RP
13	**QA Criteria** (choose one that applies Ref. RM-0012) Other Criteria (CONOPS, etc.) (not RM-0012 applicable)	[ ] 1 Program [ ] 2 Training [ ] 3 Quality Improv. [ ] 4 Document/Records [ ] 5 Workprocess [ ] 6 Design [ ] 7 Procurement [ ] 8 Inspect/Test [ ] 9 Management Assessment [ ] 10 Independent Assessment [ ] Other
14	**Requirement Description** Cite the requirement (clearly, concisely, and completely) and its source, including document identification number, page and paragraph number. A copy of the document (or page of the document) in which the requirement appears may be attached or added to the NCR file. Use additional or separate sheets as necessary.	
15	**Nonconformance Description** Describe the nonconformance. Include details such as supplier names, container numbers, purchase order, work order, or requisition numbers) and clearly describe the deviation from the written requirement. Use additional or separate sheets as necessary.	Nonconformance Title or Short Description:_____
16	**Tagging Required / Number of Tags**	[ ] Yes [ ] No Number of Tags:
17	**Originator/Assessor**	Name: _____ Signature:_____ Date: _____
	ORIGINATOR'S/ASSESSOR'S TEAM LEADER'S/COACH'S REVIEW	
18	**Originator's/Assessor's Team Leader/Coach**	Name: _____ Signature:_____ Date:_____
19	**Response Date From Resp. Organ.**	(Reply within 20 working days)

SAMPLE

000238 FS-F-4370

Form 15-2. Nonconformance Report Form (Page 1 of 2)

	RESPONSIBLE ORGANIZATION'S CORRECTIVE ACTION RESPONSE	
	Nonconformance Number/Revision	NCR No.: Revision No.
20	**Root Cause Analysis** Provide documentation as attachment. Use additional or separate sheets as necessary	[ ] YES Level 1 Cat. [ ] 1H (human perf.) [ ] 1N (nat. phenom/sabotage [ ] 1E (equip.) [ ] 1Z (other) [ ] NO **TapRoot Cause Code(s)** _____
21	**Corrective Action (CA) Description and Disposition** Describe the actions necessary to correct the nonconformance. Corrective actions must be detailed and complete. They must be written in a clear, concise, and verifiable manner. The corrective action plan must also include actions to prevent recurrence. Use additional or separate sheets as necessary. (A disposition of Accept-as-is or Repair REQUIRES a written Technical Concurrence/Justification below)	Hardware: [ ] Accept-as-is [ ] Repair [ ] Rework [ ] Reject Non-Hardware: [ ] Other
22	**Technical Concurrence/Justification (mark NA if not applicable)**	Name: _____ Signature: _____ Date: _____
23	**Was a Design Change Notice Required?**	[ ] Yes [ ] No DCN # Date Issued
24	**Was a SBDR Performed?** **Was a USQD Performed?**	[ ] Yes [ ] No SBDR # Date Issued [ ] Yes [ ] No USQD # Date Issued
25	**Actions taken to Prevent Recurrence** Use additional or separate sheets as necessary.	
26	**Proposed Completion Date For CA**	Date:
27	**Responsible Team Leader/Coach/Vendor**	Name: _____ Signature: _____ Date: _____
	EVALUATION OF THE CORRECTIVE ACTION RESPONSE BY THE ORIGINATOR/ASSESSOR	
28	**Response Acceptable?**	[ ] Yes [ ] No
29	**Originator's/Assessor's**	
	COMPLETION OF THE CORRECTIVE ACTIONS BY THE RESPONSIBLE ORGANIZATION	
30	**Date Corrective Action Completed**	Date:
31	**Responsible Team Leader/Coach**	
	VERIFICATION OF COMPLETED CORRECTIVE ACTIONS BY THE VERIFIER	
32	**Verification Action** (Describe what objective evidence was examined to verify completion of this action and attach documentation to the NCR)	
33	**Verifier**	
	CLOSURE BY THE ASSESSOR'S VERIFIER'S TEAM LEADER/COACH	
34	**Verifier's Team Leader/Coach**	

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Data Quality Objectives Summary Form

1.A. Task/Description:

1.B. Project Phase: Put an X in the appropriate selection.

RI ☐ FS ☐ RD ☐ RA ☐ R,A ☐ Other ☐

1.C. DQO No.:_____ DQO Reference No.:_____

---

2. Media Characterization: Put an X in the appropriate selection.

Air ☐ Biological ☐ Groundwater ☐ Sediment ☐ Soil ☐

Waste ☐ Wastewater ☐ Surface water ☐ Other (specify) _____

---

3. Data Use with Analytical Support Level (A-E): Put an X in the appropriate Analytical Support Level selection(s) beside each applicable Data Use.

Site Characterization
A ☐ B ☐ C ☐ D ☐ E ☐

Risk Assessment
A ☐ B ☐ C ☐ D ☐ E ☐

Evaluation of Alternatives
A ☐ B ☐ C ☐ D ☐ E ☐

Engineering Design
A ☐ B ☐ C ☐ D ☐ E ☐

Monitoring during remediation activities
A ☐ B ☐ C ☐ D ☐ E ☐

Other
A ☐ B ☐ C ☐ D ☐ E ☐

4.A. Drivers:

4.B. Objective:

---

5. Site Information (Description):

FS-F-5204

Form C-1. Example DQO Summary Form (Page 1 of 7)

EXAMPLE

DQO Number: _____ P-1720

6.A. Data Types with appropriate Analytical Support Level Equipment Selection and SCQ Reference: Place an "X" to the right of the appropriate box or boxes selecting the type of analysis or analyses required. Then select the type of equipment to perform the analysis if appropriate. Please include a reference to the SCQ Section.

1.	pH	☐	2.	Uranium	☐	3.	BTX	☐
	Temperature	☐		Full Radiological	☐		TPH	☐
	Spec. Conductance	☐		Metals	☐		Oil/Grease	☐
	Dissolved Oxygen	☐		Cyanide	☐			
	Technetium-99	☐		Silica	☐			

4.	Cations	☐	5.	VOA	☐	6.	Other (specify)	☐
	Anions	☐		BNA	☐			
	TOC	☐		Pesticides	☐			
	TCLP	☐		PCB	☐			
	CEC	☐						
	COD	☐						

6.B. Equipment Selection and SCQ Reference:

Equipment Selection	Refer to SCQ Section
ASL A _____	SCQ Section: _____
ASL B _____	SCQ Section: _____
ASL C _____	SCQ Section: _____
ASL D _____	SCQ Section: _____
ASL E _____	SCQ Section: _____

7.A. Sampling Methods: Put an X in the appropriate selection(s).

Biased	☐	Composite	☐	Environmental	☐	Grab	☐	Grid	☐
Intrusive	☐	Non-Intrusive	☐	Phased	☐	Source	☐		

Form C-1. Example DQO Summary Form (Page 2 of 7)

DQO Number: _____

7.B. Sample Collection Reference:

Sample Collection Reference:_____

8. Quality Control Samples: Place an "X" in the appropriate selection box.

8.A. Field Quality Control Samples:

Trip Blanks	☐	Container Blanks	☐
Field Blanks	☐	Duplicate Samples	☐
Equip. Rinsate Samples	☐	Split Samples	☐
Preservative Blanks	☐	Performance Evaluation Samples	☐
Other (specify)	☐		

8.B. Laboratory Quality Control Samples:

Method Blank	☐	Matrix Duplicate/Replicate	☐
Matrix Spike	☐	Performance Evaluation Samples	☐
Surrogate Spikes	☐		

Other (specify) _____

9. Other: Please provide any other germane information that may impact the data quality or gathering of this particular objective, task or data use.

EXAMPLE

Form C-1. Example DQO Summary Form (Page 3 of 7)

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INSTRUCTIONS FOR COMPLETING THE DATA QUALITY OBJECTIVE SUMMARY FORM

These instructions are provided to assist in completing the DQO summary form. Each section and section element is explained as it appears on the form. The DQO summary form shall be completed using the information and logic flow statements explained in Appendix C.

SECTION 1

Section 1A

Task/Description - Provide concise description of the task (e.g., RCRA ground water sampling).

OU# (Operable Unit Number) - Identify the operable unit where the sampling will occur. (See SCQ Section 2 for a description of OUs.)

Section 1B

Project Phase - Identify the work phase for which the data will be used. More than one phase may be circled because data generated by a sampling and analysis activity may support more than one phase of the project. If OTHER is used, provide an explanation (e.g., RCRA detection monitoring).

Explanations of acronyms

RI - Remedial Investigation

FS - Feasibility Study

RD - Remedial Design

RA - Remedial Action

R_vA - Removal Action

Section 1C

DQO No. - Enter the number assigned to this particular DQO. It will be assigned by the FEMP sampling and analysis management coordinator of the prime operating contractor.

DQO Reference No. - Identify all other DQOs that are related to the DQO being prepared.

EXAMPLE

Form C-1. Example DQO Summary Form (Page 4 of 7)

SECTION 2

Media Characterization - Specify the medium being investigated. Only one medium will be considered per DQO. If other media are sampled to support a work phase, a separate DQO for each medium and sampling activity shall be prepared. If **OTHER** is used, include an explanation.

SECTION 3

Data Use with Analytical Support Level (A-E) - Identify data use by activity and the Analytical Support Levels (ASLs) specified for generation of data. (ASLs are described in SCQ Section 2.) More than one activity or ASL may be indicated because an activity may be required to generate data from field measurements to laboratory analysis. Each discrete task requires a separate evaluation of its respective ASL. If **other** is used, include an explanation.

Explanations of terminology

- **Site Characterization** - Determination of the level, extent and location of contamination
- **Risk Assessment** - Endangerment assessment or public health evaluation
- **Evaluation of Alternatives** - Evaluation or screening of remedial alternatives
- **Engineering Design** - Detailed engineering design of remedial actions for the site
- **Monitoring** - During remediation activities, monitoring remedy implementation or establishing baseline conditions for long term monitoring after site remediation

SECTION 4

Section 4A

Regulatory Drivers - Identify regulatory drivers and Applicable or Relevant and Appropriate Requirements (ARAR) associated with the task.

Section 4B

Objective - Provide a clear, concise statement of the reason for the sampling activity (e.g., 1991 amended Consent Agreement requirement, RCRA monitoring, waste characterization). Include imminent health risks associated with sampling effort.

EXAMPLE

Form C-1. Example DQO Summary Form (Page 5 of 7)

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SECTION 5

Site Information - Identify information required to gain an overview of the site and the relative complexity and extent of data requirements. Briefly describe the physical setting, dimensions, and current use of the site.

SECTION 6

Section 6A

Data Types, Analytical Support Level, Equipment Selection, and SCQ Reference - Specify data requirements for establishing the type, degree, extent, and migration characteristics of the contaminants and the required site characteristics.

Explanation

- **Analytical Parameters 1 - 6** - Describe the necessary analysis to acquire data necessary to satisfy task requirements by data quality level and analysis activity. (Full radiological includes uranium.)

  The list of analytes and **other** category are completed according to data requirements.

Section 6B

Equipment Selection and SCQ Reference (ASLs A through E with SCQ) - Identify equipment required to analyze sample parameters and corresponding reference to that equipment by analytical method in Attachment I, the FEMP Laboratory Analytical Methods Manual.

SECTION 7

Section 7A

Sampling Methods - Identify appropriate sampling methods for acquiring required data in accordance with task objectives, including methods for determining sample collection location, frequency, and type, but not the physical collection of the sample.

- **Biased** - Sampling of a specific site area, characteristic, or problem factor based upon site knowledge and/or modeling
- **Composite** - A mixture of a number of grab samples to represent the average properties of the parameters of concern over the extent of the area sampled
- **Environmental** - Media sampling of air, water, soils, and biological environment to determine the extent of contamination
- **Grab** - Discrete samples that are representative of a specific location at a specific point in time

Form C-1. Example DQO Summary Form (Page 6 of 7)

EXAMPLE

- **Grid** - Unbiased sampling that provides a representative estimate of the contamination problem over the entire site
- **Intrusive** - Physically extracting samples from the media being sampled
- **Non-intrusive** - Obtaining data using methods and equipment that do not require physical extraction of material from the media being sampled
- **Phased** - Performing discrete time-phased sampling events and using the information obtained in the previous event to refine the subsequent sampling event
- **Source** - Sampling of actual contamination source

Section 7B

Sample Collection Reference - The procedures to be used in obtaining the required samples are to be defined. The requirement of obtaining background samples is to be provided. This section references the appropriate sample collection procedures and methods to insure the integrity and defensibility of the samples required to satisfy the objective of the task.

SECTION 8

Quality Assurance/Control (QA/QC) Samples - Identify minimum standards for field QA and laboratory quality control samples. Definitions and use of QA samples are defined in SCQ Section 4. Required frequencies of QA/QC samples are specified for each ASL in Table 2-2 (Appendix A). If the number of samples to be collected is not specified, define the frequency in the project-specific plan.

Section 8A

Field QC Samples - Identify QA/QC samples required for sample integrity and data defensibility to be taken in the field.

Section 8B

Laboratory QC Samples - Identify QA/QC samples required for sample integrity and data defensibility to be analyzed at the analytical laboratory.

SECTION 9

Other - Provide other information relevant to the DQO process.

EXAMPLE

Form C-1. Example DQO Summary Form (Page 7 of 7)

000246

Fluor Daniel Fernald
PO Box 538704
Cincinnati, OH 45253-8704

1720

DATE:

TO: (Lab Manager)
COMPANY NAME: (Lab Name)
ADDRESS (Address)
FAX NUMBER: **TELEPHONE:**
FROM: **FAX:** **TELEPHONE:**

RIR ID: 3789 **Priority?: No** **Acknowledgement Due:**
SDG Number: **Final Resolution Due:**

Release Numbers Affected: 1000012345

FDF requests that **you** please submit a signed and dated CLP Inorganic cover page for this release.

If you have any questions or concerns, please call me.

Thank you,

Denise Arico

RESPONSE TO RIR:

RESPONDER'S SIGNATURE:_____
DATE:_____

Requestor:

Form D-1. Example Request for Additional Information/Resubmittal Format, (Page 1 of 2)

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RIR REVIEW SHEET

Date submitted to requestor:

RIR ID	Requestor	Laboratory	Release Number(s)
3789		(Lab Name)	1000012345

The attached is a copy of the response received for the requested RIR.
Upon review, please complete the following as applicable:
The response received was:

- ☐ Acceptable, and the RIR is closed
- ☐ Unacceptable, and the RIR is closed
- ☐ Unacceptable, and the RIR remains open

Actions to be taken:

- ☐ Resubmit RIR (provide text below)
- ☐ Resubmit RIR with attachment(s)
- ☐ Request conference call with TR and Laboratory

Requestor Signature **Date**

PLEASE RETURN TO RIR COORDINATOR UPON COMPLETION OF THE ABOVE

RIR COORDINATOR USE ONLY

Distribution, check as applicable:

- ☐ Records Management, original
- ☐ RIR file, copy
- ☐ Date Entry, copy
- ☐ Data Validation, copy
- ☐ Other
- ☐ None

EXAMPLE

Form D-1. Example Request for Additional Information/Resubmittal Format, (Page 2 of 2)

Appendix C

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APPENDIX C

DATA QUALITY OBJECTIVES

APPENDIX C DATA QUALITY OBJECTIVES

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Appendix C

DATA QUALITY OBJECTIVES

E- 1720

C.1 INTRODUCTION

DOE Orders, environmental regulations, the FEMP Federal Facilities Compliance Agreement, Ohio Environmental Protection Agency Director's Findings and Orders, and the USEPA/DOE 1991 Amended Consent Agreement require sampling and analysis by specific methods and procedures for analytes of FEMP environmental media. All sampling and analysis programs at the FEMP ultimately contribute toward fulfillment of the site mission - the restoration of the environment. The samples collected will fulfill one of these purposes:

A. Identification of potential contamination (e.g., routine monitoring programs, air and water permit verification, investigation of suspect source areas, sampling of decommissioned equipment and materials);

B. Confirmation of contamination (e.g., authoritative sampling of spill areas, collection of samples from areas targeted during screening investigations, sampling of suspected asbestos-containing materials);

C. Characterization of contamination (e.g., delineation of source areas or plumes by random, authoritative, or combination methods; sampling of containerized waste);

D. Determination of environmental and human health risks (e.g., risk assessments and environmental assessments);

E. Evaluation of remedial alternatives (e.g., treatability studies);

F. Design of remedial alternatives (e.g., remedial design);

G. Monitoring of response actions (e.g., monitoring during removal actions, confirmation sampling to evaluate the effectiveness of a response action);

H. Monitoring to comply with regulations (e.g., 1991 Amended Consent Agreement, CERCLA, NPDES, RCRA);

I. Determination of background concentration of contaminants;

J. Determination that cleanup levels have been achieved and that the response action can be terminated, or that the operations and maintenance phase can begin.

Data Quality Objectives (DQOs) are scoping and planning tools applicable to every environmental sample collection effort and are a necessary step in the generation of a project-specific plan. DQOs are quantitative and qualitative descriptions of the data required for one of these purposes. As target values for data quality, they are not necessarily criteria for acceptance or rejection of data. The DQO process generates a logical set of decisions that determine whether collection of samples is necessary; specifies the types of samples to collect,

including quality control samples; describes the design of the sample collection effort, including the number of samples; specifies analytical requirements, including precision, accuracy, comparability, completeness, and sensitivity of the method; and determines the overall confidence level that the resultant data will meet project requirements.

Decisions should be made so that existing data gaps are filled and the resulting data will meet the requirements of its intended use. All steps of the DQO logic flow process should be completed in sequence and be appropriately documented.

Analytical Support Levels (ASLs) must be specified for each analysis. See SCQ Section 2.3.4 for a description of FEMP ASLs and example uses. All DQOs will be approved (see Section 1.5) and documented in a separate document controlled by the FEMP DQO coordinator.

C.2 DATA QUALITY OBJECTIVE LOGIC FLOW PROCESS

The DQO logic flow process presents the rationale for deciding what data are necessary, the quality and type of data required, the data's technical defensibility, and the understanding and minimization of risk throughout the remediation process (U.S. Environmental Protection Agency, 1994f).

The logic flow will help to identify areas of concern, the selection of equipment, quality assurance requirements, and analytical support levels. The logic statement is a DQO supporting document that is kept on file. This logic flow process has seven steps.

Step 1. State the problem;

Step 2. Identify the decision;

Step 3. Identify inputs to the decision;

Step 4. Define the study boundaries;

Step 5. Develop a decision rule;

Step 6. Specify limits on decision errors;

Step 7. Optimize the design for obtaining data.

These steps as defined by USEPA (1994b) are presented in paragraphs C.2.1 through C.2.7.

The steps listed above may not be applicable in all instances, such as routine monitoring plans. Therefore, if a step does not apply, indicate that it is not applicable and provide detailed, complete justification in the logic flow. Do not simply leave a step blank.

C.2.1 State the Problem (Step 1)

This step describes problem definition and any resource, time, or other practical limits on data collection. The purpose of step 1 is to evaluate existing knowledge about the problem and identify available resources. By carefully defining the problem early in the planning process, the

planning team can ultimately save time and money. In addition, refinements to the way in which the problem is stated are often made when the planning team better understands the implications of the original problem definition. Items to be addressed include, but are not limited to, the following:

A. Identification of the planning team, including senior program staff, technical experts, senior managers (decision makers) whose planning input will be needed during the process to ensure implementation of the study findings and a statistician (or someone with statistical expertise).

B. Specification of resource or time limits for this study, including the anticipated budget and availability of key personnel. Identify obvious practical considerations, such as time of year when data collection is not possible. These practical considerations will be expanded upon later in the process.

C. Statement of the problem, including the following elements:

1. Description of the problem as it is currently understood;

2. Consideration of possible regulatory, customer, or stakeholder concerns to the problem;

3. Identification, review, and evaluation of existing information including preliminary studies, and identification of the source and reliability of the information;

4. Literature searches and evaluation of on-going studies to ensure that the problem was not previously resolved;

5. Depending on the complexity of the problem, organization of the problem into components, each of which could be addressed by a separate study. Try to prioritize these components for further planning.

D. Determination of whether new data are critical to resolving this problem.

C.2.2 Identify the Decision (Step 2)

Step 2 is identification of a primary decision that will address the concern, a list of alternate actions that address the problem, and the actions that will result. If the planning team believes actions may be taken based on the study data, but cannot identify the specific actions, then try to elicit possible actions from the decision maker in order to understand the intended use of the data. The decision should be stated as narrowly and specifically as possible. General statements of goals or objectives are not adequate.

Items to be addressed include, but are not limited to, the following as appropriate:

A. State the decision so that the role of data is clear in deciding action to be taken.

1. Describe initial ideas on approaches to resolving the problem.

2. State the range of actions that may be taken based on the outcome of the study. Consider agency policies that may influence these actions (e.g., agency emphasis on pollution prevention instead of source containment or treatment).

3. Specify criteria for taking these actions as "if . . ., then . . ." scenarios when possible. Specify how unknown criteria will be established.

4. State the decision as a choice among alternative courses of action that will resolve one or more components of the problem.

B. If several separate decisions must be made to address a component of the problem, begin by mapping out a decision or logic tree. This exercise should reveal the relationship among decisions. Try to find the relative importance of each decision to the complete problem. Decide which decisions require new environmental data and the importance of those data to the decision. Use the DQO process for each decision that requires new data starting with the most important decision. In certain cases, go back and reflect further on the problem.

The decision maker (data user) should be involved in step 2 and is encouraged to provide general guidance for taking action.

C.2.3 Identify Inputs to the Decision (Step 3)

This step discusses identification of environmental variables or characteristics that serve as criteria for taking action and other information needed to make the decision. During step 3 the planning team should identify all variables or environmental characteristics that may be relevant to the decision and then focus on those that must be measured to provide information needed for the decision. Items to address shall include, but are not limited to, the following as appropriate:

A. Development of a list of variables or environmental characteristics that may affect the decision and separation of those that must be measured to make the decision (which action to take). Identify those variables that together will provide sufficient information to make the decision.

B. Specification of criteria for taking action. Identify information from other studies and regulations needed to establish the criteria for taking action.

C. Confirmation that each variable (environmental characteristic) can be measured. If it cannot, decide if it is reasonable to make assumptions about the variable to draw conclusions without data. If the necessary assumptions cannot be defended, conduct a pilot study or select an alternative approach that involves different variables that are measurable. If no practical approach can be developed, consider shifting the effort to develop the research tools needed to address the problem. Consider not conducting the study at this time.

C.2.4 Define the Study Boundaries (Step 4)

This step concerns development of a statement addressing the domain of the decision. The purpose of step 4 is to define the population for which the decision will be made (people,

objects, portions of media) so that it is clear what belongs in this population and what the boundaries on this population are (area or volume and time period).

When the population consists of people and objects, it is important to define space and time boundaries and other characteristics to indicate what belongs in and out of the population. Alternatively, the population may consist of a continuous medium (air, water, soil). In this case, the portion of the medium that belongs in the population can usually be defined just by spatial and temporal boundaries, although other characteristics may help to define it further.

Sampling from this population may be necessary to make inferences about the population as a whole. Sometimes it is not possible to sample from the entire population. In this case, either make inferences only to that portion of the population that can be measured or make assumptions that allow inference to the entire population. Statistical analysis will be implemented based upon available data on the population.

Items to address include, but are not limited to, the following as appropriate:

A. Specify the population for which the decision will be made so that it is clear what belongs in this population.

B. Define the spatial and temporal boundaries of this population.

C. Define additional characteristics needed to decide what belongs in the population.

D. If applicable, specify the smallest sub-population for which the decision will be made. The cost of the study usually increases for each sub-population group because more samples are required to estimate the variables within each group.

E. Make sure that practical considerations (step 1) are consistent with these boundaries.

C.2.5 Develop a Decision Rule (Step 5)

This step describes steps in developing a statement to define how environmental data will be summarized and used to make the decision. After the data for a study are collected, they are summarized to form a result for the study which is compared to the criteria for taking action to make the decision. The purpose of step 5 is to integrate output from previous steps into a single statement specifying how environmental data will be summarized and used to make the decision, including quantitative criteria for determining what action to take.

It is important to have staff with statistical expertise involved in this step to ensure that the logic statement (decision rule) is written in a way that leads to an efficient sample collection design.

Items to be addressed include, but are not limited to, the following as appropriate:

A. Describe the intended study result (the way in which the data will be summarized) and how the result will be calculated (e.g., mean, range, maximum).

B. Develop a decision rule as an "if . . ., then . . ." statement that incorporates the study result, criteria for taking action, and actions that will be taken under various possible scenarios.

Example: If, in the monthly sample, X analyte exceeds Y ppm for two sampling periods, increase sample frequency to weekly.

In this example, the study result is the X analyte, the criterion for taking action is the maximum allowable concentration of Y ppm being exceeded in two out of four consecutive sampling periods, and the actions are to increase the sampling analysis frequency to weekly.

C. Confirm that all data collected are necessary. If they are not, define a more narrowly-focused set of input variables.

D. Consider uses of the data by other FEMP programs. For example, if the primary reason for collecting the data is to determine the nature and extent of potential groundwater contamination, could the same data be used in a risk assessment? If so, the DQOs should include the additional potential uses of the data.

C.2.6 Specify Limits on Decision Errors (Step 6)

This step discusses the development of constraints on uncertainty. The decision maker's expressed need to control decision errors should be stated as limits on the acceptable probability of making an incorrect decision based on the study findings. These limits on uncertainty may be expressed as acceptable false positive and false negative error rates.

There is always some error in environmental data and as a result, some degree of uncertainty will exist in any decision based on these data. The limits on uncertainty should be based on careful consideration of the consequences of incorrect conclusions. The planning team will need to estimate the economic, health, and ecological consequences of decision errors. Also, the decision maker will need to consider the political and social consequences when setting limits on uncertainty.

The decision maker (data user) needs to be actively involved in the specification of limits on uncertainty. In addition, the planning team should work with a statistician during step 6 to ensure that the limits are reasonable and complete.

There are two types of decision errors that may occur in studies that will be used to support a decision on whether to take action: false positives and false negatives. The definition of what constitutes false positive and false negative errors depends on how the decision is defined. Consult a statistician if there are questions.

Limits on uncertainty for these studies can be expressed as limits on the acceptable rates of false positive and false negative errors.

The uncertainty associated with data and the inherent natural variability make it unreasonable (very expensive) to find small differences in an environmental variable. When true conditions are very close to the criterion for taking action, it is difficult (if not impossible) to determine if

conditions are above or below the criterion. To respond to this problem, consider defining a region of indifference where either decision is acceptable. This region may be placed around, at, or below the criteria for taking action, depending on the decision being made. The width of this interval can vary, but generally, the cost of the study increases with a narrower region of indifference.

Items to address shall include, but are not limited to, the following as appropriate:

A. Define false positive (f(+)) and false negative (f(-)) errors for the decision (decision errors) and describe scenarios in which each type of error might take place.

B. Order the importance of expected economic, ecological, health, political and social consequences according to the level of concern the decision maker has with each. Consider the possible regulatory, customer, or stakeholder concerns.

C. Determine if false positive or false negative errors are of greater concern.

D. Determine whether the level of concern for either type of decision error depends on the magnitude of the error (e.g., a case where there is a threshold below which a decision error leads to economic consequences and above which it also leads to adverse health effects). The decision maker should be more concerned about a larger decision error that has both health and economic consequences.

E. Consider the estimated magnitude of the expected consequences and decide what magnitude of false positive and false negative errors would be almost always, often, sometimes, or almost never acceptable. It may not be necessary to assign values to all four categories.

F. Establish, with statistical advice, an acceptable probability for the occurrence of each of these errors. Also, specify a region of indifference (the area in which you choose not to control the probability of an incorrect outcome because, under the stated conditions, either decision is acceptable). This region may be narrow or broad and must be acceptable to the decision maker.

G. Combine the probability statements into a formal statement of the levels of uncertainty that can be tolerated in the results. This formal statement may take the form of a table or graph.

C.2.7 Optimize the Design for Obtaining Data (Step 7)

This step addresses how to optimize data collection by identifying the most efficient plan that will achieve the desired constraints on uncertainty. Items to address shall include, but are not limited to, the following, as appropriate:

A. What are the estimated variabilities and distributions of site-related contaminants of potential concern?

B. Based on existing estimates of variabilities and distributions of contaminants of potential concern and relative costs of proposed sampling and analysis options, what is

the lowest cost sampling and analysis plan that will achieve the desired data and constraints on uncertainty (i.e., how many samples will be collected; how will sampling points be identified or chosen; what is the sampling method; how frequently will samples be collected; what level of Quality Control is required; what are the requirements for precision, accuracy, sensitivity, and completeness; and what analytical methods are appropriate)?

C.2.8 Summary

Using the information of the logic flow, state the analytical support levels required and briefly explain the rationale. Analytical support levels are specified based on the intended use of the data. In addition, identify the analytes, quality control and quality assurance samples required to support the analytical support levels identified. List the summary information on the bottom of the logic flow document.

C.3 THE DATA QUALITY OBJECTIVE SUMMARY FORM

A FEMP DQO Summary Form, FS-F-5204 (Form C-1, Appendix B), was designed using USEPA guidance (U.S. Environmental Protection Agency, 1987b). This form shall be completed to supplement the documentation for DQO development and shall become a part of the DQO package.

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Appendix D

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APPENDIX D

DATA VALIDATION PLAN

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DATA VALIDATION PLAN

D.1 INTRODUCTION

Data generated for Fernald Environmental Management Project (FEMP) activities is validated to ensure that it complies with data quality objectives (DQOs) defined in Appendix C and with the requirements of the appropriate project-specific plan (PSP) as described in Section 4 and to assess the data's usability for the intended purpose. Implementation of procedures in this data validation plan is one step in providing quality data on which to base definitive decisions at a known level of confidence.

Data validation procedures generally fall into two categories depending upon whether the data in question are field- or laboratory-generated. Field data validation consists of verifying PSP compliance and appropriate documentation of field activities. The laboratory data validation process includes assessment of data package completeness to ensure that data generated are at the specified Analytical Support Level (ASL).

D.1.1 Purpose

This data validation plan has been developed to ensure prescribed data validation procedures are implemented in a timely, independent, and systematic process thereby ensuring FEMP data are in compliance with specified criteria and are adequate for their intended use.

D.1.2 Scope

This data validation plan establishes requirements for validating FEMP data for all topics listed in the table of contents.

D.2 TECHNICAL APPROACH

The following technical approach will be applied to ensure that data validation activities are technically sound and carried out in a consistent manner.

D.2.1 Data Validation Guidance

Guidance herein meets technical, regulatory, and quality assurance (QA) requirements and guidance of the documents listed in the following section.

D.2.2 Checklists

Checklists are developed for reviewing data and documenting the validation process. Checklists may either be on hard copy or automated. When possible, data validation shall be conducted electronically.

Data validation checklists are developed based on the following documents:

- FEMP DQOs (Appendix C);
- *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, (U.S. Environmental Protection Agency, February 1994d);*

- *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review*, (U.S. Environmental Protection Agency, February 1994e);

- QA acceptance criteria for radiochemical methods (e.g., *Guidance for Radiochemical Data Validation*, U.S. Department of Energy, 1995b; and *Radiochemical Data Verification and Validation*, Lockheed Martin Energy Systems, 1995).

Data review checklists contain questions and specific guidance on information to be provided for each major measurement parameter. Completion of the checklist will reveal missing data, anomalous data or lack of criteria compliance that may threaten data integrity.

D.2.2.1 **Field Checklist Development**. Checklists for validating field data packages are determined by the requirements(including QC samples)specified in the DQO and PSP and by the SCQ requirements for daily logs (see Sections 5.1 and 6.1) for the field activities that generated the data (see Section J.4.1.1-10 and Appendix K). The field validator shall review the SCQ, PSP, and DQO to identify all field records required for the field data package. The standard FEMP field data validation checklist (available as an electronic file) shall than be modified to include all required field records and QC samples.

D.2.2.2 **Laboratory Checklist Development**. Checklists for validating analytical results shall be directly traceable to appropriate requirements and industry standards [e.g., American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), American Society of Mechanical Engineers (ASME) and/or USEPA validation guidelines]. Laboratory data validation criteria in each checklist are determined by analytical methods and ASLs specified for the data. A checklist will also provide direction regarding qualification of any affected data.

D.2.3 Analytical Support Levels

Reporting and deliverable requirements are determined by the ASL specified for each analysis. A graded approach shall be applied to determine the extent of validation effort required and usability of data generated based on the intended use of data and required level of confidence.

D.2.4 Data Qualifier Codes

Codes shall be assigned to data during the validation process to identify the confidence level of qualitative identification and quantitation. Most qualifiers are taken from the following references:

A. *"USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review,"* (U.S. Environmental Protection Agency, February 1994d);

B. *"USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review,"* (U.S. Environmental Protection Agency, February 1994e);

C. *"Guidance for Radiochemical Data Validation,"* (U.S. Department of Energy, 1995b);

D. *"American National Standard Measurement and Associated Instrument Quality Assurance for Radioassay Laboratories,"* ANSI N42.23-1996, American National Standards Institute, 1997.

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E. *"DOE Methods for Evaluating Environmental and Waste Management Samples,"* DOE/EM-0089T, U.S. Department of Energy, 1993.

The following are three sets of qualifier codes. The first set, identified as the FEMP data validation process codes, is used by data validation groups to qualify the final data results before the data are used. The second and third sets, identified respectively as laboratory codes for organic data and laboratory codes for metals and cyanide data, are to be used by any laboratory performing organic or metal/cyanide analyses for the FEMP. The meaning of each symbol depends upon the set of qualifier codes being used.

D.2.4.1 FEMP Data Validation Process Codes. The following qualifier code symbols and definitions shall be used by validators involved in the FEMP data validation process.

J The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample, but may not be consistent with amount present in the environmental sample due to deficiencies in the sample collection or analysis process. The data are considered quantitatively estimated. Data are useable for making decisions.

R The sample result was unusable due to serious deficiencies in the sample analysis, the instrument calibration, and/or the accompanying quality control analyses. The presence or absence of the analyte cannot be verified. Resampling and/or reanalysis are necessary to confirm or deny presence of the analyte.

RP Data is unusable for the intended purpose for which it was collected. The analysis is of sufficient quality to qualitatively demonstrate the presence of the analyte. However, quantitative results are not sufficiently accurate, precise, or sensitive to meet the objectives of the sampling program.

U Analyses were performed, but the analyte was not detected above the reported sample quantitation limit. Associated numerical value indicates the approximate concentration above which the analyte was determined not to be present.

UJ The analyte was not detected above the quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample. This is a combination of the "U" and "J" qualifiers. The detection limit is considered estimated based on quality control (QC) considerations. If a decision requires quantitation of the analyte close to the associated numerical level, reanalysis or alternative analytical methods should be considered.

N The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification." The result can be used for decision-making purposes, but further information may be necessary to confidently identify the analyte in this sample.

NJ The analysis indicates the presence of an analyte that has been "tentatively identified" and the associated numerical value represents its approximate concentration. This

qualifier indicates the presumptive presence of the analyte, but the result can only be considered estimated. This qualifier is not used in typical inorganic analyses, but could be used to qualify organic or radiochemistry data due to spectral interpretation problems.

NV The data were not validated. The reasons for nonvalidation are given in the Data Validation Report associated with the data set. This code is for informational purposes only, and is normally applied when some results within a release/fraction are validated but others are not.

Z This qualifier indicates that a more technically useable/representative result for the analyte exists in another analysis of the sample (a dilution, re-extraction or reinjection). The data should not be used. This code is for informational purposes.

- The data validator has not assigned a qualifier code to the positive result, signifying that the result is confident as reported. (When an undetected result is not further qualified, the validator will enter the "U" qualifier in the qualifier column.)

D.2.4.2 **Laboratory Codes for Organic Data.** The laboratory may assign the following qualifier codes when reporting data from organic analyses.

B The compound is detected in an associated lab blank.

J The result was detected above the PQL but below the CRDL, and should be considered estimated.

E The result is above the calibration range of the instrument.

U Analyses were performed, but the analyte was not detected above the reported sample quantitation limit.

D The result is reported from a diluted analysis of the original sample.

X The result was identified and quantified manually (as opposed to software identification).

P The pesticide result exhibited a significant degree of imprecision between the two chromatographic columns.

C This pesticide or polychlorinated biphenyl (PCB) identification was confirmed by the gas chromatography/mass spectroscopy semivolatile analysis of the same sample.

A For USEPA Contract Laboratory Program analyses only. The tentatively identified compound (TIC) is a suspected aldol condensation product.

H The sample was analyzed after the maximum holding time had elapsed.

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G The analyte detected is not from gasoline or diesel fuel, but is believed to be some other combination of hydrocarbons.

N The "N" qualifier indicates the presumptive presence of the analyte (i.e., TICs). The result can be used for decision-making purposes, but further information may be necessary to confidently identify the analyte in this sample.

D.2.4.3 **Laboratory Codes for Metals and Cyanide Data.** The laboratory may assign the following qualifier codes when reporting data from metals and cyanide analyses. These codes will be examined by data validators and may be used to help them requalify the data.

B Reported value was obtained from a reading that was less than the contract required detection limit (CRDL) but greater than or equal to the instrument detection limit (IDL).

E Normally used when serial dilution is performed in ICP analysis. The result is considered estimated because of possible matrix effects demonstrated by the serial dilution analysis. Also used in place of "W" (see below) to indicate that the GFAA post digestion spike recovery was less than 30 percent.

M GFAA duplicate injection precision was not met for results above the CRDL.

N Spiked sample recovery was not within control limits.

S Reported value was determined by the method of standard additions (MSA), and the correlation was greater than or equal to 0.995.

W Post-digestion spike for GFAA analysis is out of control limits (85 to 115 percent), while sample absorbance is less than 50 percent of spike absorbance.

* Duplicate analysis was not within control limits.

+ Correlation coefficient for this result reported from the MSA was less than 0.995.

No combination of "S", "W", or "+" shall appear in the same field for an analyte. Use of these qualifiers is mutually exclusive.

D.2.5 Sequence of Data Validation Activities

Validation activities for field sample collection and laboratory analysis data shall be accomplished in the following sequence. Appendix D.5 provides complete field data validation guidance. Appendices D.6 through D.12 provide complete laboratory analysis data validation guidance.

D.2.5.1 **Field Data Validation.** Validation of field activities, including results of field analytical methods for ASL A, shall be performed in the following sequence.

A. Prior to beginning data validation, ensure that the PSP, custody record, and daily log, as well as field instrument calibration logs, are available. Sample numbers on the custody record should be compared to the sample collection logs to make sure the numbers are identical.

B. Review completed sampling data in the field log and associated documentation to ensure that forms specified in PSP and the SCQ have been properly completed and submitted.

C. If field validation checklist requirements are not met, itemize the deficiencies on the checklist, and request the missing information by submitting a copy of the checklist to the appropriate sampling group.

D. Report field data validation results to the project manager by hard copy or electronic data transfer.

E. Retain copies of completed review checklists in the data quality organization files. Transfer original field forms, and the field validation checklist files for retention in the FEMP project files.

D.2.5.2 **Laboratory Analysis Validation**. Laboratory analysis data validation activities shall be performed in the following sequence. At each step, WISDM (Windows Integrated Sample and Data Management) and/or other appropriate tracking systems will be updated by the responsible parties.

A. Obtain copy of completed laboratory certificate-of-analysis data packages. A completeness review must be performed.

B. Review data sets using laboratory analysis review instructions, procedures, and checklists.

C. If laboratory analyses or results are incomplete or not understandable, initiate the RIR process specified in Appendix D.2.6.

D. Submit deliverables (completed checklists) with support documentation, summary forms of qualifiers with qualified data sheets and support documentation, and any RIRs to the senior reviewer for concurrence.

E. After the concurrence process is complete, submit concurred package to the data validation support group to be copied and sent to the appropriate parties.

F. Retain copies of completed review checklists in the data quality organization files until the entire project is complete and finalized.

G. Where applicable, confirm accuracy of information entered in site database by comparing retained copies of completed review checklists with a database printout.

D.2.6 Request for Additional Information/Resubmittal (RIR)

During compliance screening and data validation, there may be questions concerning potential errors and/or lack of expected information related to the following items:

A. Project-specific plan;

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B. Sample collection/tracking;

C. Sample holding times;

D. Calibration requirements;

E. Quality control procedures;

F. Compliance with measurement procedures, Appendix G performance specifications, or method procedures;

G. Laboratory contamination.

If necessary, the following formal request (D.2.6.1) shall be implemented to obtain missing information, new copies of illegible information, reanalyses, and/or corrected information data (i.e., recalculations).

D.2.6.1 **Initiation of RIR.** If necessary, the validator or other reviewer shall initiate a Request for Additional Information/Resubmittal (RIR). Each group (e.g., the FEMP data quality organization, FEMP laboratory, offsite laboratory) will follow a written procedure for complying with the FEMP's computerized RIR system, known as WISDM.

A. The RIR form (Appendix B, Form D-1) generated by WISDM shall be used.

B. The RIR form shall have the following items completed:

1. Narrative describing the specific problem and required actions to resolve/clarify the issue;

2. Date;

3. Response narrative;

4. Dated signature of designated response person;

5. Case number;

6. Requestor name and group affiliation;

7. Priority.

D.2.6.2 **Resolution of RIR.** The completed RIR form shall be attached to the missing and/or additional information submittal. The person identified by the local group procedure(s) will process the missing and/or additional information submittal package as well as track and file these requests.

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D.2.6.3 Completion of RIR. Local group procedures shall reflect the following elements to ensure successful completion of the RIR process. The procedures shall:

A. Identify all requests submitted and whether successful comment resolution was achieved;

B. Include the ability to track and retrieve requests on demand;

C. Include instruction on how response(s) to the request will be processed;

D. Require that the original copy of an RIR be filed with the applicable original data package.

D.2.7 Data Validation Documentation
All documentation of the data validation process shall become part of FEMP files and shall include the following:

A. Original project documentation, validation documentation, and reports summarizing or evaluating validation effort;

B. Data validation team reports to the project manager that document progress of validation;

C. Surveillance reports.

D.2.8 Surveillance and Audit
The data validation process shall be subject to periodic surveillance and audit by the designated FEMP QA organization to monitor and document data validation team compliance with the data validation plan and to assess data validation team effectiveness.

D.3 ORGANIZATIONAL RESPONSIBILITIES AND FUNCTIONS
The data validation team members have the authority to access and review all required sampling and analytical information, qualify the data results if necessary, summarize the findings for each set of data examined, assign data qualifiers, and transmit the data validation package to the user. The following sections outline specific functions associated with each organizational responsibility.

It is not a requirement that all data validation functions be performed by the data validation group of the designated FEMP data quality organization. Validation functions can be done by other qualified groups at the direction of the FEMP data generating group. However, the data validators shall be independent of the data user and the laboratory producing the data, and they must meet the requirements of this SCQ and the applicable sitewide data validation procedure. FEMP data validators must meet the training requirements listed in the applicable FEMP data validation procedure. Training requirements for subcontractor validators are listed within the individual contracts.

The FEMP sample management organization (including analytical project managers and subcontract technical representatives) provides the only direct interface between FEMP

projects and subcontractor laboratories. The sample management organization has the responsibility for supplying required data/information to the data validation team for the resolution of RIRs.

D.3.1 FEMP Data Quality Organization Manager

The FEMP data quality organization manager is responsible for: 1720

A. The planning, assignment, direction, coordination, control and reporting of data validation activities and results;

B. Ensuring adequate training of data validation personnel;

C. Development of procedures and checklists;

D. Review and approval of data validation summary reports;

E. Providing guidance as requested to project managers for the development of DQOs, PSPs, and/or workplans.

D.3.2 Field Data Validation Personnel

Field data validation personnel shall perform the following activities in accordance with supervisory guidance and the data validation plan:

A. Examine field paperwork to ensure compliance to and consistency with data validation procedural requirements and project-specific requirements, such as the PSP, DQO, workplan, SCQ, and standard operating procedures.

B. Identify nonconformances, evaluate corrective actions identified by sampling personnel for appropriateness, and follow up on corrective actions as needed.

C. Perform an assessment of the sample collection activities for accuracy, precision, and completeness, taking into account the overall project objectives, background data points, and field quality control samples to determine if the PSP objectives were met.

D. Maintain a record of field validation activities performed in the data quality group and sitewide computer tracking programs.

E. Track field issues discovered in validation to minimize reoccurrences.

D.3.3 Laboratory Data Validation Personnel

Laboratory data validation personnel shall be responsible for performing the following activities in accordance with supervisory guidance and the data validation plan:

A. Assess the data and apply qualifiers to designate level of reliability;

B. Complete review checklists;

C. Prepare RIR forms when necessary;

D. Prepare summary reports of data validation results;

E. Provide technical assistance to offsite and onsite organizations that audit data producers.

D.4 DATA VALIDATION AND REPORTS

Data validation begins with a review of data by a data validator who is independent of the data user, the data acquisition process, and the analytical laboratory. The review shall confirm whether the data was generated as specified. The data review also shall verify whether the analytical results were processed and reported properly, and the reviewer will qualify the data based on how well it fulfills its intended purpose.

D.4.1 Overview of Data Validation

The following describes the basic approach to be used for validating data.

A. The data package shall include the following, as applicable:

1. Raw data;
2. Data sheets and QC summary forms;
3. Strip charts;
4. Dates of sample receipt, preparation, and analysis;
5. Lab bench sheets;
6. Computer input/output;
7. Calculations;
8. Sources for input parameters such as response factors;
9. Custody documentation;
10. Case narrative.

B. Data package items shall be identified so that the analyses and instrument QC can be associated with the appropriate FEMP samples.

C. The independent validator shall review the data package for the following, as applicable:

1. Appropriateness of methodology;
2. Appropriateness and correctness of equations;

3. Correctness of numerical output, including correct units and consistent rounding of numerical values;

4. Numerical correctness of calculations (by repeating computations);

5. Correct interpretation of strip charts, spectra, and other instrument data;

6. Appropriate detection limits;

7. QC acceptance criteria;

8. Usability for determining project objectives.

D. The validator shall qualify (i.e., assign data validation qualifier codes) analytical results based on specific procedural instructions, complete the appropriate checklists, and generate summary reports.

Validators will include all documents, calculations, and entries which are specified to be included in validation package per the specific data validation procedure. All documents needed to support qualification of any data should be included in the validation package. No correction of laboratory-reported data is to be made by validator without written confirmation from the laboratory. A RIR shall be initiated where information is unclear for field or laboratory personnel to provide corrected versions of the errors found and to officially add these corrections to the data package.

If the data have been processed using a computer, the validator shall check the input accuracy. Generally, a percentage of the computer-processed computations shall be checked for output accuracy. If a calculation error is found, all similar computations shall be checked.

D.4.2 Data Validation Report Requirements

Data validation reports include the following components:

A. A completed checklist. This checklist is a step by step description of the validation process formatted into a sequence of questions. Each question has standard (no action required) and nonstandard (answers identified) responses. Following the checklist is a comments section which explains the impact of nonstandard checklist answers on data quality. Support documentation consisting of laboratory summary reports, raw data, laboratory and/or validator calculations, and other material required to verify the correctness of the checklist answers and comments shall be attached to the checklist.

B. One or more summary forms. The summary forms list the ASL of the data, release number, sample delivery group number or other identifying tracking numbers, project name, type of analysis, sample numbers, analyte names, qualified numerical results, validation qualifier(s) applied, reasoning for qualification, signature and date completed for both validator, senior reviewer and verifier of subcontractor deliverables, as applicable. Support documentation consisting of validated data sheets, laboratory deliverables, and/or other materials needed to verify the correctness of the applied qualifiers shall be attached to the summary form(s).

D.4.3 Concurrence Review of Data Validation Summary Reports

Data validation summary reports must be reviewed to ensure that correct procedures were followed, that all required items are present, the logic used is consistent and correct (e.g., application of data validation qualifier codes), and to spot-check items examined and verified by the data validator. This review shall be completed BEFORE qualifiers are entered into the database system and the data package is sent for transmission to the user.

Any problems found during this review shall be documented and ultimately resolved by the original validator. The reviewer shall approve the summary report by signing and dating the report.

D.5 FIELD DATA VALIDATION

Field data validation guidance is based on the Remedial Investigation/ Feasibility Study (RI/FS) Data Validation Plan (an addendum to the RI/FS Quality Assurance Project Plan, U.S. Department of Energy, 1988b). The purpose of field data validation is to ensure that sample collection and documentation was in accordance with DQOs, PSPs, and the SCQ.

Field measurements and observations generated at the FEMP have consisted primarily of radiological screening data; field temperature, pH, and specific conductance data; and data associated with soil boring advancement, monitoring well installation and development, geophysical logging, and soil classification. These data shall be validated by a review of project documentation to ensure that forms specified in PSPs are complete and comply with SCQ requirements and that documentation exists for required instrument calibration.

D.5.1 General Instructions

The following general guidelines shall be applied throughout the field data validation process.

A. Indicate all documents reviewed on the field validation.

B. Maintain traceability of each document reviewed.

C. Use the field data validation checklist.

D. Follow applicable instructions, guidelines and procedures referenced in other appendices and sections of the SCQ and/or the PSP, as well as any other reference documents specified in the group-specific procedure.

E. Supply suggested recommendations to analytical data validation personnel, or supply potential qualifications that, based on field data validation review, should be applied to the data.

D.5.2 Guidance for Field Data Validation

The FEMP data quality organization manager is responsible for the development, implementation and maintenance of specific field data validation procedures. Refer to the most recent version of this controlled document for specific field data validation instructions.

D.5.2.1 <u>Field Logs</u>. The validator shall review all sampling event logs and documentation to assure completeness and compliance with the PSP, DQO, and SCQ. This check shall verify

that field measuring instruments [e.g., water quality meter and sensors, pH meters, conductivity meters, flame-ionization detectors (FID), and photo-ionization detectors (PID)] were calibrated in accordance with SCQ and PSP requirements. Additionally, the check shall assure the comparability of documented information on the different logs and chain-of-custody forms. Discrepancies as well as fulfillment of requirements shall be indicated on the checklist.

D.6 VOLATILE AND SEMIVOLATILE ORGANIC DATA VALIDATION GUIDANCE FOR ASLs B, C, AND D

Volatile (VOA) and semivolatile (SVOA) organic data validation guidance is based on *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review* (U.S. Environmental Protection Agency, 1994e). This section describes procedures for validation of data that must be in compliance with ASL C and D. For organic data validation, use the organic data validation checklist. Complete the checklist by examining the data package to the appropriate ASL and list qualifiers on the organic data validation summary report.

D.6.1 Guidelines for ASL B Data

There are two sublevels of ASL B data, and they require different validation guidance. If standard, predefined ASL B analysis is specified, QC information shall be reviewed and compared to the QC acceptance criteria of the individual methods. The portions of ASL C and D guidance that are applicable (e.g., matrix spike/matrix spike duplicate, blanks, laboratory control samples) shall be used as the outline for review. The specific acceptance criteria from the Appendix G method shall be used.

If the samples taken are user-defined as ASL B, they shall be validated in accordance with requirements in the PSP for that sampling event. When the data user specifies the quality control (QC) requirements, the validation requirements shall also be specified in the PSP. The data validator must review the PSP to ensure compliance with PSP requirements.

D.6.1.1 Holding Times and Preservation

D.6.1.1.1 Criteria. For both water and soil matrices, samples analyzed for purgeables and/or extractables shall be properly preserved and analyzed within the holding times specified in Table 6-1 (Appendix A).

D.6.1.1.2 Guidance for VOAs.

A. Establish actual preservation and holding times by comparing sample collection dates on the chain of custody with dates of analysis and/or extraction.

B. If the samples were not appropriately preserved, use professional judgement to qualify the data.

C. If holding times were exceeded either on the first analysis or upon reanalysis, qualify results as estimated (J/UJ). Document that holding times were exceeded. The reviewer may determine that undetected data should be qualified unusable (R) if the

holding times exceeded two times the standard holding time. Indicate in the validation report and on the summary forms that these results, which have exceeded hold times, may be biased low.

D. Toxicity Characteristic Leaching Procedure (TCLP) analysis shall be completed within 28 days of the TCLP extraction.

D.6.1.1.3 Guidance for SVOAs.

A. Establish actual preservation and holding times by comparing sample collection dates on the chain of custody with dates of analysis and/or extraction.

B. If the samples were not appropriately preserved, use professional judgement to qualify the data.

C. For extractions performed 15 to 21 days after sample collection for solids and 8 to 14 days after sample collection for liquids, qualify results as estimated (J/UJ).

D. For extractions performed more than 21 days after sample collection for solids or more than 14 days after sample collection for liquids, qualify detected results as estimated (J). Qualify undetected early eluting SVOAs (phenol through pentachlorophenol) as unusable (R) and qualify undetected late eluting SVOAs (eluting after pentachlorophenol) as estimated (UJ). Note in the data validation report that extended holding times have little effect on late eluting polynuclear aromatic hydrocarbons (PAHs) or their detection limits. This is due to the fact that they are persistent in the environment, and they are not easily subject to biological or chemical degradation or reactions, or loss from the sample container.

E. For analyses performed 41 to 54 days after extraction for solid samples and 41 to 80 days for liquid samples, qualify results as estimated (J/UJ).

F. For analyses performed more than 54 days after extraction for solid samples and 80 days for liquid samples, qualify detected results as estimated (J). Qualify undetected early eluting SVOAs (phenol through pentachlorophenol) as unusable (R) and qualify undetected late eluting SVOAs (eluting after pentachlorophenol) as estimated (UJ). Note in the data validation report that extended holding times have little effect on late eluting polynuclear aromatic hydrocarbons (PAHs) or their detection limits. This is due to the fact that they are persistent in the environment, and they are not easily subject to biological or chemical degradation or reactions, or loss from the sample container.

D.6.2 Gas Chromatography/Mass Spectroscopy Tuning

Tuning and performance criteria for Gas Chromatography/Mass Spectroscopy (GC/MS) are established to ensure adequate mass resolution, identification, and, to some degree, sensitivity. The criteria are from the USEPA Contract Laboratory Program Statement of Work, OLMO3.1 (U.S. Environmental Protection Agency, 1994f) and SW-846 Third Edition (Sept. 1994) and are subject to review and change. If the listed criteria have been superseded, laboratories shall use the most recent set of criteria.

D.6.2.1 Criteria. Criteria are not sample-specific; they are determined using standard materials and shall be met in all circumstances.

A. **BromoFluoroBenzene (BFB) for Volatile Organic Compounds**

m/z	Ion Abundance Criteria ASL B	ASL C and D
50	15.0 - 40.0% of m/z 95	8.0 - 40.0% of m/z 95
75	30.0 - 60.0% of m/z 95	30.0 - 66.0% of m/z 95
95	base peak, 100% relative abundance	Same
96	5.0 - 9.0% of m/z 95	Same
173	less than 2.0% of m/z 174	Same
174	> 50.0 of m/z 95	50.0 - 120.0% of m/z 95
175	5.0 - 9.0% of m/z 174	4.0 - 9.0% of m/z 174
176	95.0 - 101.0% of m/z 174	93.0 - 101.0% of m/z 174
177	5.0 - 9.0% of m/z 176	Same

B. **DecaFluoroTriPhenylPhosphine (DFTPP) for Semivolatile Organic Compounds**

m/z	Ion Abundance Criteria ASL B	ASL C and D
51	30.0 - 60.0% of m/z 198	30.0 - 80.0% of m/z 198
68	less than 2.0% of m/z 69	Same
69	present (record % relative abundance)	Same
70	less than 2.0% of m/z 69	Present
127	40.0 - 60.0% of m/z 198	25.0 - 60.0% of m/z 198
197	less than 1.0% of m/z 198	Same
198	base peak, 100% relative abundance	Same
199	5.0 - 9.0% of m/z 198	Same
275	10.0 - 30.0% of m/z 198	Same
365	greater than 1.0% of m/z 198	Same
441	present but less than m/z 443	Same
442	> 40.0 of m/z 198	40.0 - 110.0% of m/z 198
443	17.0 - 23.0% of m/z 442	15.0 - 24.0% of m/z 442

D.6.2.2 Guidance for ASL D.

A. Verify from raw data that mass calibration is correct.

B. Compare data presented for each tuning to each mass listing submitted.

C. Ensure the following:

1. Forms are available for each 12-hour period that samples are analyzed as specified in the laboratory contract;

2. Laboratory made no transcription errors;

3. Appropriate number of significant figures has been reported (number of significant figures given for each ion in ion abundance criteria column);

4. Laboratory made no calculation errors (e.g., percent mass of m/z 443 relative to mass of m/z 442 was calculated using the following equation):

$$percent\ abundance = \frac{relative\ abundance\ of\ m/z\ 443}{relative\ abundance\ of\ m/z\ 442}\ x\ 100\%$$

D. If possible, verify that spectra were generated using appropriate background subtraction techniques. DFTPP and BFB spectra are obtained from chromatographic peaks that should be free from coelution problems; background subtraction should be straightforward and designed only to eliminate column bleed or instrument background ions. Background subtraction actions resulting in spectral distortions for the sole purpose of meeting contract specifications are contrary to QA objectives and are unacceptable.

E. If mass calibration is in error, classify associated data as unusable (R).

D.6.2.3 <u>Guidance for ASL C and D</u>.

A. If BFB/DFTPP GC/MS performance checks are not available (including bar graph spectra, mass/charge listings, and confirmation that performance checks were done every 12 hours of sample analyses), check the raw data or run log to determine if performance checks were performed. Submit a RIR to the laboratory for the missing data if it was performed. If the BFB/DFTPP checks were not performed, qualify all associated data as unusable (R).

B. If ion abundance criteria are not met and the data in question are needed on a 12-hour basis, use the following guidelines and apply professional judgement to determine extent of data that may be used.

1. BFB - The most important factors to consider are the empirical results that are relatively insensitive to location on the chromatographic profile and the type of instrumentation. Therefore, the critical ion abundance criteria for BFB are the m/z 95/96, 174/175, 176/177, and 174/176 ratios. Relative abundance of m/z 50 and 75 are of lesser importance.

2. DFTPP - The most critical factors in DFTPP criteria are noninstrument-specific requirements that are not unduly affected by location of the spectrum on the chromatographic profile. The m/z 198/199 and 442/443 ratios are based on natural abundance of carbon 12 and carbon 13 and are critical. They shall always be met.

   Similarly, m/z 68, 70, 197, and 441 relative abundance ratios indicate condition of the instrument and suitability of resolution adjustment and are very important. These ratios relate to adjacent ions and are relatively insensitive to differences in instrument design and position of the spectrum on the chromatographic profile.

For ions at m/z 51, 127, and 275, actual relative abundance is not as critical. For instance, if m/z 275 has 40 percent relative abundance (criteria 10 to 30 percent) and other criteria are met, the deficiency is minor.

The relative abundance of m/z 365 is an indicator of suitable instrument zero adjustment. If m/z 365 relative abundance is zero, minimum detection limits may be affected. However, if m/z 365 is present but is less than the 1.0 percent minimum abundance criteria, the deficiency is not as serious.

C. In line with guideline B, an expansion of minus ten percent of the low limit and plus ten percent of the high limit for selected ions may be appropriate. For example, in DFTPP, the m/z 51 ion abundance criteria might be expanded from 30 to 80 percent of m/z 198 to 27 to 88 percent of m/z 198. Complete expanded criteria for DFTPP and BFB follows.

1. **BFB Expanded Criteria**

m/z	Ion Abundance Criteria
50	11.0 - 50.0% of m/z 95
75	22.0 - 75.0% of m/z 95
95	base peak, 100% relative abundance
96	5.0 - 9.0% of m/z 95
173	less than 2% of m/z 174
174	> 50.0% of m/z 95
175	5.0 - 9.0% of m/z 174
176	95.0 - 101.0% of m/z 174
177	5.0 - 9.0% of m/z 176

2. **DFTPP Expanded Criteria**

m/z	Ion Abundance Criteria
51	27.0 - 88.0% of m/z 198
68	less than 2.0% of m/z 69
70	less than 2.0% of m/z 69
127	30.0 - 75.0 % of m/z 198
197	less than 1.0% of m/z 198
198	base peak, 100% relative abundance
199	5.0 - 9.0% of m/z 198
275	> 7.0 - 37.0% of m/z 198
365	greater than 0.75% of m/z 198
441	present, but less than m/z 443
442	> 30.0% of m/z 198
443	17.0 - 23.0% of m/z 442

If results fall within these expanded criteria, data may be acceptable. If results fall outside these expanded criteria, data are unusable (R).

If the reviewer has reason to believe that tuning criteria were achieved using techniques that distorted the spectra, full documentation on tuning quality control shall be obtained. If techniques employed are found to be at variance with accepted practices, the laboratory QA program may merit evaluation.

The reviewer has the discretion, based on professional judgement, to qualify data associated with times which meet expanded criteria, but fail to meet basic criteria. If only one element falls within the expanded criteria, qualification may not be needed. On the other hand, if several data elements are in the expanded windows, associated data may merit an estimated qualifier (J). The data reviewer is not required to use expanded criteria.

The reviewer may still choose to qualify data associated with a tune as unusable (R) if it is appropriate to do so. A decision to use expanded criteria shall be based on intended use of the data.

D.6.3 Calibration

Compliance requirements for instrument calibration are established to ensure that the instrument is capable of producing acceptable quantitative data. Initial calibration demonstrates that the instrument is initially capable of acceptable performance. Continuing calibration checks document satisfactory maintenance and adjustment of the instrument on a day-to-day basis.

D.6.3.1 Criteria.

A. Initial calibration criteria for volatile and semivolatile fractions follow:

1. Average Relative Response Factors (AVGRRF) shall be greater than or equal to 0.05 for Target Compound List (TCL) or Hazardous Substances List (HSL) compounds, and greater than 0.01 for all other compounds.

2. Percent Relative Standard Deviations (%RSD) shall be less than or equal to 30 percent.

B. Continuing calibration criteria for volatile and semivolatile fractions follow:

1. Relative Response Factors (RRF) shall be greater than or equal to 0.05 for TCL or HSL compounds, and greater than 0.01 for other compounds.

2. Percent difference shall be less than or equal to 25 percent.

D.6.3.2 Initial Calibration Guidance.

A. Evaluate RRF for compounds and verify the following:

1. Check and recalculate the RRF and AVGRRF for one or more volatile and semivolatile compounds and verify that recalculated values agree with laboratory reported values.

2. Verify that TCL and HSL compounds have an AVGRRF of at least 0.05, and that all other compounds have AVGRRFs of at least 0.01. The other compounds not on the HSL or TCL, such as amines or ketones, are often times "poor performers". If these analytes are held to the same AVGRRF requirement of 0.05, they will often fail to meet it. This will result in qualification of much of the data as estimated or unusable. Since it is known that these analytes may present a problem, a more realistic acceptance criterion has been set for use in data validation.

B. Evaluate %RSD for compounds and verify the following:

$$\%RSD = (s \div \bar{x}) * 100\%$$

Where:

$$Standard\ Deviation\ (s) = \left| \sum_{i=1}^{n} \frac{(x_i - \bar{x})^2}{(n-1)} \right|^{1/2}$$

s = standard deviation of values

$\bar{x}$ = mean of n values

x_i = individually measured value

1. Check and recalculate %RSD for one or more compounds and verify that recalculated values agree with laboratory-reported values.

2. Verify that compounds (volatile and semivolatile) have a %RSD of less than or equal to 30 percent.

C. If errors are detected in calculations of either RRF or %RSD, perform a more comprehensive recalculation.

D. If a compound has an AVGRRF of less than 0.05 for TCL or HSL compounds or less than 0.01 for all other compounds, proceed as follows:

1. Qualify positive results for that compound as estimated (J).

2. Qualify non-detects for that compound as unusable (R).

E. If any compound has a %RSD greater than 30 percent, proceed as follows:

1. Qualify positive results for that compound as estimated (J).

2. Qualify non-detects as estimated (UJ).

3. Any non-detect with %RSD ≥ 50 percent should be qualified as unusable (R).

F. For VOA low level soil samples, if purge and trap was not heated, qualify positive results as estimated; and non-detects as unusable (R).

D.6.3.3 Continuing Calibration Guidance.

A. If continuing calibration data are required and are not available, submit an RIR to the laboratory for the missing data. If the required continuing calibrations were not performed, qualify all associated data as unusable (R).

B. If a compound has an RRF of less than 0.05 for TCL or HSL compounds or less than 0.01 for all other compounds, proceed as follows:

1. Qualify positive results for that compound as estimated (J).

2. Qualify non-detects for that compound as unusable (R).

C. If any compound has a percent difference between initial and continuing calibration greater than 25 percent, proceed as follows:

1. Qualify positive results for that compound as estimated (J).

2. Qualify non-detects using professional judgement.

D.6.4 Blanks

Blank analysis results shall be assessed to determine existence and magnitude of contamination problems.

D.6.4.1 Criteria. Criteria for evaluation apply to blanks associated with samples. If there is a problem with a blank, evaluate associated sample data to determine whether there is an inherent variability in data for the case or if the problem is an isolated occurrence not affecting other data. Contaminants should not be present in blanks at levels exceeding the specified contract required detection limits (CRDLs).

D.6.4.2 Guidance.

A. For ASL D:

1. Review results of associated blanks, laboratory quality control (QC) forms, and raw data (e.g., chromatogram, reconstructed ion chromatogram, quantitation reports or data system printouts).

B. For ASL C and D:

1. Verify that method blank analysis has been reported per matrix, per concentration level per 12-hour period for each GC/MS system used to analyze VOA samples and for each extraction batch for semivolatiles. When unsuitable blank results are obtained, action depends on circumstances and origin of the

blank. The method blank summary may be used to assist in identifying samples associated with each method blank.

2. When more than one blank is associated with a given sample, base qualification upon comparison with the associated blank having the highest concentration of contaminant.

Results shall not be corrected by subtracting a blank value.

3. Take no action if compound is found in a blank but not found in the sample. If other compounds are found at low levels in blanks, record them in data review comments because this may be indicative of a laboratory problem.

4. Qualify compounds other than those listed in step 5 as undetected (U) if they are detected in the sample and also detected in an associated blank when sample concentration is less than five times the blank concentration.

5. For the common contaminants listed below, qualify positive sample results as undetected (U) if the sample results are not more than ten times the concentration of these analytes in any field or laboratory blank. Report a positive result if the concentration of a compound in the sample exceeds ten times amount in a blank.

   a. Methylene chloride

   b. Acetone

   c. 2-butanone (Methyl-ethyl Ketone)

   d. Common phthalate esters

6. The blank analyses might not involve the same weights, volumes, or dilution factors as the associated samples. These factors shall be taken into consideration when applying the 5-times and 10-times criteria so that a true comparison of the total amount of contamination is made.

7. There may be instances where little or no contamination is present in the associated blanks, but qualification of the sample is deemed necessary (e.g., contamination introduced through dilution water). Although it is not always possible to determine, instances of this can be detected when contaminants are found in the diluted sample result but are absent in the undiluted sample result.

8. If the reviewer determines that a result stems from contamination from a source other than those evidenced by the blank samples, data shall be qualified. In this case, the 5-times or 10-times rules do not apply and the sample value shall be qualified as undetected (U).

Following are examples of applying blank qualification guidelines; however, certain circumstances may warrant deviation from these guidelines.

Case 1 Sample result is greater than contract required quantitation limit (CRQL) but less than (5- or 10-times) required amount of the blank result.

	Rule	
	10 Times	5 Times
Blank Results	7	7
CRQL	5	5
Sample Results	60	30
Qualified Sample Result	60U	30U

In the example for the 10-times rule, sample results less than 70 (or 10 x 7) are qualified as non-detects.

For the 5-times rule, sample results less than 35 (or 5 x 7) are qualified as non-detects.

Case 2 Sample result is less than CRQL and also less than (5- or 10-times) required amount of the blank result.

	Rule	
	10 Times	5 Times
Blank Results	6	6
CRQL	5	5
Sample Results	4J	4J
Qualified Sample Result	5U	5U

Data are not reported as 4U because this indicates a detection limit below the CRQL.

Case 3 Sample result is greater than (5- or 10-times) required amount of the blank result.

	Rule	
	10 Times	5 Times
Blank Results	10	10
CRQL	5	5
Sample Results	120	60
Qualified Sample Result	120	60

For both 10-times and 5-times release, sample results exceeded adjusted blank results of 100 (or 10 x 10) and 50 (or 5 x 10). The result is reported with a "-" flag (no qualifier), signifying a positive result that is confident as reported.

7. If gross contamination exists (e.g., saturated peaks by GC/MS), qualify affected compounds as unusable (R) in samples affected by interference.

8. If tentatively identified compounds (TIC) are found in both the sample and associated blanks, record this in data review comments because it may be indicative of a

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laboratory problem. TICs should be qualified as unusable (R) if they are also detected in associated blanks.

D.6.5 Percent Surrogate Recovery

Laboratory performance on individual samples is checked by spiking samples with surrogate compounds prior to sample preparation and then evaluating the percent recovery. Evaluation of results of surrogate spikes is not necessarily straightforward. The sample itself may produce effects caused by such factors as interferences and high concentrations of analytes. Because effects of the sample matrix are frequently outside laboratory control and may present relatively unique problems, review and validation of data based on specific sample results is frequently subjective and demands analytical experience and professional judgement. Accordingly, the following procedures consist primarily of guidelines and, in some cases, optional approaches are suggested.

D.6.5.1 **ASL C and D Criteria**. Sample and blank surrogate recoveries for volatile and semivolatile compounds shall be within limits specified in the laboratory contract.

D.6.5.2 **Guidance for ASL D Data** Check raw data (e.g., chromatogram, quantitation list) to verify recoveries on surrogate recovery form.

D.6.5.3 **Guidance for ASL C and D Data.**

A. From surrogate recovery forms, determine whether any two surrogates within a SVOA fraction (base/neutral or acid), or one surrogate for the VOA fraction are out of specification or whether any one SVOA or VOA surrogate has a recovery of less than ten percent.

B. From surrogate recovery forms, determine whether recoveries are out of specification with no evidence of repurging, reinjection, or re-extraction. If so, the laboratory has failed to perform satisfactorily.

C. Investigate whether the problem is instrumental or matrix dependant by determining if the blanks also have surrogates outside criteria parameters.

D. If there are two or more analyses for a particular fraction, determine which are the better results to report based on the following considerations:

1. Surrogate recovery (marginal versus gross deviation);

2. Internal standard recoveries;

3. Holding times;

4. Comparison of compound values reported in each fraction.

E. For surrogate spike recoveries out of specification, proceed as follows.

1. If at least two surrogates in either the semivolatile fraction, or one surrogate in the volatile fraction, are out of specification but have recoveries greater than ten percent, proceed as follows:

   a. Qualify positive results for that fraction as estimated (J).

   b. Qualify undetected results for that fraction with the sample quantitation limit as estimated (UJ).

   c. Do not qualify non-detects if surrogate recoveries are above allowable limits.

2. If a surrogate in a fraction shows less than ten percent recovery, proceed as follows:

   a. Qualify positive results for that fraction as estimated (J).

   b. Qualify undetected results for that fraction as unusable (R).

3. Data are not normally qualified with respect to surrogate recovery unless at least two surrogates are out of specification in a semivolatile fraction (base/neutral or acid) or one is out of specification in the volatile fraction, or unless recovery of a surrogate is less than ten percent. If reanalysis was performed, results of the original analysis and reanalysis should be compared to assess whether the results are due to matrix effects or to a problem with the analytical process.

4. For a blank analysis with surrogates out of specification, give special consideration to the validity of associated sample data and determine whether problems are isolated to the blank alone or if there is a fundamental problem with the analytical process. For example, if one or more samples in the batch show acceptable surrogate recoveries, the blank problem may be considered an isolated occurrence. Even if this judgement allows some use of the affected data, analytical problems remain, which shall be reported to and corrected by the laboratory.

5. Professional judgement can be used to qualify compounds that have a strong correlation to a surrogate (e.g., phenol with $d_5$phenol) even if the surrogates from the fraction are not outside central limits.

D.6.6 Matrix Spike/Matrix Spike Duplicates

Matrix spike and matrix spike duplicate (MS/MSD) data are generated to determine long-term precision and accuracy of the analytical method on various matrices. These data alone cannot be used to evaluate precision and accuracy of individual samples. MS/MSD results can also be used to confirm matrix effects.

D.6.6.1 <u>Criteria</u>. Spike recoveries and relative percent differences (RPD) between MS/MSD recoveries shall be within advisory limits in the applicable method (Appendix G).

D.6.6.2 Guidance for ASL C and D Data. The following guidance is applicable to both ASL C and D data:

A. Inspect data results for MS/MSD recovery.

B. Verify transcriptions from raw data for ASL D and verify calculations.

C. Do not use MS/MSD data alone to qualify an entire case. Use informed professional judgement and MS/MSD results in conjunction with other QC criteria to determine the need for some qualification of the data.

D. Try to determine the effect of MS/MSD results on associated data with regard to the MS/MSD sample and specific analytes for samples associated with the MS/MSD.

E. If it can be determined that results of the MS/MSD affect only the spiked sample, limit qualification to this sample alone.

F. If it is determined through MS/MSD results that a laboratory is having a systematic problem in analysis of one or more analytes, apply qualification to associated samples, and notify the FEMP QA organization and the FEMP analytical project manager.

D.6.7 Field Duplicates

Field duplicate samples may be taken and analyzed as an indication of overall precision. These analyses measure both field and laboratory precision; therefore, results may have more variability than laboratory duplicates, which measure only laboratory performance. It is also expected that solid matrix duplicate results will have a greater variance than water matrices because of difficulty in collecting identical samples.

D.6.7.1 Criteria. Generally, the review criteria for field duplicate analyses are the same as those for laboratory duplicate analyses.

D.6.7.2 Guidance.

A. Identify samples that are field duplicates using FEMP forms specified in the laboratory contract or PSP.

B. Compare results reported for each sample and calculate the RPD (or actual difference, when a least one of the results is below 5x the CRDL).

C. Provide evaluation of field duplicates with reviewer comments.

D.6.8 Internal Standards Performance

D.6.8.1 Criteria. The following internal standards (IS) performance criteria ensure that GC/MS sensitivity response is stable during every analytical run.

A. IS area counts shall not vary by more than a factor of two (-50 percent to +100 percent) from associated calibration standard.

B. Retention time of the IS shall not vary more than ±30 seconds from the associated calibration standard.

D.6.8.2 **Guidance for ASL D Data.** Check raw data (e.g., chromatograms, quantitation lists) and verify recoveries reported as specified in the laboratory contract.

D.6.8.3 **Guidance Data for ASL C and D.**

A. If the BFB/DFTPP GC/MS performance checks are not available (including bar graph spectra, mass/charge listings, and confirmation that performance checks were done every 12 hours of sample analysis), check the raw data or run log to determine if performance checks were performed. Submit an RIR to the laboratory for the missing data, if it was performed. If BFB/DFTPP checks were not performed, qualify all associated data as unusable (R).

B. Verify that retention times and IS areas are acceptable.

C. If there are two analyses for a particular fraction, determine which results are better to report considering the following:

1. Magnitude and direction of the IS area shift;

2. Magnitude and direction of the IS retention time shift,;

3. Holding times;

4. Comparison of results for compounds values reported in each fraction.

D. Qualify data as follows based on IS results obtained:

1. If the IS area count is greater than the upper limit (+100% of the expected value), qualify detected results as estimated (J). Undetected compounds are not qualified.

2. If the IS area count is less than the lower limit (-50% of the expected value), qualify all results as estimated (J/UJ).

3. If the IS area count is extremely low or performance exhibits a major drop off, use professional judgement to qualify undetected compounds unusable (R).

E. If an IS retention time varies by more than 30 seconds, examine the chromatographic profile for that sample to determine whether false positives or negatives exist.

F. For shifts of a large magnitude, consider partial or total rejection of data for that sample fraction.

D.6.9 Target Compound Identification 1720

The objective of criteria for GC/MS qualitative analysis is to minimize the number of erroneous identifications of compounds. An erroneous identification can either be a false positive (reporting a compound present when it is not present) or a false negative (not reporting a compound that is present).

Identification criteria can be applied much more easily to detect false positives than false negatives. More information is available because of the requirement for submittal of data supporting positive identifications. Negatives (non-detected compounds), however, represent an absence of data and are, therefore, much more difficult to assess.

In addition, identification should be checked for errors of coeluting compounds that share common ions, such as styrene and xylenes, some PAHs/ISs, and surrogates. Software occasionally misidentifies surrogates and ISs as target compounds.

D.6.9.1 Criteria.

A. A compound shall be within ±0.06 relative retention time (RRT) units of the standard RRT.

B. Mass spectra of the sample compound and a current laboratory-generated standard shall match according to the following criteria:

1. Ions present in the standard mass spectrum at a relative intensity greater than ten percent shall be present in the sample spectrum;

2. Relative intensities of ions shall agree within ±20 percent between the standard and sample spectra (e.g., for an ion with 50 percent abundance in the standard spectrum, the corresponding sample ion abundance shall be between 30 and 70 percent);

3. Ions greater than ten percent in the sample spectrum but not present in the standard spectrum must be accounted for.

D.6.9.2 Guidance.

A. Ensure that the RRT of reported compounds is within 0.06 units of reference standard.

B. Compare laboratory standard spectra with sample compound spectra for ASL D validation as specified in Appendix D.6.9.1.

C. Be alert for situations where sample carryover is a possibility (e.g., high concentration samples preceding low concentration samples) and use professional judgement to determine if instrument cross-contamination has affected positive compound identification.

D. Use professional judgement to apply qualitative criteria for GC/MS analyses; if it is determined that incorrect identifications were made, qualify such data as tentatively identified (N), not detected (U), or unusable (R).

E. Use professional judgement to qualify data if it is determined that cross-contamination occurred.

D.6.10 Compound Quantitation and Reported Detection Limits (RDLs)
The data validation objective is to ensure that reported quantitation results and the RDL are accurate.

D.6.10.1 Criteria.

A. Compound quantitation as well as adjustment of the RDL shall be calculated according to the applicable method.

B. Compound RRF shall be calculated based on the IS specified in the method for that compound.

C. Quantitation shall be based on the ion (m/z) specified in the method.

D. Compound quantitation shall be based on the RRF from the appropriate daily standard.

E. Samples identified as solids (e.g., soils) shall have a solids content greater than or equal to 50 percent.

F. Samples for volatile organic compounds shall be taken properly. There must be no air bubbles in the vial, and the septum must form a tight seal.

D.6.10.2 Guidance for ASL D.

A. For fractions, examine raw data to verify correct calculation of sample results reported by the laboratory.

B. Compare quantitation lists, chromatogram, and sample preparation log sheets to reported positive sample results and quantitation limits.

C. Verify that correct internal standard, quantitation ion, and RRF were used.

D.6.10.3 Guidance for ASL C and D.

A. Verify that reported results and detection limits have been adjusted to reflect sample dilutions, concentrations, splits, clean-up activities, and dry-weight factors which are not accounted for by the method.

B. If discrepancies are found, obtain from the laboratory additional information that may resolve differences. If discrepancies remain unresolved, decide which values are better. Reviewer may determine that qualification of data is warranted.

C. Qualify all organic data as estimated (J/UJ) from any sample identified as a solid sample which was determined to contain less than 50 percent solids.

D. Qualify all positive results as estimated (J) and non-detects as unusable (R) if the VOA vial analyzed contained air bubbles.

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D.6.11 Tentatively Identified Compounds (TICs). This procedure for TICs is applicable to ASL D data. Potential TICs include chromatographic peaks in volatile and semivolatile fraction analyses that are:

A. Not on the TCL, HSL, RCRA Appendix IX lists, or other applicable target lists;

B. Not target analytes, surrogates, or internal standards.

The reviewer shall qualitatively identify TICs by GC/MS library search and assessment.

D.6.11.1 Criteria. For each sample, the laboratory shall conduct a mass spectral search of the National Institute of Standards and Technology (NIST) library and report possible identities for the ten largest VOA fraction peaks and the 20 largest SVOA fraction peaks that are not surrogate, IS, or compounds, but which have area/height greater than ten percent of the size of the nearest IS. TIC results shall be reported for each sample. Guidelines for tentative identification are as follows:

A. Major ions (greater than ten percent relative intensity) in the reference spectrum shall be present in the sample spectrum.

B. Relative intensities of major ions shall agree within ±20 percent between the sample and reference spectra.

C. Characteristic ion patterns present in the reference spectrum shall be present in the sample spectrum.

D. Ions present in the sample spectrum but not in the reference spectrum shall be reviewed for possible background contamination, interference, or coelution of additional compounds.

E. Even if these criteria are not met, the data reviewer may report identification if a mass spectral interpretation specialist reviewer judges it to be correct.

F. If, in the data reviewer's judgement, identification is uncertain or there are extenuating factors affecting compound identifications, the TIC result may be reported as "unknown".

D.6.11.2 Guidance.

A. Check raw data to verify that the laboratory has generated a library search for required peaks in the chromatogram (samples and blanks).

B. Examine the blank chromatogram to verify that TIC peaks present in samples are not in blanks. If a low-level compound that is a common artifact or laboratory contaminant is detected in a sample, check the blank chromatogram for peaks of less than ten percent of IS height which are present in the blank chromatogram at a similar RRT.

C. Examine mass spectra in each sample and blank.

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D. Because TIC library searches often yield several candidate compounds with a close matching score, consider all reasonable choices. TIC list components should be

compared to the list of requested analytes (i.e., TCL, HSL, Appendix IX, etc.). Matches should be added to the target list if not listed, or, if also reported as a target, should be qualified as unusable (R).

E. Be alert for the following common laboratory artifacts or contaminants that may be present in blanks and not reported as sample TICs.

1. Common laboratory contaminants: CO_2 (m/z 44), siloxanes (m/z 73), diethyl ether, hexane, certain freons (1,1,2-trichloro-1,2,2-trifluoroethane or fluoro-trichloromethane), and phthalates at levels less than 100 μg/l or 4000 μg/kg.

2. Solvent preservatives: cyclohexene, a methylene chloride preservative, and related by-products including cyclohexanone, cyclohexenone, cyclohexanol, cyclohexenol, chlorocyclohexene, and chlorocyclohexanol.

3. Aldol reaction products of acetone including 4-hydroxy-4-methyl-2-pentanone; 4-methyl-2-penten-2-one; and 5,5-dimethyl-2(5H)-furanone.

A compound may be identified in the proper analytical fraction by nontarget library search procedures even though it was not found on the quantitation list.

F. If total-area-quantitation method was used, request laboratory recalculation of the result using proper quantitation ion. Also, evaluate other sample chromatograms and check library reference retention times on quantitation lists to determine if the false negative result is an isolated occurrence or if data from the entire case is affected.

G. Compounds may be identified in more than one fraction, so verify that quantitation is made from the proper fraction. Volatile compounds detected in the semivolatile fraction but not in the volatile fraction, or semivolatile target compounds detected in the volatile fraction but not in the semivolatile fraction can be presumed to be artifacts and should be qualified as unusable (R).

H. Qualify TIC results as tentatively identified with estimated concentrations (NJ).

I. If it is determined that tentative identification of a compound is not acceptable, change the tentative identification to "unknown" or an appropriate identification.

J. If contractually required peaks were not library searched, request the data from the laboratory.

K. Do not report TICs that are not sufficiently above the detected level in the blank. Consider dilutions and sample size when comparing amounts present in blanks and samples.

L. When a compound is not found in blanks but is a suspected artifact or a common laboratory contaminant, qualify result as unusable (R).

M. Exercise professional judgement to evaluate a TIC that was identified by a library search. If there is more than one reasonable match, report result as either compound "X" or "Y". If there is a lack of isomer specificity, change TIC result to a nonspecific isomer result (e.g., 1,3,5-trimethyl benzene to trimethyl benzene isomer) or to compound class (e.g., 2-methyl-3-ethyl benzene to substituted aromatic compound). The reviewer may elect to summarize and report similar isomers as a total (e.g., alkanes may be reported as total hydrocarbons).

NOTE

Other case factors may influence TIC judgements. If a sample TIC match is poor but other samples have a TIC with a good library match, similar relative retention time, and the same ions, identification information may be inferred from the other TIC results. Physical constants, such as boiling point, may be factored into professional judgement of TIC results.

D.6.11.3 **Guidance for ASL C**. Because the ASL C data package does not include the raw data, it is not possible to review the spectra and tentative spectral identifications of TICs. However, the reviewer shall examine the reported list of TICs as well as the apparent reported concentrations and tentative identifications. The review shall consider other reported site data and information in assessing the overall significance of reported TICs.

D.6.12 System Performance

After instrument performance QC checks (e.g., blanks, tuning, calibration), changes may occur that degrade data quality. While this degradation is not directly shown until the next series of analytical QC checks, a thorough review of ongoing data acquisition can indicate degradation of instrument performance. Following are some examples of these indicators.

A. Abrupt, discrete shifts in reconstructed ion chromatograph baseline may indicate gain or threshold changes.

B. Poor chromatographic performance affects both qualitative and quantitative results. Indications of substandard performance include the following:

1. High reconstructed ion chromatograph background levels or shifts in absolute retention times of internal standards;

2. Excessive baseline rise at elevated temperature;

3. Extraneous peaks;

4. Loss of resolution suggested by factors such as nonresolution of 2,4- and 2,5-dinitrotoluene;

5. Peak tailing or peak splitting which may result in inaccurate quantitation.

Continued analytical activity with degraded performance suggests lack of attention or professional experience. Using instrument performance indicators, the data reviewer shall decide whether the system has degraded to the point that data quality or validity is affected.

data quality may have been affected, data shall be qualified using reviewer's professional judgement.

D.6.13 Overall Assessment of Data for a Case

It is appropriate for the data reviewer to make professional judgements and express concerns and comments on validity of the overall data package for a case. This is particularly true when there are several QC criteria out of specification.

The additive nature of QC factors out of specification is difficult to assess in an objective manner, but the reviewer has a responsibility to inform users concerning data quality and data limitations in order to avoid inappropriate use of data while not precluding consideration of the data. The reviewer is greatly assisted if DQOs are provided.

D.7 PESTICIDES DATA VALIDATION GUIDANCE FOR ASLs B, C, AND D

Data validation guidance for pesticides is based on the *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review*, (U.S. Environmental Protection Agency, 1994e).

This section describes general procedures for data validation from gas chromatography (GC) analysis of pesticides (e.g., herbicides and organo-phosphate pesticides). Specific performance criteria, surrogates, spike compounds, instrument performance requirements, calibration, and standards are provided in Appendix G and shall be used as validation criteria. The following procedures shall be performed for GC data validation in the order indicated. For organic data validation, use the organic data validation checklist, and confirm completion of the checklist and the data package on the organic data validation summary report.

D.7.1 Guidelines for ASL B Data

There are two sublevels of ASL B data, and they require different validation guidance. If standard, predefined ASL B analysis is specified, QC information shall be reviewed and compared to the QC acceptance criteria of the individual methods. The portions of ASLC and D guidance that are applicable (e.g., matrix spike/matrix spike duplicate, blanks, laboratory control samples) shall be used as the outline for review. The specific acceptance criteria from the Appendix G method shall be used.

If the samples taken are user-defined as ASL B, they shall be validated in accordance with requirements in the PSP for that sampling event. When the data user specifies the quality control (QC) requirements, the validation requirements shall also be specified in the PSP. The data validator must review the PSP to ensure compliance with PSP requirements.

D.7.1.1 Holding Times and Preservation

The objective of validating holding time data is to establish validity of analysis results by ensuring that sample holding times from receipt to analysis or preparation were in compliance.

D.7.1.1.1 Criteria.

A. Extraction of aqueous samples by the separatory funnel methods shall be completed within 7 days of sample collection date.

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B. Extraction of aqueous samples by continuous liquid/liquid extraction shall be started within 7 days of sample collection time.

C. Extraction of solid samples by sonication shall be completed within 14 days of sample collection time.

D. Analysis of samples shall be completed within 40 days following start of extraction.

E. Toxicity Characteristic Leaching Procedure (TCLP) analysis shall be completed within 28 days of the TCLP extraction.

D.7.1.1.2 Guidance.

A. Establish actual preservation and holding times by comparing sample collection dates on the chain of custody with dates of analysis and/or extraction.

B. If the samples were not appropriately preserved, use professional judgement to qualify the data.

C. For extractions performed > 14 days after sample collection for solids and > 7 days after sample collection for liquids, qualify results as estimated (J/UJ).

D. For analyses performed > 40 days after extraction for solids and liquids (> 28 days for TCLP extracts), qualify results as estimated (J/UJ).

D.7.2 Instrument Performance

D.7.2.1 Criteria. Criteria are established to ensure that adequate chromatographic resolution and instrument sensitivity are achieved by the chromatographic system. These criteria are not sample specific. Conformance is determined using standard materials; therefore, criteria shall be met in all circumstances.

D.7.2.2 Guidance for ASL D.

A. Check raw data to verify that the following conditions exist:

1. Retention-time windows are reported and pesticide standards are within established windows.

2. Percent breakdown for DDT or endrin does not exceed 20 percent in evaluation standard analyses.

$$\underset{(DDT)}{\%\ Breakdown} = \frac{Total\ (DDE+DDD)}{Total\ (DDE+DDD+DDT)}\ x\ 100\%$$

$$\underset{(Endrin)}{\%\ Breakdown} = \frac{Total\ (Endrinketone+Endrinaldehyde)}{Total\ (Endrinketone+Endrinaldehyde+Endrin)}\ x\ 100\%$$

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3. Percent breakdown for combined endrin and DDT does not exceed 30 percent in evaluation standard analyses.

4. If the retention time shift for dibutylchlorendate is greater than 0.3 percent for narrow-bore capillary columns or greater than 1.5 percent for wide-bore capillary columns, the analyses may be qualified unusable (R) for that sample, but the reviewer shall use professional judgement to qualify data. Care should be taken to ensure that a retention time shift is not a result of a coeluting PCB. If coelution is the source of the shift, the surrogate outlier should not be used to qualify results.

B. Check affected sample chromatograms for peaks within an expanded window surrounding the expected retention-time window for the analyte of interest and proceed as follows to ensure that standards fall within retention-time windows. Retention-time windows are used for qualitative identification. If standards do not fall within the windows, associated sample results shall be evaluated. Samples injected after the last in-control standard may be affected.

1. If no peaks are present within or close to the window of the deviant target compound, there is usually no effect on data. Non-detected values can be considered valid.

2. If affected sample chromatograms contain peaks that may be of concern (i.e., above the practical quantitation limit and those peaks are either close to or within expected retention-time window of analyte), two options (steps 3 and 4) are available to determine affect on data.

3. If no additional effort is warranted, qualify positive results and quantitation limits as unusable (R). In the comments, emphasize the possibility of either false negatives or false positives as appropriate.

4. If additional effort is warranted (e.g., if data are needed on a priority basis and if peaks may represent a level of concern for that particular analyte), proceed as follows to determine a useable window for affected samples.

   a. Examine data package for presence of three or more standards containing the analyte of interest that were run within a 24-hour period during which the sample was analyzed.

   b. If three or more such standards are present, reevaluate the mean and standard deviation of retention-time window.

   c. If all standards and matrix spikes fall within the revised window, determine valid positive or negative sample results using this window.

   d. Record additional efforts taken and their resultant impact on data useability.

e. Include calculations and comparisons generated in the support documentation.

D.7.3 Calibration

Calibration requirements ensure that the measuring instruments are capable of producing acceptable quantitative data. Initial calibration ensures that instruments are originally capable of specified performance. Continuing calibration ensures that instruments remain in calibration specific time periods and that required calibration documentation is maintained.

D.7.3.1 Initial Calibration Criteria for ASL C and D Data.

A. Retention-time windows are specified for compounds in the applicable method (Appendix G).

B. All single component analytes except surrogates shall have a percent relative standard deviations (%RSD) less than or equal to 20.0 percent, except that up to two single column analytes per column may fall between 20.0 and 30.0 percent.

C. Surrogates shall have a %RSD less than or equal to 30.0 percent.

D. Up to two target compounds (except surrogates) may have a %RSD greater than 20.0 percent but less than or equal to 30.0 percent.

D.7.3.2 Continuing Calibration Criterion for ASL C and D Data. Relative percent difference (RPD) shall be less than or equal to 25.0 percent.

D.7.3.3 Guidance for Initial Calibration Data for ASL C.

A. Verify that %RSD for the calibration factor of each analyte is less than or equal to 20 percent for each 12-hour period.

B. If linearity criteria are not met, qualify associated quantitative results as estimated (J/UJ).

D.7.3.4 Guidance for Initial Calibration Data for ASL D.

A. Verify that %RSD for the calibration factor of each analyte is less than or equal to 20 percent for each 12-hour period.

B. If linearity criteria are not met, qualify associated quantitative results as estimated (J/UJ).

C. Inspect standards results and verify agreement with raw GC data (chromatograms and data system printouts).

D. Check raw data and recalculate a minimum of one percent of the calibration factors and %RSD for calibration concentrations.

E. If errors are detected, perform more comprehensive recalculations.

F. Inspect multicomponent analysis results and verify agreement with the raw data.

D.7.3.5 Guidance for Continuing Calibration Data for ASL C and D.

A. To verify quantitative results, check the percent difference between calibration factors by recalculating approximately ten percent of the values reported in raw data using the following formula.

$$\%D = \frac{R_1 - R_2}{R_1} x\ 100\%$$

Where:

R_1 = Calibration factor from first analysis
R_2 = Calibration factor from subsequent analysis

B. If percent difference between calibration factors is greater than 25 percent of the quantitated compounds, qualify associated positive quantitative results as estimated (J).

D.7.4 Blanks

Assessment of blank analysis results determines the existence and magnitude of contamination problems. If problems exist, data associated with the case shall be evaluated to determine whether there is an inherent variability in data for the case or if the problem is an isolated occurrence not affecting other data.

D.7.4.1 Criteria for ASL C and D. No contaminants should be present in blanks above the contract required detection limit (CRDL).

D.7.4.2 Guidance for ASL C and D.

A. Verify that method blank analyses contain less than CRDL of target analytes or interfering peaks.

B. Verify that method blank analysis has been reported per matrix, per concentration level, per GC system used to analyze samples for each extraction batch.

C. When unsuitable blank results occur, action depends on the circumstances and origin of the blank. Positive sample results shall be qualified "U" unless compound concentration in the sample exceeds five times the amount in the blank. When more than one blank is associated with a given sample, qualification shall be based upon a comparison with the associated blank having the highest concentration of a contaminant. Results shall not be corrected by subtracting the blank value.

D. If a contaminant is found in the blank but not in the samples, take no action.

E. Qualify target analytes "U" if detected in sample and also detected in an associated blank when sample concentration is less than five times blank concentration.

F. Blank analyses may not involve the same weights, volumes, or dilution factors as associated samples. These factors shall be taken into consideration when applying the 5-times criteria so that a comparison of the total amount of contamination may be made.

G. There may be instances where little or no contamination was present in the associated blanks, but qualification of the sample is deemed necessary (e.g., contamination introduced through dilution water). Although it is not always possible to determine, this situation may be detected when contaminants are found in a diluted sample result, but are absent in the undiluted sample result. It may be impossible to verify this source of contamination. However, if the reviewer determines that contamination is from a source other than the sample, the data shall be qualified. In this case, the 5-times criterion does not apply; the sample value shall be reported as a non-detect.

Examples of applying blank qualification guidelines follow. Certain circumstances may warrant deviations from these guidelines.

Case 1 Sample result is greater than CRDL but is less than required amount (5 times) of blank result.

5-Times	
Blank result	1.0
CRDL	0.5
Sample result	4.0
Qualified sample result	4.0U

In this case, sample results less than 5.0 (5 x 1.0) are qualified as non-detects.

Case 2 Sample result is greater than required amount (5-times) of blank result.

5-Times	
Blank result	1.0
CRDL	0.5
Sample result	6.0
Qualified sample result	6.0

The result is reported with a "-" flag (no qualifier), signifying a positive result that is confident as reported.

D.7.4.3 Procedure for ASL D. In addition to the procedure in Appendix D.7.4.2, Review results of associated blanks and raw data (chromatograms, quantitation reports or data system printouts).

D.7.5 Percent Surrogate Recovery

Quality of laboratory analysis of individual samples is established by spiking samples with a surrogate compound prior to sample preparation and then evaluating the percent recovery. However, evaluation of results of surrogate spikes is not necessarily straightforward. The sample itself may produce effects caused by factors such as interferences and high concentrations of analytes. The review and validation of data based on specific sample results

is frequently subjective and demands analytical experience and professional judgement because effects of the sample matrix are frequently outside the control of the laboratory and may present relatively unique problems. Accordingly, this guidance consists primarily of guidelines and, in some cases, several optional approaches are suggested.

D.7.5.1 Criteria. Sample and blank recoveries of surrogates shall be within advisory limits of the specified method (Appendix G).

D.7.5.2 Guidance for ASL C. Verify that surrogate recoveries are within advisory limits prior to and in addition to following the guidance in Appendix D.7.5.4.

D.7.5.3 Guidance for ASL D. The following guidance shall be performed prior to and in addition to guidance in Appendix D.7.5.4.

A. Check raw data (e.g., chromatograms, quantitation list) to verify recoveries.

B. If recoveries are not within advisory limits, check raw data for possible interferences that may have affected surrogate recoveries.

D.7.5.4 Guidance for ASL C and D. The following guidance shall be performed after the guidance in Appendices D.7.5.2 and D.7.5.3. Use the following guidelines if surrogate recoveries are outside advisory windows:

A. If low recoveries are obtained, qualify associated positive results and quantitation limits as estimated (J/UJ).

NOTE

A high bias may be caused by coeluting interferences.

B. If high recoveries are obtained, use professional judgement to determine the appropriate action.

C. If a zero surrogate recovery is reported, examine the sample chromatogram to determine if the surrogate may be present but slightly outside its retention-time window.

D. If the surrogate is present, in addition to assessing surrogate recovery for quantitative bias, investigate the qualitative validity of analysis.

E. If surrogate is not present, qualify undetected results as unusable (R).

D.7.6 Matrix Spike/Matrix Spike Duplicates (MS/MSD)

MS/MSD data are generated to determine long-term precision and accuracy of the analytical method (Appendix G) on various matrices. These data alone cannot be used to evaluate precision and accuracy of individual samples.

D.7.6.1 Criteria.

A. Advisory limits are established for spike recovery limits in the applicable method identified in Appendix G and on laboratory contract-specified FEMP forms.

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B. Advisory limits are established for relative percent difference between matrix spike and matrix spike duplicate recoveries in the applicable method identified in Appendix G and on laboratory contract-specified FEMP forms.

D.7.6.2 Guidance.

A. Inspect results for MS/MSD recoveries.

B. Verify transcriptions from raw data for ASL D evaluation.

C. Verify calculations.

D. Do not use MS/MSD data alone to qualify an entire case, but use informed professional judgement and MS/MSD results in conjunction with other QC criteria to determine need for qualification of data.

E. First try to determine extent of effects of MS/MSD results on associated data. Make this determination in regard to the sample as well as specific analytes for samples associated with MS/MSD.

F. If it can be determined that results of MS/MSD affect only the spiked sample, limit qualification to that sample alone.

G. If it is determined through MS/MSD results that a laboratory is having a systematic problem in analysis of one or more analytes that affect associated samples, FEMP QA and the FEMP laboratory contacts shall be notified and the affected samples shall be qualified.

D.7.7 Field Duplicates

Field duplicate samples may be collected and analyzed to evaluate overall precision. These analyses measure both field and laboratory precision; therefore, results may have more variability than laboratory duplicates, which measure only laboratory performance. It is also expected that solid matrix duplicate results will have a greater variability than duplicates of water matrices because of difficulty collecting identical samples.

D.7.7.1 Criteria. Field duplicates shall agree within ± 5x the CRDL when at least one result is below the CRDL, or within 20 percent RPD when both results are above the CRDL.

D.7.7.2 Guidance.

A. Identify samples that are field duplicates using FEMP forms specified in the laboratory contract or PSP.

B. Compare results reported for each sample and calculate the relative percent difference (or actual difference, when a least one of the results is below the contract required detection limit (CRDL).

C. Provide evaluation of field duplicates with reviewer comments.

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D.7.8 Compound Identification
Qualitative criteria for compound identification were established to minimize erroneous identifications, which can be either a false positive (reporting a compound when it is not present) or a false negative (not reporting a compound that is present).

D.7.8.1 Criteria for ASL C and D.

A. Retention times of reported compounds shall fall within calculated windows for the two chromatographic columns.

B. Gas chromatography/mass spectroscopy confirmation is required if the concentration of a compound exceeds 10 ng/μL in the final sample extract.

D.7.8.2 Guidance for ASL D Data. The following guidance shall be performed prior to and in addition to the guidance in Appendix D.7.8.3.

A. Review compound identification results and associated raw data (chromatograms, data system printouts).

B. Confirm reported positive detects using appropriate retention times and retention-time windows. Verify that compounds listed as "not detected" are correct.

D.7.8.3 Guidance for ASL C and D Data.

A. Verify that positive identifications have dissimilar column analyses.

B. If qualitative criteria for the two-column confirmation were not met, consider reported positive detects as non-detects. Use professional judgement and assign an appropriate quantitation limit based on the following guidelines:

1. If a misidentified peak was sufficiently outside the target pesticide retention-time window, report CRDL (adjusted for dilutions and dry weight corrections as required).

2. If the identified nontarget peak interferes with potential detection of target peak, consider the reported target value unreliable. If undetected, report quantitation limit and qualify it as estimated (UJ).

D.7.9 Compound Quantitation and Reported Detection Limits (RDLs)
The validation objective is to ensure that reported quantitation results and RDLs are accurate.

D.7.9.1 Criteria.

A. Compound quantitation, as well as adjustment of the RDL, shall be calculated in accordance with the specified method in Appendix G.

B. Samples identified as solids (e.g., soils) shall have a solids content greater than or equal to 50 percent.

D.7.9.2 Guidance for ASL C and D.

A. Verify that RDLs were adjusted to reflect sample dilutions, splits, concentrations, clean-up activities, and dry weight factors that were not accounted for in the method.

B. Qualify quantitation limits affected by large, off-scale peaks as unusable (R).

C. If the target compound peak is affected by interference, and if the target compound is undetected, qualify the quantitation limit as estimated (UJ) for each affected compound.

D. Use professional judgement to decide whether a much larger concentration obtained in one column versus the other column indicates presence of an interfering compound and qualify the result as estimated (J).

NOTE

When the percent difference for the results of two columns is greater than 25 percent, the laboratory is required to report the lower result and code it (P).

E. Document that presence of interferences has obscured attempt at second-column confirmation.

F. Samples identified as solids (e.g., soils) with a solids content of less than 50 percent are qualified as estimated (J/UJ).

D.7.9.3 Guidance for ASL D. The following guidance applies to ASL D data only and shall be performed in addition to guidance in Appendix D.7.9.2.

A. Examine raw data to verify correct calculation of sample results reported by the laboratory.

B. Compare quantitation reports, chromatograms, and sample preparation logs to reported positive sample results and quantitation limits.

NOTE

When multicomponent compounds are analyzed, one detected compound can often obscure smaller concentration of other multicomponent and single component compounds. When multicomponent compounds are reported, the reviewer should carefully scan for the presence of other multicomponent compounds that may have been obscured.

D.7.10 Overall Assessment of Data for a Case

The data reviewer shall make professional judgements, express concerns, and comment on validity of the overall data package. This is particularly appropriate when there are several QC criteria out of specification.

The additive nature of QC factors out of specification is difficult to assess in an objective manner, but the reviewer has a responsibility to inform users concerning data quality and limitations. Availability of DQOs and PSP may be needed for this review. The information will help the user avoid inappropriate use of data and yet not preclude all consideration of the data.

D.8 DATA VALIDATION GUIDANCE FOR GAS CHROMATOGRAPHY ANALYSIS OF ORGANIC COMPOUNDS FOR ASLs B, C, AND D

Gas chromatography guidance for organic compounds is adapted from *Test Methods for Evaluating Solid Waste*, USEPA SW-846, Third Edition, September 1994c. The following guidance applies to data for ASLs B, C, and D. For organic data validation, use the organic data validation checklist, and confirm completion of the checklist and the data package on the organic data validation summary report.

D.8.1 Validation Guidelines for Gas Chromatography Data

D.8.1.1 **Guidelines for ASL B Data**. There are two sublevels of ASL B data, and they require different validation guidance.

If standard, predefined ASL B analysis is specified, QC information shall be reviewed and compared to the QC acceptance criteria of the individual methods. The portions of ASL C and D guidance that are applicable (e.g., matrix spike/matrix spike duplicate, blanks, laboratory control samples) shall be used as the outline for review. The specific acceptance criteria from the Appendix G method shall be used.

If the samples taken are user-defined as ASL B, they shall be validated in accordance with requirements in the PSP for that sampling event. When the data user specifies the quality control (QC) requirements, the validation requirements shall also be specified in the PSP. The FEMP data validation must review the PSP to ensure compliance with PSP requirements.

D.8.1.2 **Guidelines for ASL C and D**. As gas chromatography (GC) methods are identified or developed for ASL C and D analyses, corresponding data validation guidance shall be developed and implemented.

D.8.2 Holding Times and Preservation

Holding time is measured from sample collection to time of sample analysis.

D.8.2.1 **Criteria**. Samples shall be analyzed within the holding times and preserved as specified in Appendix A, Table 6-1.

D.8.2.2 **Guidance for Volatiles (VOAs)**.

A. Establish actual preservation and holding times by comparing sample collection dates on the chain of custody with dates of analysis and/or extraction.

B. If the samples were not appropriately preserved, use professional judgement to qualify the data.

C. If holding times were exceeded, qualify positive results as estimated (J) and sample quantitation limits as estimated (UJ). Document that holding times were exceeded. Reviewer may determine that undetected data should be qualified unusable (R). Indicate in the validation summary narrative that these results which have exceeded hold times may be biased low.

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D.8.2.3 Guidance for Semivolatiles (SVOAs).

A. Establish actual preservation and holding times by comparing sample collection dates on the chain of custody with dates of analysis and/or extraction.

B. If the samples were not appropriately preserved, use professional judgement to qualify the data.

C. For extractions performed 15 to 22 days after sample collection for solids and 8 to 15 days after sample collection for liquids, qualify results as estimated (J/UJ).

D. For extractions performed more than 22 days after sample collection for solids or more than 15 days after sample collection for liquids, qualify detected results as estimated (J). Qualify undetected early eluting SVOAs (phenol through pentachlorophenol) as unusable (R), and qualify undetected late eluting SVOAs (eluting after pentachlorophenol) as estimated (UJ). Note in the data validation report that extended holding times have little effect on late eluting polynuclear aromatic hydrocarbons (PAHs) or their detection limits. This is due to the fact that they are persistent in the environment, and they are not easily subject to biological or chemical degradation or reactions, or loss from the sample container.

E. For analyses performed 41 to 54 days after extraction (solids and liquids), qualify results as estimated (J/UJ).

F. For analyses performed more than 55 days after extraction (solids and liquids), qualify detected results as estimated (J). Qualify undetected early eluting SVOAs (phenol through pentachlorophenol) as unusable (R), and qualify undetected late eluting SVOAs (eluting after pentachlorophenol) as estimated (UJ). Note in the data validation report that extended holding times have little effect on late eluting polynuclear aromatic hydrocarbons (PAHs) or their detection limits. This is due to the fact that they are persistent in the environment, and they are not easily subject to biological or chemical degradation or reactions, or loss from the sample container.

D.8.3 Calibration

D.8.3.1 Criteria. An external calibration guidance shall be used for quantitation by the laboratory.

A. If the calibration factor is used for sample quantitation, the following criteria shall apply:

1. For initial calibration, percent relative standard deviation shall be less than or equal to 20 percent.

2. For continuing calibration, percent difference shall be less than 15 percent.

B. If the linear regression method is used for sample quantitation, the following criteria apply:

1. Verification of the calibration curve is required.

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2. Correlation coefficient shall be greater than or equal to 0.995.

D.8.3.2 **Guidance.** In the primary analysis, standards shall be analyzed at the beginning of the 12-hour period followed by the proper sample/standard sequence. Confirmation analysis requires a mid-level standard at the beginning of the 12-hour period. The mid-level standard shall be run at the end of the sample/standard sequence but within the 12-hour period. If calibration criteria are not met, proceed as follows:

A. If criteria for initial calibration are not met, qualify associated quantitative results as estimated (J).

B. If criteria for continuing calibration are not met in the primary analysis, qualify associated quantitative results as estimated (J).

C. If criteria for continuing calibration are not met in the confirmation analysis, use professional judgement to determine data reliability.

D. If proper standards have not been analyzed, use professional judgement to determine data reliability.

D.8.4 Blanks

D.8.4.1 **Criteria.** Blank criteria apply to method, trip, and field blanks. Criteria for evaluation of blanks apply to blanks associated with samples. If there is a problem with a blank, data associated with the case shall be evaluated to determine if there is an inherent variability in data for the case or if the problem is an isolated occurrence not affecting other data. Contaminants should not be present in blanks.

D.8.4.2 **Guidance.**

A. Review of raw data (e.g., chromatogram, reconstructed ion chromatogram, quantitation reports or data system printouts) for associated blanks. Also review FEMP forms as specified in the laboratory contract.

B. Verify that method blank analysis has been reported per matrix, per concentration level per 12-hour period for each GC system used to analyze VOA samples, and for each extraction batch for other analyses. The method blank summary may be used to assist in identifying samples associated with each method blank.

NOTE

When unsuitable blank results are obtained, action depends on circumstances and origin of the blank.

C. Qualify positive sample results as undetected (U) unless concentration of compound in the sample exceeds ten times amount in any blank for common contaminants listed in step H or five times the amount for other compounds.

D. When more than one blank is associated with a given sample, base qualification upon comparison with the associated blank having the highest concentration of the contaminant.

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E. Results shall not be corrected by subtracting a blank value.

F. Take no action if compound is found in a blank but not found in the sample.

G. Qualify compounds other than those listed in step H that are detected in the sample and also detected in an associated blank when the sample concentration is less than five times the blank concentration.

H. Report a positive result if the concentration of a compound in the sample exceeds ten times the amount in a blank for the following common laboratory contaminants:

1. Methylene chloride,

2. Acetone,

3. 2-butanone (Methyl-ethyl Ketone),

4. Common phthalate esters.

NOTE

The blank analyses may not involve the same weights, volumes, or dilution factors as the associated samples. These factors shall be considered when applying the 5-times and 10-times criteria so that a comparison of the total amount of contamination is actually made. There may be instances (e.g., contamination introduced through dilution water) where little or no contamination is present in associated blanks, but qualification of the sample was deemed necessary. Instances of this can be detected when contaminants are found in the diluted sample result but are absent in the undiluted sample result. However, if the reviewer determines that the contamination is from a source other than the sample, the data shall be qualified. In this case, the 5-times or 10-times rules do not apply and sample value shall be reported as a non-detect.

Following are examples of applying blank qualification guidelines; however, certain circumstances may warrant deviation from these guidelines.

Case 1 Sample result is greater than the contract required detection limit (CRDL) but less than (5- or 10-times) required amount of the blank result.

	Rule	
	10 Times	5 Times
Blank Results	7	7
CRDL	5	5
Sample Results	60	30
Qualified Sample Result	60U	30U

In the example for the 10-times rule, sample results less than 70 (or 10 x 7) are qualified as non-detects. For the 5-times rule, sample results less than 35 (or 5 x 7) are qualified as non-detects.

Case 2 Sample result is less than CRDL and also less than (5- or 10-times) required amount of the blank result.

	Rule	
	10 Times	5 Times
Blank Result	6	6
CRDL	5	5
Sample Result	4J	4J
Qualified Sample Result	5U	5U

Data are not reported as 4U because this indicates a detection limit below the CRDL.

Case 3 Sample result is greater than (5- or 10-times) required amount of the blank result.

	Rule	
	10 Times	5 Times
Blank Result	10	10
CRDL	5	5
Sample Result	120	60
Qualified Sample Result	120	60

For both 10-times and 5-times release, sample results exceeded adjusted blank results of 100 (or 10 x 10) and 50 (or 5 x 10). The result is reported with a "-" flag (no qualifier), signifying a positive result that is confident as reported.

I. If gross contamination exists, qualify affected compounds as unusable (R) in samples affected by interference.

J. If inordinate amounts of other compounds are found at low levels in blanks, record this information in data review comments. It may be indicative of a laboratory problem.

D.8.5 Surrogates

Laboratory performance for individual samples is checked by spiking samples with surrogate compounds prior to sample preparation. Evaluation of results of surrogate spikes is not necessarily straightforward. The sample itself may produce effects caused by such factors as interferences and high concentrations of analytes. Effects of the sample matrix are frequently outside laboratory control and may present unusual problems. Review and validation of data based on specific sample results are frequently subjective and demand analytical experience and professional judgement. Accordingly, the following guidance consists primarily of guidelines and, in some cases, optional approaches are suggested.

D.8.5.1 **<u>ASL C and D Criteria</u>.** Sample and blank surrogate recoveries for volatile and semivolatile compounds shall be within limits specified in the applicable method and the laboratory contract.

D.8.5.2 **<u>Guidance</u>.**

A. For ASL D, check raw data (e.g., chromatogram, quantitation list) to verify recoveries on surrogate recovery form.

B. When unacceptable surrogate recoveries are followed by successful reanalyses, report only the successful run, unless other QC factors such as internal standards or expired holding times indicate otherwise.

C. From surrogate recovery forms, determine if any one surrogate is out of specification or if any surrogate has a recovery of less than ten percent. If so, reanalysis is required, unless the outlier is demonstrated to be due to coelution with a masking PCB.

D. From surrogate recovery forms, determine if recoveries are out of specification with no evidence of repurging, reinjection, or re-extraction. If so, the laboratory has failed to perform satisfactorily.

E. Verify that no blanks have surrogates outside criteria parameters.

F. If there are two or more analyses for a particular fraction, determine which are the better data to report based on the following considerations:

1. Surrogate recovery (marginal versus gross deviation);

2. Internal standard recoveries;

3. Holding times;

4. Comparison of the values of compounds reported in each fraction.

G. For surrogate spike recoveries out of specification, proceed as follows.

1. If a surrogate is out of specification but has recoveries greater than ten percent, proceed as follows:

   a. Qualify detected results for that fraction as estimated (J);

   b. Qualify undetected results for that fraction with the sample quantitation limit as estimated (UJ).

2. If a surrogate in a fraction shows less than ten percent recovery, proceed as follows:

   a. Qualify detected results for that fraction as estimated (J).

   b. Qualify undetected results for that fraction as unusable (R).

3. Do not qualify data with respect to surrogate recovery unless one is out of specification, or unless recovery of a surrogate is less than ten percent.

4. For a blank analysis with surrogates out of specification, give special consideration to the validity of associated sample data and determine whether the problems are isolated to the blank or if there is a fundamental problem with the analytical process. For example, if one or more samples in the batch show

acceptable surrogate recoveries, the blank problem may be an isolated occurrence. Even if this judgement allows some use of the affected data, analytical problems remain, which shall be reported to and corrected by the laboratory.

D.8.6 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

MS/MSD data are generated to determine long-term precision and accuracy of the analytical method on various matrices. These data alone cannot be used to evaluate precision and accuracy of individual samples.

D.8.6.1 Criteria. Spike recoveries and relative percent differences between MS/MSD recoveries shall be within advisory limits in the applicable method in Appendix G.

D.8.6.2 Guidance for ASL C and D Data.

A. Inspect data results for MS/MSD recovery.

B. Verify transcriptions from raw data and verify calculations for ASL D validation.

C. Do not use MS/MSD data alone to qualify an entire case. Use informed professional judgement and MS/MSD results in conjunction with other QC criteria to determine the need for some qualification of the data.

D. Assess the effect of results of MS/MSD on associated data with regard to the MS/MSD sample itself plus specific analytes for samples associated with the MS/MSD.

E. When the LCS is within QC limits, but the MS/MSD results are outside those limits, significant matrix interference probably exists in the sample used for MS/MSD and all similar samples.

F. If it can be determined that results of the MS/MSD affect only the spiked sample, limit qualification to this sample alone.

G. If it is determined through MS/MSD results that a laboratory is having a systematic problem in analysis of one or more analytes, apply qualification to all associated samples.

D.8.7 Compound Identification

D.8.7.1 Criteria.

A. Retention times of reported compounds shall fall within the calculated window for two chromatographic columns.

B. Second-column confirmation is mandatory for detected results for ASL C and D. If the qualitative criteria for two-column confirmation are not met, reported positive detects shall be considered non-detects.

D.8.7.2 Guidance. Use professional judgement to assign an appropriate quantitation limit based on the following guidelines:

A. If a misidentified peak was sufficiently outside target compound retention-time window, the contract required quantitation limit may be reported.

B. If a peak poses an interference with the potential detection of a target peak and the target compound is undetected, qualify the quantitation limits as estimated (UJ).

D.8.8 Laboratory Control Samples (LCS)

D.8.8.1 Criteria. Internal QC limits set by the applicable method (Appendix G) for a given sample matrix shall be applied.

D.8.8.2 Guidance.

A. When the LCS is within QC limits, but the MS/MSD results are outside those limits, significant matrix interference probably exists in the sample used for MS/MSD and all similar samples.

B. If the LCS exceeds method limits for a given sample matrix, inspect data from the associated sample batch.

C. If no analytical problems are found, compare data analyzed with the out-of-control point in the QC section of the case narrative provided with the data package from the laboratory performing the analyses.

D. If problems are found in the analytical data, data should be reported from the reanalysis, unless other QC factors indicate otherwise.

E. If holding times are exceeded during reanalysis, include both sets of data in the data package. Evaluate the impact of all QC factors and use professional judgement to select which result to report.

F. If LCS and matrix spike results are outside method limits, data should be reported from reanalyses or qualified as unusable (R).

D.8.9 Compound Quantitation and Reported Detection Limits (RDLs)
The objective is to ensure that reported quantitation results and RDLs are accurate.

D.8.9.1 Criteria for ASL C and D.

A. Compound quantitation, as well as adjustment of the reported quantitation limit , shall be calculated in accordance with the method specified in Appendix G.

B. Samples identified as solids (e.g., soils) with solid content less than 50 percent should be qualified estimated (J/UJ).

C. VOAs can be lost if the sample is not taken properly (e.g., air bubbles in the vial).

D.8.9.2 Guidance for ASL C and D.

A. Verify that reported quantitation limits were adjusted to reflect sample dilutions, splits, concentrations, clean-up activities, and dry weight factors that were not accounted for in the analytical method.

B. Qualify quantitation limits affected by large, off-scale peaks as unusable (R).

C. If interference is on-scale, provide a numerical estimate of the quantitation limit and qualify the values as estimated (UJ) for each affected compound.

D. Use professional judgement to decide whether a much larger concentration obtained in one column versus the other column indicates presence of an interfering compound.

E. If an interfering compound is indicated, report the lower of the two values and qualify it as presumptively present at an estimated quantity (NJ). This will necessitate the determination of an estimated concentration from the confirmation column.

F. Document that interfering compounds have prevented second-column confirmation.

G. Qualify all organic data as estimated (J) from any sample identified as a solid sample which was determined to contain less than 50 percent solids.

D.8.9.3 Guidance for ASL D. The following guidance applies to ASL D data only and shall be performed in addition to the guidance in Appendix D.8.9.2:

A. Examine raw data to verify correct calculation of sample results reported by the laboratory.

B. Compare quantitation reports, chromatograms, and sample preparation logs to reported positive sample results and quantitation limits.

D.8.10 Overall Assessment of Data for a Case

The data reviewer shall make professional judgements, express concerns, and comment on validity of the overall data package. This is particularly appropriate when there are several QC criteria out of specification.

The additive nature of QC factors out of specification is difficult to assess in an objective manner, but reviewer has a responsibility to inform users concerning data quality and limitations. Availability of DQOs is helpful in this review. The information will help the user avoid inappropriate use of data and yet not preclude all consideration of the data.

D.9 DRINKING WATER DATA VALIDATION GUIDANCE FOR ASL B VOLATILE ORGANIC COMPOUNDS

Drinking water data validation guidance is based on the *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review* (U.S. Environmental Protection Agency, February 1994e).

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D.9.1 Holding Times and Preservation
Determine that sample holding time from sample collection to sample preparation or analysis, was not exceeded and that the sample was properly preserved.

D.9.1.1 Criteria. Samples shall be properly preserved and analyzed within the holding times specified in Table 6-1 (Appendix A).

D.9.1.2 Guidance.

A. Establish actual preservation and holding times by comparing sample collection dates on the chain of custody with dates of analysis and/or extraction.

B. If the samples were not appropriately preserved, use professional judgement to qualify the data.

C. If holding times were exceeded, qualify positive results as estimated (J) and sample quantitation limits as estimated (UJ). Document that holding times were exceeded. The reviewer may determine that the undetected data should be qualified unusable (R) if the reported holding times exceeded 2x the holding time limits. Indicate in the validation summary narrative that these results, which have exceeded hold times, may be biased low.

D.9.2 Internal Standards (IS)

D.9.2.1 Criteria. The following IS performance criteria will ensure that gas chromatography/mass spectroscopy sensitivity response is stable during every run.

A. IS area counts shall not vary by more than a factor of two (-50 percent to +100 percent) from associated calibration standard.

B. IS retention time shall not vary more than ±30 seconds from associated calibration standard.

D.9.2.2 Guidance.

A. Check raw data to verify recoveries of ISs.

B. Verify retention times.

C. If ISs are outside retention time windows, consider rejection of data for that sample fraction.

D.9.3 Percent Surrogate Recovery
Quality of laboratory analysis of individual samples is established by spiking samples with a surrogate compound prior to sample preparation and then evaluating the percent recovery. However, evaluation of results of surrogate spikes is not necessarily straightforward. The sample itself may produce effects caused by factors such as interferences and high concentrations of analytes. The review and validation of data based on specific sample results is frequently subjective and demands analytical experience and professional judgement because

effects of the sample matrix are frequently outside the control of the laboratory and may present relatively unique problems. Accordingly, this guidance consists primarily of guidelines and, in some cases, several optional approaches are suggested.

D.9.3.1 Criteria. Sample and blank recoveries of surrogates shall be within advisory limits of the specified method (Appendix G).

D.9.3.2 Guidance.

A. Verify that surrogate recoveries are within advisory limits.

B. If low recoveries are obtained, qualify associated positive results and quantitation limits as estimated (J/UJ).

NOTE

A high bias may be caused by coeluting interferences.

C. If high recoveries are obtained, use professional judgement to determine the appropriate action.

D. If a zero surrogate recovery is reported, examine the sample chromatogram to determine if the surrogate may be present but slightly outside its retention-time window.

E. If the surrogate is present, in addition to assessing surrogate recovery for quantitative bias, investigate the qualitative validity of analysis.

F. If surrogate is not present, qualify undetected results as unusable (R).

D.9.4 Laboratory Duplicates

Analysis of laboratory duplicates gives a measure of the precision associated with laboratory guidance.

D.9.4.1 Criteria. Specific criteria for laboratory duplicate analyses comparability are specified in the applicable method (Appendix G).

D.9.4.2 Guidance.

A. Compare results for each sample and calculate relative percent difference (RPD).

B. If laboratory duplicate samples are outside control limits, reanalyze them.

D.9.5 Field Guidance.

Analysis of field duplicates gives a measure of precision to sample collection, preservation, and storage as well as to laboratory procedures. Field duplicate samples are collected for every sampling round or sample delivery group.

D.9.5.1 Criteria. Generally, the review criteria for field duplicate analyses are the same as those for laboratory duplicate analyses.

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D.9.5.2 **Guidance**. Compare results for each sample and calculate RPD.

A. Identify samples that are field duplicates using FEMP forms specified in the laboratory contract or PSP.

B. Compare results reported for each sample and calculate the RPD (or actual difference, when a least one of the results is below the contract required detection limit (CRDL).

C. Provide evaluation of field duplicates with reviewer comments.

D.9.6 Blanks

Assessment of blank analysis results determines the existence and magnitude of contamination problems. If problems exist, data associated with the case shall be evaluated to determine whether there is an inherent variability in data for the case or if the problem is an isolated occurrence not affecting other data.

D.9.6.1 **Criteria**. No contaminants should be present in blanks above the contract required detection limit (CRDL).

D.9.6.2 **Guidance**.

A. Verify that method blank analyses contain less than CRDL of target analytes or interfering peaks.

B. Verify that method blank analysis has been reported per matrix, per concentration level, per GC system used to analyze samples for each extraction batch.

C. When unsuitable blank results occur, action depends on the circumstances and origin of the blank. Positive sample results shall be qualified "U" unless compound concentration in the sample exceeds five times the amount in the blank. When more than one blank is associated with a given sample, qualification shall be based upon a comparison with the associated blank having the highest concentration of a contaminant. Results shall not be corrected by subtracting the blank value.

D. If a contaminant is found in the blank but not in the samples, take no action.

E. Qualify target analytes "U" if detected in sample and also detected in an associated blank when sample concentration is less than five times blank concentration.

F. Blank analyses may not involve the same weights, volumes, or dilution factors as associated samples. These factors shall be taken into consideration when applying the 5-times criteria so that a comparison of the total amount of contamination may be made.

G. There may be instances where little or no contamination was present in the associated blanks, but qualification of the sample is deemed necessary (e.g., contamination introduced through dilution water). Although it is not always possible to determine, this situation may be detected when contaminants are found in a diluted sample result, but are absent in the undiluted sample result. It may be impossible to verify this source of contamination. However, if the reviewer determines that contamination is from a source

other than the sample, the data shall be qualified. In this case, the 5-times criterion does not apply; the sample value shall be reported as a non-detect.

Examples of applying blank qualification guidelines follow. Certain circumstances may warrant deviations from these guidelines.

Case 1 Sample result is greater than CRDL but is less than required amount (5 times) of blank result.

5-Times	
Blank result	1.0
CRDL	0.5
Sample result	4.0
Qualified sample result	4.0U

In this case, sample results less than 5.0 (5 x 1.0) are qualified as non-detects.

Case 2 Sample result is greater than required amount (5-times) of blank result.

5-Times	
Blank result	1.0
CRDL	0.5
Sample result	6.0
Qualified sample result	6.0

The result is reported with a "-" flag (no qualifier), signifying a positive result that is confident as reported.

D.9.7 Laboratory Performance Check Solutions
A laboratory check solution is made up of one or more compounds and is used to evaluate performance of the instrument system.

D.9.7.1 Criteria. Criteria are established in the applicable method (Appendix G).

D.9.7.2 Guidance. If check solution is outside control limits, take corrective action (e.g., trouble-shoot instrument and standards preparation).

D.9.8 Matrix Spike/Matrix Spike Duplicates (MS/MSD)
MS/MSD data are generated to determine long-term precision and accuracy of the analytical method (Appendix G) on various matrices. These data alone cannot be used to evaluate precision and accuracy of individual samples.

D.9.8.1 Criteria.

A. Advisory limits are established for spike recovery limits in the applicable method identified in Appendix G and on laboratory contract-specified FEMP forms.

B. Advisory limits are established for relative percent difference between matrix spike and matrix spike duplicate recoveries in the applicable method identified in Appendix G and on laboratory contract-specified FEMP forms.

D.9.8.2 Guidance.

A. Inspect results for MS/MSD recoveries.

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B. Verify calculations.

C. Do not use MS/MSD data alone to qualify an entire case, but use informed professional judgement and MS/MSD results in conjunction with other QC criteria to determine need for qualification of data.

D. First try to determine extent of effects of MS/MSD results on associated data. Make this determination in regard to the sample as well as specific analytes for samples associated with MS/MSD.

E. If it can be determined that results of MS/MSD affect only the spiked sample, limit qualification to that sample alone.

F. If it is determined through MS/MSD results that a laboratory is having a systematic problem in analysis of one or more analytes that affect associated samples, FEMP QA and the FEMP laboratory contacts shall be notified and the affected samples shall be qualified.

D.9.9 Calibration

Calibration requirements ensure that the measuring instruments are capable of producing acceptable quantitative data. Initial calibration ensures that instruments are originally capable of specified performance. Continuing calibration ensures that instruments remain in calibration specific time periods and that required calibration documentation is maintained.

D.9.9.1 Initial Calibration Criteria.

A. Retention-time windows are specified for compounds in the applicable method (Appendix G).

B. All single component analytes except surrogates shall have a percent relative standard deviations (%RSD) less than or equal to 20.0 percent, except that up to two single column analytes per column may fall between 20.0 and 30.0 percent.

C. Surrogates shall have a %RSD less than or equal to 30.0 percent.

D. Up to two target compounds (except surrogates) may have a %RSD greater than 20.0 percent but less than or equal to 30.0 percent.

D.9.9.2 Continuing Calibration Criterion. Relative percent difference (RPD) shall be less than or equal to 25.0 percent.

D.9.9.3 Guidance for Initial Calibration.

A. Verify that %RSD for the calibration factor of each analyte is less than or equal to 20 percent for each 12-hour period.

B. If linearity criteria are not met, qualify associated quantitative results as estimated (J/UJ).

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D.9.9.4 Guidance for Continuing Calibration Data for ASL C and D.

A. To verify quantitative results, check the percent difference between calibration factors by recalculating approximately ten percent of the values reported in raw data using the following formula.

$$\%D = \frac{R_1 - R_2}{R_1} \; x \; 100\%$$

Where:

R_1 = Calibration factor from first analysis
R_2 = Calibration factor from subsequent analysis

B. If percent difference between calibration factors is greater than 25 percent of the quantitated compounds, qualify associated positive quantitative results as estimated (J).

D.9.10 Compound Quantitation and Reported Detection Limits (RDLs)

The validation objective is to ensure that reported quantitation results and RDLs are accurate.

D.9.10.1 Criteria. Compound quantitation, as well as adjustment of the RDL, shall be calculated in accordance with the specified method (Appendix G).

D.9.10.2 Guidance.

A. Examine raw data to verify correct calculation of sample results reported by the laboratory.

B. Compare quantitation reports, chromatograms, and sample preparation logs to reported positive sample results and quantitation limits.

C. Verify that RDLs were adjusted to reflect sample dilutions, splits, concentrations, clean-up activities that were not accounted for in the Appendix G method.

D. Qualify quantitation limits affected by large, off-scale peaks as unusable (R).

E. If the target compound peak is affected by interference, and if the target compound is undetected, qualify the quantitation limit as estimated (UJ) for each affected compound.

F. Use professional judgement to decide whether a much larger concentration obtained in one column versus the other column indicates presence of an interfering compound and qualify the result as estimated (J).

NOTE

When the percent difference for the results of two columns is greater than 25 percent, the laboratory is required to report the lower result and code it (P).

G. Document that presence of interferences has obscured attempt at second-column confirmation.

D.9.11 Overall Assessment of Data for a Case

The data reviewer shall make professional judgements, express concerns, and comment on validity of the overall data package. This is particularly appropriate when there are several QC criteria out of specification. Although it is difficult to assess in an objective manner the additive nature of QC factors which are out of specification , the reviewer has a responsibility to inform users concerning data quality and limitations. Availability of DQOs and the PSP may be needed for is helpful in this review. The information will help the user avoid inappropriate use of data and yet not preclude all consideration of the data.

D.10 INORGANIC DATA VALIDATION GUIDANCE FOR ASL B, C, AND D

This section describes validation guidance for inorganic data for ASL B, C, and D. The following guidance is based on the *USEPA Contract Laboratory Program National Functional Guidelines For Inorganic Data Review,* (U.S. Environmental Protection Agency, 1994d).

D.10.1 Holding Times and Preservation

The objective of validating holding time and preservation data is to establish the validity of analysis results by ensuring that sample holding times from receipt to analysis or extraction were in compliance with the specified method (Appendix G).

D.10.1.1 Criteria. Samples shall be properly preserved and analyzed within the holding times specified in Appendix A, Table 6-1.

D.10.1.2 Guidance.

A. Establish holding times by comparing sample collection date with dates of analysis in raw laboratory data (e.g., digestion logs and instrument run logs). Analyte holding time (days) equals analysis date minus sample collection date.

B. Examine laboratory receipt notes, case narrative, and chain of custody, as well as digestion and distillation logs to determine if samples were preserved at pH and/or temperature specified in Appendix A, Table 6-1.

C. If preservation requirements are not met, qualify results as estimated (J/UJ).

D. If holding times are exceeded, qualify all data as estimated (J/UJ). If holding times were severely exceeded (> 2x listed) the reviewer may use professional judgement to qualify data < IDL (instrument detection limit) unusable (R).

D.10.2 Calibration

Requirements for instrument calibration are established to ensure that instruments are capable of producing acceptable quantitative data Initial calibration demonstrates that an instrument is capable of required performance at the beginning of an analysis run. Verification of continuing calibration ensures that the initial calibration remains valid.

D.10.2.1 Initial Calibration Verification (ICV) Criteria for ASL B, C, and D. Instruments shall be calibrated and an initial calibration verification shall be performed daily as well as each time it is set up.

A. **Inductively Coupled Plasma (ICP) Analysis** - Initial calibration results shall fall within control limits of 90 to 110 percent recovery (%R) of the true value.

B. **AA Analysis** - Initial calibration results shall fall within control limits of 90 to 110 %R of true value.

C. **Mercury Analysis** - Initial calibration results shall fall within control limits of 90 to 110 %R.

D. **Cyanide Analysis** - Initial calibration results shall fall within control limits of 90 to 110 %R.

D.10.2.2 Initial Calibration Criteria for ASL D. The following criteria apply to data for ASL D only and are in addition to criteria in Appendix D.10.2.1.

A. **ICP Analysis**
A blank and at least one standard shall be used to establish the analytical curve.

B. **AA Analysis**
1. A blank and at least three standards, one of which is at the specified contract required detection limit (CRDL), shall be used to establish the analytical curve.

2. The correlation coefficient shall be greater than 0.995. The correlation coefficient of 0.995 is a technical criterion and not contractual.

C. **Mercury Analysis**
1. A blank and at least four standards shall be used to establish the analytical curve.

2. The correlation coefficient shall be greater than approximately 0.995.

D. **Cyanide Analysis**
1. A blank and at least three standards shall be used to establish the analytical curve.

2. The correlation coefficient shall be greater than approximately 0.995.

3. A mid-range standard shall be distilled.

D.10.2.3 Continuing Calibration Verification (CCV) Criteria. The following criteria apply to both ASL B, C, and D data. Continuing calibration verifications are performed every tenth sample or every two hours following the initial calibration verification, whichever is more frequent.

A. Continuing calibration results shall fall within control limits of 90 to 110 %R of true value for all analytes including mercury and cyanide.

D.10.2.4 **Guidance for ASL B, C, and D.** If either ICV or CCV frequency requirements are not met, use professional judgement to qualify the associated data. If ICV or CCV %R falls outside acceptance windows, qualify the associated data and indicate the direction of bias as follows:

A. For all analytes except cyanide and mercury, use the following guidelines:

1. If an ICV or CCV %R is 75 to 89 percent, qualify the results as estimated (J/UJ) and indicate a low bias.

2. If an ICV or CCV %R is greater than 110 percent, qualify detected results as estimated (J) and indicate a high bias. Any ICV or CCV %R which is greater than 150 percent should be considered extremely high and professional judgement should be used to qualify data.

3. If an ICV or CCV %R is less than 75 percent, qualify results as unusable (R).

B. For cyanide, use the following guidelines:

1. If an ICV or CCV %R is 70 to 89 percent, qualify the results as estimated (J/UJ) and indicate a low bias.

2. If an ICV or CCV %R is greater than 110 percent, qualify detected results as estimated (J) and indicate a high bias. Any ICV or CCV %R which is greater than 150 percent should be considered extremely high and professional judgement should be used to qualify data.

3. If an ICV or CCV %R is less than 70 percent, qualify results as unusable (R).

C. For mercury, use the following guidelines:

1. If an ICV or CCV %R is 65 to 89 percent, qualify the results as estimated (J/UJ) and indicate a low bias.

2. If an ICV or CCV %R is greater than 110 percent, qualify detected results as estimated (J) and indicate a high bias. Any ICV or CCV %R which is greater than 150 percent should be considered extremely high and professional judgement should be used to qualify data.

3. If an ICV or CCV %R is less than 65 percent, qualify results unusable (R).

D.10.2.5 **Guidance for ASL D.** The following guidance applies to calibration data for ASL D only and shall be performed in addition to the guidance in Appendix D.10.2.4.

A. Verify that the instrument was calibrated daily and each time it was set up using the correct number of standards and blanks.

B. Verify that the correlation coefficient was 0.995 or greater.

C. If the minimum number of standards were not used for initial calibration, or if instrument was not calibrated daily and each time it was set up, use professional judgement to determine if it is necessary to qualify the data as unusable (R).

D. If the correlation coefficient is smaller than 0.995, qualify results as estimated (J/UJ).

E. Check the distillation log and verify that the mid-range cyanide standard was distilled. If the mid-range cyanide standard was not distilled, qualify associated results as estimated (J).

F. Recalculate one or more of the initial calibration verification (ICV) and continuing calibration verification (CCV) %R per type of analysis (e.g., ICP, or GFAA) using the following equation. Verify that the recalculated value agrees with the laboratory-reported values. Because of possible rounding discrepancies, allow results to fall within one percent of contract windows (e.g., 89 to 111 percent).

$$\%R = \frac{Found}{True} \times 100\%$$

Where:

Found = Concentration (in μg/L) of each analyte measured in analysis of ICV or CCV solution.

True = Concentration (in μg/L) of each analyte in ICV or CCV source.

D.10.3 Blanks

Blank analysis results are assessed to determine existence and magnitude of sample contamination problems. Criteria for blanks evaluation apply to all blanks associated with a sample. If problems with blanks data for ASL B, C, or D exist, associated data shall be evaluated to determine whether there is an inherent variability in the data or if the problem is an isolated occurrence not affecting other data.

D.10.3.1 **Criteria**. There shall be no contaminants in blanks above the CRDL.

D.10.3.2 **Guidance**.

A. Review analytical results as well as raw data (e.g., ICP printouts, strip charts, printer tapes, bench sheets) for blanks and verify that results are reported accurately.

NOTE

If the absolute value of a blank contaminant concentration is less than or equal to the IDL, qualification of sample results is not necessary. If a blank analyte concentration is above the IDL, the lowest concentration of that analyte in associated samples shall be five times the blank concentration.

B. Qualify associated detected results with an analyte concentration less than five times the blank value as undetected (U).

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C. Do not correct sample concentration for the blank value.

D. If concentration of the blank is negative, but the absolute value is greater than IDL, use professional judgement to qualify associated data.

E. If the blank result is below the negative CRDL, samples associated with the blank and having an absolute analyte concentration < 10x the absolute blank concentration are qualified unusable (R).

F. If the blank result is above the CRDL, samples with detected results associated with the blank and having a result < 10x the blank result are qualified unusable (R).

D.10.4 Inductively Coupled Plasma (ICP) Interference Check Sample
The ICP interference check sample (ICS) verifies interelement and background correction factors.

D.10.4.1 Criteria.

A. An ICS shall be run at the beginning and end of each sample analysis run or a minimum of twice per 8-hour shift, whichever is more frequent.

B. Results for ICS solution AB analysis shall fall within control limits of ±20 percent of true value.

D.10.4.2 Guidance for ASL B, C, and D Data.

NOTE

This criterion shall be ignored if the laboratory does not report ICS data for ASL B.

A. Check ICS raw data for ASL D results with an absolute value greater than or equal to IDL for those analytes that are not present in the ICS solution.

B. For samples with concentrations of aluminum, calcium, iron, and magnesium that exceed 50 percent of respective levels in the ICS, proceed as follows:

1. If possible, indicate bias for estimated results in the review.

2. If the required ICP interference check standard was not run, and/or the required frequency was not maintained, qualify all associated results as estimated (J) if the concentration of Al, Ca, Fe or Mg was higher than the concentration in the ICS.

3. If ICS recovery for an element is greater than 120 percent and sample results are undetected, identify data as acceptable for use.

4. If ICS recovery for an element is greater than 120 percent and sample results are detected, qualify affected data as estimated (J).

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5. If an element is detected in the sample and the ICS recovery for that element falls within the range of 50-79 percent, qualify the affected data as estimated (J).

6. If an element is undetected in the sample and the ICS recovery for that analyte falls within the range of 50-79 percent, the possibility of false negatives may exist; qualify data for these samples as estimated (UJ).

7. If ICS recovery results for an element are less than 50 percent, use professional judgement and further consideration of the laboratory control sample (LCS) and matrix spike (MS) recoveries for that element to qualify detected sample results as estimated (J) or unusable (R).

8. If ICS recovery results for an element are less than 50 percent, use professional judgement and further consideration of the laboratory control sample (LCS) and matrix spike (MS) recoveries for that element to qualify all undetected results as estimated (UJ) or unusable (R).

9. If extraneous analytes are detected in the ICS standards, use professional judgement (e.g., compare concentration levels of ICP ICS and associated samples) to qualify the data if those analytes are above the IDL in the unknown sample.

10. The detection of negative results in the ICS greater than the absolute value of the IDL for analytes not included in the ICS standard may indicate a negative bias. Sample results of equivalent absolute magnitude should be qualified estimated (UJ) and considered to be biased low.

D.10.4.3 <u>**Guidance for ASL D**</u>. The following guidance applies to ASL D data only and shall be performed in addition to guidance in Appendix D.10.4.2:

A. From ICP printout, recalculate one or more recoveries using the following equation for %R and verify that the recalculated value agrees with the laboratory-reported value.

$$ICS\ \%R = \frac{Found\ Solution\ AB}{True\ Solution\ AB} \times 100\%$$

Where:

Solution AB_{Found}	=	concentration (in μg/L) of each analyte measured in analysis of solution AB
Solution AB_{True}	=	concentration (in μg/L) of each analyte in solution AB

B. If detected results are observed for elements that are not present in USEPA-provided ICS solution (a possible false positive), evaluate associated sample data for affected elements.

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C. For samples with comparable or higher levels of interferents and with analyte concentrations that approximate those levels found in the ICS (false positive), qualify detected results as estimated (J).

D. If absolute value of negative results is greater than or equal to IDL, negative results are observed for elements not present in USEPA ICS solutions, and their absolute value is greater than IDL (a possible false negative), evaluate associated sample data.

E. For samples with comparable or higher levels of interferents, qualify results for affected analytes as estimated (UJ).

NOTE

In general, sample data can be accepted if concentrations of aluminum, calcium, iron and magnesium in the sample are found to be less than or equal to their respective concentrations in the ICS.

F. If these elements are present at concentrations greater than level in ICS or other elements are present in the sample at more than 10 mg/L, investigate possibility of other interference effects.

D.10.5 Laboratory Control Sample (LCS)

The LCS serves as a monitor of overall laboratory analysis performance including sample preparation.

D.10.5.1 Criteria.

A. Aqueous LCS results shall fall within control limits of 80 to 120 %R except for antimony and silver, which have no control limits.

B. Solid LCS results shall fall within control limits.

C. The laboratory must analyze an LCS.

D.10.5.2 Guidance for ASL B, C, and D.

A. Review data and verify that results fall within control limits.

B. For liquid LCSs, proceed as follows:

1. If LCS recovery for an analyte falls within the range of 50 to 79 percent or is greater than 120 percent, qualify detected results as estimated (J).

2. If results are undetected and LCS recovery is greater than 120 percent, identify data as acceptable.

3. If results are reported as undetected and LCS recovery falls within the range of 50 to 79 percent, qualify data for affected analytes as estimated (UJ).

4. If LCS recovery results are less than 50 percent, qualify data for these samples as unusable (R).

5. If the laboratory fails to analyze an LCS, use professional judgement to determine whether to qualify all associated data as estimated (J/UJ).

C. For solid LCSs, proceed as follows:

1. If LCS recovery for an analyte falls outside control limits, qualify detected results as estimated (J).

2. If LCS results exceed control limits and sample results are undetected , identify data as acceptable.

3. If LCS results are below control limits, qualify sample results as estimated (UJ).

4. If the laboratory fails to analyze an LCS, use professional judgement whether to qualify all associated data as estimated (J).

D.10.5.3 **Guidance for ASL D**. The following guidance applies to ASL D data only and shall be performed in addition to guidance in Appendix D.10.5.2:

A. Check raw data (ICP printout, strip charts, bench sheets) to verify reported recoveries.

B. Recalculate one or more of recoveries (%R) using the following equation.

$$LCS\ \%R = \frac{LCS_{Found}}{LCS_{True}} \ x\ 100\%$$

Where:

LCS_{Found} = concentration (in μg/L for liquid, mg/kg for solid) of each analyte measured in analysis of LCS solution.

LCS_{True} = concentration (in μg/L for liquid, mg/kg for solid) of each analyte in LCS source.

D.10.6 Duplicate Sample Analyses

Duplicate analysis results are indicators of laboratory precision for each sample matrix.

D.10.6.1 **Criteria**.

A. Samples identified as field blanks cannot be used for duplicate sample analyses.

B. A control limit of ±20 percent relative percent difference (RPD) for water samples and ±35 percent RPD for soil samples shall be used for sample values greater than five times CRDL.

C. A control limit of ±CRDL (aqueous) and ±2x CRDL (solid) shall be used for sample values less than five times the CRDL, including those cases where only one of duplicate results is less than five times the CRDL.

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D.10.6.2 Guidance for ASL B, C, and D.

A. Review and verify that results fall within control limits.

B. If duplicate analysis results for an analyte fall outside appropriate control windows, qualify results for the analyte in associated samples of the same matrix as estimated (U/UJ).

C. If a field blank was used for duplicate analysis, use professional judgement to determine whether the associated data should be qualified. The failure to perform laboratory duplicate analysis must be reported to the appropriate FEMP analytical project manager or FEMP QA contact for action.

D.10.6.3 Guidance for ASL D. The following guidance applies to ASL D data only and shall be performed in addition to guidance in Appendix D.10.6.2:

A. Check raw data and recalculate one or more RPD using the following equation to verify that results have been correctly reported.

$$RPD = \frac{|S-D|}{(S+D)/2} \times 100\%$$

Where:

S = first sample value (original).

D = second sample value (duplicate).

D.10.7 Matrix Spike Sample Analysis

The matrix spike sample analysis provides information about the effect of each sample matrix on digestion and measurement methodology.

D.10.7.1 Criteria.

A. Samples identified as field blanks shall not be used for spiked sample analysis.

B. A spiked sample shall be performed for every 20 samples, or one per batch per matrix, whichever is more frequent.

C. Spike recovery (%R) shall be within 75 to 125 percent; however, spike recovery limits do not apply when sample concentration exceeds spike concentration by a factor of four or more.

D. If the spiked sample was not analyzed for every 20 samples and/or for each matrix type and/or each concentration range, notify the analytical project manager and inform them of the deficiency. Depending on the project, the samples may need to be reanalyzed.

D.10.7.2 Guidance for ASL B, C, and D.

A. If the field blank was not the only aqueous sample in the sample delivery group (SDG) and it was used as the spike sample, evaluate the data for impact on data. Outlier recoveries in a blank may indicate an instrument performance problem that requires

qualification. The failure to perform a matrix-specific matrix spike analysis must be reported to the analytical project manager for action.

B. Review and verify that results fall within specified limits.

C. If spike recovery is greater than 125 percent and the sample result is reported as undetected, identify data as acceptable.

D. If a spike recovery is greater than 125 percent, qualify associated detected results as estimated (J).

E. If spike recovery is within the range of 30 to 74 percent, qualify data as estimated (J/UJ).

F. If a spike recovery is less than 30 percent, qualify associated detected results as estimated (J), and qualify results reported as undetected as unusable (R).

NOTE

If the matrix spike and the analytical spike recovery (i.e., post digestion spike) are both low, this indicates a specific matrix interference and should not affect other sample results. Under these circumstances, only qualify the associated analytes in the sample used for spike recovery as estimated (J/UJ).

D.10.7.3 <u>Guidance for ASL D</u>. The following guidance applies to ASL D data only and shall be performed in addition to guidance in Appendix D.10.7.2.

A. Check raw data and recalculate one or more %R using the following equation to verify that results were correctly reported.

$$\%R = \frac{(SSR - SR)}{SA} x100\%$$

Where:

SSR = Spiked sample result
SR = Sample result
SA = Spike added

D.10.8 Contract Required Detection Limit (CRDL) Review for GFAA and ICP CRDL standards are analyzed after initial calibration for all metals, except for Hg, to determine instrument precision/accuracy at a specific point in time.

D.10.8.1 <u>Guidance</u>. CRA (GFAA CRDL standard) and CRI (ICP CRDL standard) results are not used by themselves to qualify analytical results. CRA/CRI results outside of acceptance criteria can be used to support other qualifications of data based on other QC findings.

D.10.9 GFAA Precision/Accuracy Check
Duplicate injections and analytical spikes establish precision and accuracy of individual analytical determinations.

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D.10.9.1 Criteria for ASL B, C, and D.

A. For sample concentrations greater than CRDL, duplicate injections shall agree within ±20 percent relative standard deviation (see Appendix D.6.3.2.B for applicable equations). Otherwise, sample shall be rerun once (at least two additional injections).

B. Analytical spike recovery limits are set as greater than or equal to 85 percent and less than or equal to 115 percent.

C. The GFAA method shall be used as specified in Appendix G.

D.10.9.2 Guidance.

A. Check raw data for ASL D validation to verify that duplicate injections agree within ±20 percent relative standard deviation (%RSD) or coefficient of variation for sample concentrations higher than CRDL.

B. Review GFAA raw data for ASL D validation to verify that the method has been followed.

C. If duplicate injections are outside ±20 %RSD or coefficient of variation limits and if the sample has not been rerun once, qualify data as estimated (J) and note the violation for the purpose of alerting the appropriate FEMP analytical project manager or FEMP QA contact.

D. If rerun sample results do not agree within ±20 %RSD limits, qualify data as estimated (J). If the analytical spike recovery is < 40 percent, the analysis should be repeated at a dilution.

E. If analytical spike recovery is less than 10 percent, qualify detected results as estimated (J) and undetected results as unusable (R).

F. If the analytical spike recovery is greater than or equal to 10 percent but less than 75 percent, qualify results as estimated (J/UJ).

NOTE

If the analytical spike is low in a sample, for which no matrix spike was analyzed, the cause cannot be determined. If the analytical spike is low in a sample where the matrix spike recovery is acceptable, there is a problem with the analytical spike that is unrelated to digestion or matrix effects. The problem is with the analytical spike itself and needs to be addressed. The raw data must be evaluated for possible instrument aliquoting errors, dilution errors, calculation errors, etc. If both the matrix spike and analytical spike recoveries for the same sample are low, this is indicative of a sample-specific matrix effect and does not affect all other samples.

G. If GFAA analytical spike recovery is greater than 125 percent, qualify detected results as estimated (J) and do not qualify undetected results.

NOTE

If GFAA analytical spike recovery is not within 75 to 125 percent and the sample

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absorbance is at least 50 percent of the analytical spike absorbance, reanalysis using the method of standard additions (MSA) is required.

H. If MSA is required but has not been done, qualify data as estimated (J).

I. If samples run by MSA have not been spiked at appropriate levels, qualify data as estimated (J). If the MSA correlation coefficient is < 0.995, the MSA analysis is to be repeated one time. If both correlation coefficients are < 0.995, ensure that the reported result has the higher correlation coefficient and qualify the result as estimated (J/UJ).

J. For ASL D review, if no duplicate injections were performed during GFAA analyses, use professional judgement to determine whether all associated data should be qualified unusable (R).

D.10.10 ICP Serial Dilution

The serial dilution determines whether significant physical or chemical interferences exist because of the sample matrix.

D.10.10.1 <u>Criteria for ASL B, C, and D</u>.

A. If analyte concentration is sufficiently high (concentration in original sample is minimally a factor of 50 above IDL), an analysis of a five-fold dilution shall agree within 10 percent difference of original results after correction for dilutions.

NOTE

If the results have already been qualified due to blank contamination, the sample should not be further considered at this point for serial dilution qualification.

B. The laboratory shall run serial dilution when performing ICP analyses.

C. Field blanks are not to be used for serial dilution.

D.10.10.2 <u>Guidance for ASL B, C, and D</u>.

A. Check raw data for ASL D validation evidence of negative interference (i.e., diluted sample results are significantly higher than original sample).

B. If the dilution analysis for one or more analytes is not within 10 percent, the associated data should be qualified as estimated (J).

C. If evidence of negative interference is found, use professional judgement to qualify data.

D. If the laboratory fails to analyze an ICP serial dilution and the analyte concentration is sufficiently high (minimally a factor of 50 above the IDL), use professional judgement to qualify any associated data.

E. If the field blank was used as ICP serial dilution, do not qualify associated data but note this fact in the data validation report.

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D.10.10.3 **Guidance for ASL D.** The following guidance applies to ASL D data only and shall be performed in addition to guidance in Appendix D.10.10.2:

A. Check raw data and recalculate percent difference using the following equation to verify that dilution analysis results agree with reported results.

$$Percent\ Difference = \frac{|I-S|}{I} \times 100\%$$

Where:

I = Initial sample result
S = Serial dilution result (instrument reading times five)

D.10.11 Sample Result Verification
The objective is to ensure that reported quantitation results are accurate.

D.10.11.1 **Criteria for ASL B, C, and D.**

A. Analyte quantitation shall be calculated as specified in the applicable method identified in Appendix G.

B. Dissolved and total analyte determinations performed for the same sample should be examined for reasonability.

C. If a sample identified as solid matrix contains less than 50 percent solids, the data shall be evaluated due to concern for inability to obtain representative or homogeneous sample for analysis.

D.10.11.2 **Guidance for ASL B, C, and D Data.**

A. For ASL D validation, examine raw data and verify correct calculation of sample results reported by the laboratory.

B. For ASL D, compare digestion and distillation logs, instrument printouts, and strip charts to reported sample results.

C. For ASL D, verify that there are no transcription or data reduction errors (e.g., dilutions, percent solids, sample weights) on one or more samples.

D. For ASL B, C, and D, verify that results fall within linear range of ICP and within calibrated range for non-ICP parameters.

NOTE

When the laboratory provides both ICP and GFAA results for an analyte in a sample and the concentration is greater than the ICP IDL, the validator may compare the two sets of results to identify a potential matrix or homogeneity problem.

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E. If ICP analysis results are used for arsenic, thallium, selenium, or lead, proceed as follows:

1. If IDL is greater than CRDL, verify that sample results are greater than five times ICP IDL.

2. If discrepancies are found, contact laboratory to obtain additional information to resolve differences. If a discrepancy remains unresolved, qualification of data may be warranted.

F. If the concentration of any dissolved analyte is more than 15 percent greater than the total analyte concentration, qualify both dissolved and total results as estimated (J).

G. If the percent solids is determined to be less than 50 percent for a sample identified as a solid matrix (e.g., soil), all associated data should be qualified as estimated (J/UJ) due to inability to obtain representative/homogeneous sample for analysis.

D.10.11.3 <u>Guidance for ASL D</u>. The following guidance applies to ASL D data only and shall be performed in addition to guidance in Appendix D.10.11.2:

A. Examine raw data for anomalies (e.g., baseline shifts, negative absorbance, omissions, legibility).

D.10.12 Field Duplicates

Field duplicate samples may be collected and analyzed as an indication of overall precision. These analyses measure both field and laboratory precision. Therefore, the result may have more variability than laboratory duplicates, which measure only laboratory performance. It is expected that soil duplicate results will have a greater variability than duplicates of water matrices because of difficulties associated with collecting identical soil samples.

D.10.12.1 <u>Criteria</u>.

A. Samples identified as field blanks cannot be used for field duplicate sample analyses.

B. A control limit of ±20 percent RPD for water samples and ±35 percent RPD for soil samples shall be used for sample values greater than five times CRDL.

C. A control limit of ±CRDL (aqueous) and ±2 x CRDL (solid) shall be used for sample values less than five times the CRDL, including those cases where only one of duplicate results is less than five times the CRDL.

D.10.12.2 <u>Guidance for ASL B, C, and D</u>.

A. Identify field duplicate samples on field sample sheets.

B. Compare reported results for each sample and calculate RPDs if appropriate.

C. If field duplicate analyses results for an analyte fall outside appropriate control windows, qualify results for the analyte in both samples as estimated (U/UJ).

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D.10.13 Instrument Detection Limits
Instrument Detection Limits will be determined quarterly, using the methodology specified in the ILM01.0 (3/90) SOW or latest version (for SW 846 methods, detection limits are determined per 40 CFR; see Section 14.6). Results detected at or above the IDL are to be considered positive results. Results less than the IDL are considered undetected and reported at the IDL, coded (U) by the laboratory. For the purposes of determining whether a compound is detected or undetected, USEPA rounding rules shall not be used. Comparisons of IDLs to other detection limits (e.g., RDLs, CRDLs) shall be performed when data are presented.

D.10.13.1 Criteria. IDLs shall be specified for all analytes in every data package, even if other detection limits are presented.

D.10.13.2 Guidance.

A. If IDLs were not included, request the data from the analyzing laboratory.

B. If the IDL is greater than the CRDL and the result is less than five times the IDL, qualify the data point as estimated (J).

C. If the IDLs were not determined within the same yearly quarter as the samples, use professional judgement to determine impact on the data.

D.10.14 Overall Assessment of Data for a Case
This guidance is applicable to ASL D data only. The data reviewer shall make professional judgements, express concerns, and comment on validity of the overall data package for a case. This is particularly appropriate when there are several QC criteria out of specification.
The additive nature of QC factors out of specification is difficult to assess in an objective manner, but the reviewer has a responsibility to inform users concerning data quality and limitations. Availability of DQOs is helpful in this review. The information will help the user avoid inappropriate use of data and yet not preclude all consideration of the data.

D.11 CONVENTIONAL (NON-METALS) DATA VALIDATION GUIDANCE
This section describes validation guidance for inorganic (non-metals) data. The conventional data validation checklist is used in conjunction with this guidance by the data validation team.

D.11.1 Holding Times and Preservation
The objective of validating holding times is to ensure that sample hold times from receipt to analysis or extraction were in compliance with the requirements of the applicable analytical methods and the SCQ.

D.11.1.1 Criteria. The maximum holding times for completion of laboratory sample analysis and the sample preservation requirements are specified in Table 6-1 (Appendix A) of the SCQ.

D.11.1.2 Guidance.

A. Establish holding times by comparing sample collection date with dates of analysis in raw laboratory data (e.g., digestion logs and instrument run logs).

B. Examine digestion and distillation logs to determine if samples were preserved as specified in Table 6-1 (Appendix A).

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C. If preservation requirements are not met, qualify detected results as estimated (J) and results reported as undetected as estimated (UJ). Analyte holding time (days) equals analysis date minus sample collection date.

D. If holding times are exceeded, use professional judgement to determine reliability of data and effects of additional storage on sample results.

D.11.2 Calibration

Requirements for instrument calibration are established to ensure that instruments are capable of producing acceptable quantitative data. Initial calibration demonstrates that an instrument is capable of required performance at the beginning of an analysis run. Verification of continuing calibration ensures that initial calibration remains valid.

Requirements for initial and continuing calibration are specified in each method. Results of initial and continuing calibration shall be compared to method requirements. If method requirements are not met the reviewer may qualify the associated data as estimated (J) if the variance is small or unusable (R) if it is major. Professional judgement shall be used to assess the nature of the variances and whether they are major or minor in effect.

D.11.3 Blanks

The assessment of blank analysis results helps to determine the existence and magnitude of sample contamination. Criteria for evaluation of blanks apply to all blanks associated with a sample. If problems with blanks data exist, data associated with the case shall be evaluated to determine whether there is an inherent variability in data for the entire case or whether the problem is an isolated occurrence not affecting other data.

D.11.3.1 Criteria. There shall be no contaminants in blanks above the contract required detection limit.

D.11.3.2 Guidance.

A. Review analytical results as well as raw data (printouts, strip charts, printer tapes, bench sheets) for blanks and verify that results are reported accurately.

B. If an analyte detected in a blank is also detected in a sample, qualify detected results less than five times the blank concentration as undetected (U).

C. Do not correct sample concentration for the blank value.

D.11.4 Laboratory Control Sample

The LCS serves as a monitor of overall laboratory analysis performance including sample preparation.

D.11.4.1 Criteria. LCS results shall fall within control limits given in Table G-2, Appendix G.

D.11.4.2 Guidance.

A. Check raw data (printout, strip charts, bench sheets) to verify reported recoveries. Review data and verify that results fall within control limits.

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B. Recalculate one or more of percent recoveries (%R) using the following equation.

$$LCS\ \%R = \frac{LCS_{measured}}{LCS_{true}} \times 100\%$$

Where:

$LCS_{measured}$ = concentration (in μg/L for liquid, mg/kg for solid) of each analyte measured in analysis of LCS solution

LCS_{true} = concentration (in μg/L for liquid, mg/kg for solid) of each analyte in LCS source

C. For liquid and solid LCSs with established LCS recovery limits of 80-120 percent, proceed as follows.

1. If LCS recovery for an analyte falls within the range of 50 to 79 percent or is greater than 120 percent, qualify detected results as estimated (J) and indicate the direction of bias.

2. If results are reported as undetected and LCS recovery is greater than 120 percent, identify data as acceptable.

3. If results are reported as undetected and LCS recovery falls within the range of 50 to 79 percent, qualify data for affected analytes as estimated (UJ) and indicate a low bias.

4. If LCS recovery results are less than 50 percent, qualify data for these samples as unusable (R) and indicate an extremely low bias.

D.11.5 Duplicate Sample Analyses

Duplicate analyses are indicators of laboratory precision based on each sample matrix.

D.11.5.1 Criteria.

A. Samples identified as field blanks cannot be used for duplicate sample analyses.

B. A control limit of ±20 percent relative percent difference (RPD) for water samples and ±35 percent RPD for soil samples shall be used for sample values greater than five times the method detection limit (MDL).

C. A control limit of ±MDL shall be used for sample values smaller than five times the MDL.

D.11.5.2 Guidance.

A. Review and verify that results fall within control limits.

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B. Check raw data and recalculate one or more RPD using the following equation to verify that results have been correctly reported.

$$RPD = \frac{|S-D|}{(S+D)/2} \times 100\%$$

Where:

S = first sample value (original)
D = second sample value (duplicate)

C. If duplicate analysis results for an analyte fall outside appropriate control windows, qualify results for the analyte in associated samples of the same matrix as estimated (J).

D. If a field blank was used for duplicate analyses, check other QC data and exercise professional judgement to evaluate data.

D.11.6 Matrix Spike Sample Analysis

The matrix spike sample analysis provides information about the effect of each sample matrix on digestion and analyte recovery.

D.11.6.1 **Criteria**. The following criteria apply to methods where matrix spike samples are analyzed:

A. Samples identified as field blanks shall not be used for spiked sample analysis.

B. Spike recovery (%R) shall be within 75 to 125 percent; however, spike recovery limits do not apply when sample concentration exceeds spike concentration by a factor of four or more.

D.11.6.2 **Guidance**.

A. Verify that the field blank was not used for spike analysis.

B. Check raw data and recalculate one or more percent recovery using the following equation to verify that results were correctly reported.

$$\%R = \frac{(SSR-SR)}{SA} \times 100\%$$

Where:

SSR = Spiked sample result
SR = Sample result
SA = Spike added

C. Review and verify that results fall within specified limits. If limits are 75 to 125 percent, the following are required:

1. If the spike recovery is greater than 125 percent, qualify detected results as estimated (J), and indicate a high bias. Undetected results are not qualified.

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2. If the spike recovery is within the range of 30 to 74 percent, qualify data as estimated (UJ/J), and indicate a low bias.

3. If the spike recovery is less than 30 percent, qualify detected result as estimated (J) and undetected results as unusable (R). Note that both are biased extremely low.

D. If the field blank was used for matrix spike analysis, check other QC data and exercise professional judgement to evaluate data.

D.11.7 Required Detection Limit Review for CN Analysis
A mid-range calibration verification standard is distilled and analyzed to determine the method accuracy/precision at a given point in time.

D.11.7.1 Guidance. If a mid-range calibration verification standard was not distilled and analyzed, and/or if the analyzed value of this standard is not within the acceptable range of its established value (±0.5 x established value), qualify all associated data as estimated (J).

D.11.8 Sample Result Verification
The objective is to ensure that reported quantitation results are accurate.

D.11.8.1 Criteria. Analyte quantitation shall be calculated as specified in the applicable method in Appendix G.

D.11.8.2 Guidance.

A. Examine raw data and verify correct calculation of sample results reported by the laboratory. Examine raw data for anomalies (e.g., baseline shifts, negative absorbance, omissions, legibility).

B. Compare digestion and distillation logs, instrument printouts, and strip charts to reported sample results.

C. Verify that there are no transcription or data reduction errors (e.g., dilutions, percent solids, sample weights) on one or more samples.

D. Verify that results fall within calibrated range.

D.11.9 Field Duplicates
Field duplicate samples may be taken and analyzed as an indication of overall precision. These analyses measure both field and laboratory precision; therefore, the result may have more variability than laboratory duplicates, which measure only laboratory performance. It is expected that soil duplicate results will have a greater variance than duplicates of water matrices because of difficulties associated with collecting identical soil samples.

D.11.9.1 Criteria.

A. Samples identified as field blanks cannot be used for field duplicate sample analyses.

B. A control limit of ±20 percent RPD for water samples and ±35 percent RPD for soil samples shall be used for sample values greater than five times MDL.

C. A control limit of ±MDL (aqueous) and ±2 x MDL (solid) shall be used for sample values less than five times the MDL, including those cases where only one of duplicate results is less than five times the MDL.

D.11.9.2 Guidance.

A. Identify field duplicate samples on field sample sheets.

B. Compare reported results for each sample and calculate RPDs if appropriate.

C. If field duplicate analysis results for an analyte fall outside the appropriate control windows, qualify results for the analyte in both samples as estimated (U/UJ).

D.11.10 Overall Assessment of Data for a Case

The data reviewer shall make professional judgements, express concerns, and comment on validity of the overall data package for a case. This is particularly appropriate when there are several QC criteria out of specification.

The additive nature of QC factors out of specification is difficult to assess in an objective manner, but the reviewer has a responsibility to inform users concerning data quality and limitations. Availability of DQOs is helpful in this review. The information will help the user avoid inappropriate use of data and yet not preclude all consideration of the data.

D.11.11 Treatment of ASL E Data

Where appropriate for specific projects where standard methods do not exist or standard method criteria are not capable of meeting DQO goals, new ASL E methods may be developed or traditional methods modified to better meet the project objectives. When this is done, the method must be thoroughly validated, with the validation process documented by laboratory personnel or other subject matter experts. Validation criteria will be developed by the data validation manager to functionally contain as appropriate the materials specified in Appendix D.2.2, and follow requirements of the data validation plan. Personnel will be trained to the new validation procedure using one of the approved training methods (e.g., a briefing) prior to performing validation work.

D.12 DATA VALIDATION GUIDANCE FOR RADIOLOGICAL ANALYSES

Generally, validation of the data will include examination of the digestion, separation, or other preparation logs, all instrument printouts including spectra and counting logs for all samples, standards, and QC samples. Chain of custody records, calibration data (including certifications of standards), calculations of the detection levels and results, background results, and computer algorithms, if available, must also be examined.

Calculations made from the raw data are verified to ensure that no transcription errors were made and that all results are correctly reported in the data package. Verification includes checking the mathematical operations, including conversion of units and dilution factors. Other radiological parameters such as the half-lives, decay corrections, branching ratios, dead times for counters, and correlation coefficients for efficiency curves may need verification as well. Requirements to be reviewed during validation are listed below:

A. Completeness checks;

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B. Calibration;

C. Blanks;

D. Detection limits and sample results;

E. Radiometric and gravimetric yields;

F. Duplicate sample analyses;

G. Laboratory control samples;

H. Holding times and sample preservation;

I. Method-specific and other quality controls;

J. Alpha sample region of interest (ROI) checks;

K. Field QC evaluations;

L. Matrix spike (MS) samples;

M. QC standards;

N. Estimated measurement uncertainties.

D.12.1 Completeness Checks
Examine the data package for completeness. Use the radiochemistry data validation checklist and the other applicable checklists, but also refer to the statement of work (SOW) for the appropriate analytical laboratory. Items specified in the SOW may supplement or take precedence over the list of items in the checklists. Confirm completion of the checklist and the data package using the radiochemistry data validation summary report.

D.12.1.1 **Evaluation Criteria.** Verify that the items listed in the SOW and the Method-Specific Appendices are included in the data package. These items may be recorded in various ways, and the data package may be organized differently than this guidance, so some searching may be required.

D.12.1.2 **Guidance.** If minor deficiencies are encountered and can not be rectified by the laboratory, all affected (associated) data must be qualified as estimated (J). Major deficiencies that can not be rectified will require that all affected data be qualified as unusable (R).

D.12.2 Calibration
Instruments must be initially calibrated in accordance with laboratory standard operating guidance and/or manufacturer's instructions. This initial calibration must be repeated whenever a detector or other major system component is changed. Frequently thereafter, less extensive continuing calibration checks, which consist of background and check source counts, must be done.

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NOTE

Specific calibration requirements for radiochemistry methods are not in this document, but are defined in the laboratory statements of work (SOWs).

D.12.2.1 **Criteria**. Review the data package to verify that the instrument was calibrated properly and within the time period specified in the laboratory SOW.

D.12.2.2 **Guidance**.

A. If the instrument was not calibrated properly within the specified time period, qualify the associated data as unusable (R).

B. Each detector in multiple counting systems must be calibrated. Compare the identifications of detectors calibrated against those used for all analyses to verify that each detector used was calibrated.

C. If the detector was not calibrated, qualify all associated data as unusable (R).

D. Use National Institute of Standards and Technology (NIST), NIST-traceable, or equivalent certified standards for calibration.

E. Review the certifications, including identification numbers, of the standards. Compare the identification numbers on the certificates with identification numbers on the instrument printouts.

F. If the standards used for calibration are not certified or traceable, or if they cannot be positively identified, qualify all associated data as unusable (R).

NOTE

The standards must not have deteriorated by the time they are used for calibration.

G. Review the expiration or issue (assay) dates and activities of the standards.

H. If the standards used were past their expiration dates and there is no confirmation for activity which meets the criteria of a FEMP-approved laboratory SOW, or if the standard is past five half-lives of the radionuclide of interest, qualify all associated results as unusable (R).

I. If the standards used for calibration did not have sufficient activity, qualify all associated data as unusable (R).

NOTE

Sufficient activity is defined to mean that each peak, window, or energy region of interest must contain at least 1000 net counts and/or a counting uncertainty of 5 percent or less.

NOTE

The activity of each radionuclide present in any calibration and check source used during analysis of samples in question must be documented.

J. If the activity and identity of the radionuclide(s) used in the check source(s) are not provided, qualify all associated data as estimated (J).

K. The check source(s) shall be counted daily or as specified in the laboratory SOW.

L. If the daily check source is not counted and the QC samples are in the applicable control limits, qualify associated results as estimated (J).

M. The check source counts shall be within the control limits provided by the laboratory but no greater than ±3 standard deviations of the mean. Review the results, including raw data, of all daily check source counts.

N. If the check source counts are outside of the control limits, qualify all associated data as unusable (R). In this case, associated data include the results for all counts within the time period covered by those check source counts. Use the raw data or compare the raw data with the count log to determine the affected time periods. Note any bias or trend in the data validation report.

O. If daily background checks (no stipulation on count times) were not performed, or if the daily background check results were not within ±2 standard deviations of the mean, qualify all associated data as estimated (J).

NOTE

The length of the background counts can vary, depending upon such factors as the type of detector, the use of background subtraction software, and the desired instrument detection limit concentration (IDLC). The germanium detectors and alpha spectrometers may have 60-hour background counts at a weekly frequency. Some beta/gamma counters may satisfy all requirements with one-hour background counts once a day. The validator must use professional judgement to determine whether the count times for backgrounds and/or the frequencies for specific analyses were correct. Consult the laboratory SOW for applicable requirements.

P. If both geometry and matrix match between samples and efficiency calibration standards are different, qualify all associated results as unusable (R). If the geometry matches and matrices are not identical, but all associated quality control analyses (LCS, duplicates, spikes) are acceptable, no qualification of data is required. If geometry match is not identical but the matrix matches are acceptable, associated data should be qualified estimated (J). However, the quantitation of the result may be considered questionable.

D.12.2.3 <u>Supplemental Calibration Requirements for Analyses Using Gas Proportional Counters: Evaluation Criteria</u>. Depending upon the type of counter/system used, review the results, as applicable, of the plateau determination, amount of alpha-beta crossover, random coincidence counts, and/or energy calibration. Review the efficiency determinations and self-

absorption curves. Verify that the weight or areal density of solids deposited on each sample planchet is bracketed by data points used to establish the applicable self-absorption curve. Self-absorption curves shall be generated for each radionuclide of interest unless other factors preclude the need to correct for self-absorption (i.e., controlled aliquot and/or particle distribution).

D.12.2.4 Supplemental Calibration Requirements for Analyses Using Gas Proportional Counters: Guidance.

NOTE

Crosstalk may exceed the stated limits, provided that the laboratory's equations for activity calculations properly compensate for the crosstalk. In this case, no qualifier should be added to the analysis results.

A. If the analysis laboratory cannot furnish data which documents that the self-absorption curves were properly determined, qualify all associated data as unusable (R).

B. If the planchets resulting from field and QC sample preparations have residue weights outside the range covered by the self-absorption curves, qualify all associated data as estimated (J).

C. If the beta or alpha efficiency calculation shows less than 20 percent efficiency, qualify all data as estimated (J).

D. If the laboratory cannot furnish data which documents that the proportional counter plateau and operating voltage were properly determined, qualify all associated data as unusable (R).

E. If the length of the plateau is less than 400 volts and/or the slope of the plateau is greater than 6 percent, qualify all associated data as estimated (J).

F. If the laboratory cannot furnish data which documents both alpha-into-beta and beta-into-alpha crosstalk, or if the alpha-into-beta cross talk is greater than 6 percent, or if the beta-into-alpha cross talk is greater than 3 percent, qualify all associated data as unusable (R).

G. If the alpha-into-beta crosstalk is between 4 percent and 6 percent, or if the beta-into-alpha crosstalk is between 1 percent and 3 percent, qualify the associated gross alpha and gross beta analysis results as estimated (J). Stability verifications, (e.g., plateau(s) or response(s) to the check sources) shall be made after each gas change. Specific verifications may not be needed if check sources are used daily. If stability verifications were not performed, qualify all data as estimated (J).

NOTE

Crosstalk may exceed the stated limits provided that the laboratory's equations for activity calculations properly compensate for crosstalk. In this case, no qualifier should be applied to the results.

D.12.2.5 Supplemental Calibration Requirements for Analyses Using Alpha Spectroscopy: Evaluation Criteria.

A. The energy and efficiency of the system should be measured over an energy range which spans the energy range of interest for samples.

B. At least three peaks should be used to calibrate the alpha spectrometry system for both energy and efficiency.

C. The efficiency from the check source count for the sample delivery group (SDG) should be within 3 sigma of the efficiency from the control charts.

D. Alpha detector efficiencies must be greater than 5 percent.

E. The resolution of each peak used in calibration should be 100 keV or less.

D.12.2.6 Supplemental Calibration Requirements for Analyses Using Alpha Spectroscopy: Guidance.

A. If the radionuclide of interest emits alpha particles with characteristic energies outside the range spanned by the source(s) used to calibrate the alpha spectrometer, qualify all results as estimated (J).

B. If less than three peaks were used (e.g., only one or two peaks were submitted), examine submitted efficiency data and other pertinent data, such as tracer data. If acceptable efficiency can be established, qualify associated data as estimated (J). If, after using professional judgement, the reported efficiency is not acceptable, qualify data as unusable (R).

C. If the alpha detector efficiency source check is not within the prescribed limits but other QC results (e.g. tracer recovery, LCS recovery, etc.) indicate that the detector is functioning properly during the sample count, qualify associated results as estimated (J). In the absence of any other data which indicates proper functioning of the detector, qualify the results obtained with that detector as unusable (R).

D. Review the calibration spectrum or printout to verify that the resolution of the detector system provides accurate identification of each peak centroid (i.e., the peaks have sufficient counts and are distinct and separate from each other.)

E. A nominal value of 100 keV (or number of channels if detector gain is available) full width half maximum (FWHM) is used to gauge resolution for each peak used to calibrate the detector system. If the resolution of the system is greater than 100 keV (or corresponding number of channels) FWHM for any of the peaks used in the calibration, qualify all results as estimated (J).

D.12.2.7 Supplemental Calibration Requirements for Analyses Using Gamma Spectroscopy: Evaluation Criteria. Gamma spectrometry systems must be calibrated for both energy and efficiency at a frequency specified in the laboratory SOW or this SCQ.

NOTE

When performing efficiency calibrations of gamma spectrometry systems, it is important to use mixed nuclide sources which contain at least six useable gamma emissions. When fewer than six peaks are used, the variation of detector efficiency with energy may not be known reliably. The range of gamma sources selected for calibration reference must encompass the entire span of photon energies to be resolved.

D.12.2.8 Supplemental Calibration Requirements for Analyses Using Gamma Spectroscopy: Guidance.

A. If the efficiency versus energy graph generated during the gamma spectrometer efficiency calibration does not approximate a smooth curve on a semilog graph with the properties listed below, qualify all associated results as unusable (R). The efficiency calibration curve should exhibit the following:

1. A broad peak with a maximum occurring between 175 keV and 225 keV;

2. The graph drops sharply on the low energy side of the maximum;

3. The graph falls less sharply on the high energy side of the maximum, approximating a straight line above 800 keV.

B. If fewer than six gamma emission lines are used to derive the efficiency versus energy graph, qualify the associated data as unusable (R).

C. If the geometry and density of the samples do not closely approximate the geometry and density of the calibration standards, qualify associated sample results as unusable (R).

D. The calibration of the detector system must cover the energy range of interest, but at least as low as reasonably achievable to 1.8 MeV. Review gamma spectrometry reports to ensure that the energies of the sample spectral peaks used to calculate quantitative results are within the energy ranges covered by the calibration standards.

E. If the energy of a particular gamma emission falls outside the range of energies used to calibrate the spectrometer, qualify all results as estimated (J).

F. Review the system energy calibration to ensure that the gamma spectrometer resolution is adequate to resolve the gamma emission of interest. If the FWHM of peaks near 1400 keV in the calibration spectrum exceeds 3.5 keV but is less than or equal to 5 keV, qualify all associated analysis results as estimated (J).

NOTE

Detector resolution varies with energy. A reasonable detector resolution at 1332 keV would be 2.1 keV. Resolution may be examined by checking the FWHM of the peaks in the energy calibration spectrum. Although detector resolution (i.e., peak FWHM) varies with energy, a resolution of 3.5 keV at an energy of 1400 keV is generally adequate.

G. If the resolution of the system is greater than 5 keV for any peaks used for calibration, qualify all results as unusable (R).

NOTE

This channel width specification for resolution may need to be altered based on gain setting used to gather data.

H. If gamma spectroscopy dead time during detector calibration of sample analysis was between 15 percent and 25 percent, qualify all associated data as estimated. If dead time exceeded 25 percent, qualify all associated data as unusable (R).

D.12.2.9 **Supplemental Calibration Requirements for Radon Emanation Scintillation Counting: Evaluation Criteria.** A counting system consists of a scintillation cell (e.g., Lucas cell) and the associated photomultiplier tube, electronics, and scaler. Each counting system should be calibrated as a unit. Calibration consists of determining a calibration constant using a NIST traceable standard(s). The calibration constant includes the de-emanation efficiency of the system and the counting efficiency of the scintillation cell. The counting system shall be calibrated according to the current laboratory SOW requirements and/or each time there is a repair or replacement of a system component that could affect the calibration (such as scintillation cell), and/or after every 20 uses, and/or semi-annually, whichever is more frequent. A system stability check source is to be counted with each use of the instrument unless otherwise stated in the FEMP laboratory SOW. The scintillation cell should be uniquely identified.

D.12.2.10 **Supplemental Calibration Requirements for Radon Emanation Scintillation Counting: Guidance.**

A. If calibration data cannot be definitely associated with the specific counting system, qualify associated sample results unusable (R).

B. If the counting system has not been calibrated at the required frequency, qualify the associated results as unusable (R).

C. If the counting system stability checks were not performed at the required frequency, qualify associated results as estimated, (J).

D.12.2.11 **Supplemental Requirements for Liquid Scintillation Counting: Evaluation Criteria.** Reference the current FEMP laboratory SOW to determine additional calibration requirements for liquid scintillation counting.

D.12.2.12 **Supplemental Requirements for Liquid Scintillation Counting Calibration: Guidance.**

A. If required quench curves cannot be obtained, then qualify all associated data as unusable (R).

B. If required interference corrections were not made by laboratory, then qualify all associated data as unusable (R).

D.12.2.13 **Supplement Requirements for Kinetic Phosphorescence Analysis, Evaluation: Criteria.** This technique is not a radiochemical counting technique, but rather a phosphorescence technique generally used to determine total uranium concentration.

D.12.2.14 **Supplemental Requirements for Kinetic Phosphorescence Analysis KPA: Guidance.**

A. Detection limit measurement shall be prepared from a solution at a concentration near the KPA detection limit. The laboratory shall analyze ten or more standard solutions and calculate the standard deviation. The detection limit will be defined as three times this standard deviation.

B. Kinetic phosphorescence systems should be calibrated at a frequency as specified in the laboratory SOW or in the SCQ.

C. Sample concentrations, except those near the minimum detectable concentration, must be bracketed by the concentrations of standards on the calibration curve.

D. If none of the following conditions are met, qualify all associated data as unusable (R); if one or more of the following conditions are not met, qualify all associated data as estimated (J):

Curve correlation coefficiency (R^2) > 0.95
Lifetime is 150-350 micro seconds
Intensity taken after 5th or higher time gate.

This information must be documented in the data packages.

E. If the calibration curve did not cover the range of concentrations for samples analyzed and the calibration curve is not linear ($R^2 < 0.95$), qualify all associated data as unusable (R).

F. If the calibration curve did not cover the full range of concentrations but it is linear, qualify associated data as estimated (J).

G. The laboratory shall supply the raw data and results of the most recent 3-point calibration verification checks (performed weekly or immediately prior to use, with calibration checks at the extremes and center of the concentration range).

H. If the discrepancy between the measured concentration of any calibration standard and the calibration curve is outside control limits, qualify associated data as estimated (J).

D.12.3 Blanks

D.12.3.1 **General Evaluation Criteria for Method Blanks**. A method blank of the same aliquot size as the samples must be processed like a sample and analyzed with each SDG on the same detector or detector system. When multiple detectors are used to analyze samples in the SDG, only one method blank must be analyzed on one of the detectors used to analyze samples in the SDG. However, background and check standard data must be submitted for all detectors used to analyze samples in the SDG. All detectors used to analyze samples in the SDG must be identified and linked to their subsequent associated counting data.

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NOTE

Instrument detection limit concentrations (IDLC) are FEMP laboratory SOW defined detection limits for background corrected results. Any method blank result (activity) above the associated IDLC is considered to be a detect, unless otherwise qualified.

Calculation of Instrument Detection Limit Concentration (IDLC)

$$IDLC = \frac{3.29 * S_{BKG}}{K} + \frac{2.71}{T_{GS} * K}$$

Where:

T_{GS} = Sample Count Time (minutes)

S_{BKG} = Standard Deviation of the Background Count Rate

K = 2.22 dpm/pCi * ALI * $e^{-\lambda t}$ * R * EFF_S * ABN_S

Where: ALI is the sample aliquot mass or volume, R is the recovery or yield, EFF_S is the sample counter efficiency, $e^{-\lambda t}$ is the decay correction, and ABN_S is the sample abundance fraction.

$e^{-\lambda t}$ ≡ decay correction factor where λ is the natural log of 2 divided by the half-life of the isotope of concern, and t is the time from sample collection to sample analysis.

$$S_{BKG} = \sqrt{\frac{2B_{SD}}{T_{GS}}}$$

Where: B_{SD} = Sample Detector Background Count Rate

T_{GS} = Sample Count Time (minutes)

D.12.3.2 General Guidance For Data Which is not Blank Corrected by the Laboratory.

NOTE

In data packages where more than one blank analysis has been done for a radionuclide, use the blank with the highest levels of contamination for assigning qualifiers.

A. If no method blank was analyzed with the analytical preparation batch/SDG, qualify all results greater than the IDLC as estimated (J).

B. If no method blank was analyzed on the same detector or detector system with the analytical preparation batch/SDG, qualify all results greater than the IDLC as estimated (J).

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C. If the analytical detectors were not identified for associated counting data, qualify all results greater than the IDLC as estimated (J).

D. If background or check standard data was submitted, qualify all results greater than the IDLC as estimated (J).

E. Verify the calculation or method of calculating the net blank value and verify that no contaminants were detected (e.g. result < IDLC). If no contamination was found, no further evaluation of the blank is necessary.

F. If laboratory analysis reveals contamination in a method blank (i.e., blank result > IDLC), qualify associated samples which were not blank corrected by the laboratory as indicated below:

1. Undetected (U), if sample result <IDLC.

2. Undetected estimated (UJ), if sample result < IDLC > HAMDC (Highest Allowable Minimum Detectable Concentration).

3. Undetected (U), if sample result > IDLC and sample result < blank result.

4. Estimated (J), if sample result >IDLC, and sample result < 5x blank result.

5. No qualifications (-), if sample result > IDLC, blank result and 5 x blank result.

NOTE

Generally, no action is taken if a radionuclide is detected in a method blank but not in the associated samples. However, the validator must be vigilant for situations when a radionuclide that is found in the method blank may cause interference with other radionuclides detected in associated samples.

G. Any method blank with a negative result whose absolute value is greater than the IDLC must be carefully evaluated to determine its effect on sample data. Review all the QC data specific to the method to evaluate the possibility of false negatives.

NOTE

If more than one lot of reagents were used to prepare a given batch of samples, additional method blanks must be analyzed to ensure that any reagent contribution to the method blank was consistent. This is especially significant in the analysis of radium due to the fact that reagents may have significant quantities of this radionuclide.

H. If additional blank samples were not analyzed to check potential contamination of reagents with a different lot number from those used for previous blanks, qualify associated results as estimated (J).

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D.12.3.3 General Guidance for Data Which is Blank Corrected by the Laboratory.
No qualification is required if results have already been blank corrected by the laboratory. The only item of concern is to determine if the method blank activity is typical (e.g. ±3 standard deviations of established mean blank activity). If blank activity used to correct associated results is outside the established range of blank activity, qualify all results as estimated (J) and/or detection limits (IDLC/minimum detectable concentration) as nondetected estimated (UJ).

D.12.3.4 Calculation of Sample-Specific Minimum Detectable Concentration.

Note

Blank count time shall meet or exceed the longest sample count time of the appropriate batch. Also, the background count time shall NOT exceed the sample count time by more than a factor of two.

Minimum detectable concentration (MDC) is calculated as follows:

$$MDC = \frac{3.29 * (S_{BLK})_i}{K} + \frac{2.71}{T * K}$$

Where,

K = a correction factor that includes such things as units conversion, sample volume/weight, decay correction, detector efficiency, chemical recovery and abundance correction, etc. (see definition of K in D.12.3.1);

T = the counting time of the sample;

$(S_{BLK})_I$ = the calculated standard deviation for the method blank assuming it had been counted in the ith chamber for the same length of time as the ith sample and that the blank tracer/chemical recovery was equal to that of the ith sample.

$(S_{BLK})_I$ is calculated as follows:

$$(S_{BLK})_i = \left((\sigma_{BMB})^2 + 2\frac{B_{SC}}{T} \right)^{1/2}$$

Where,

$$\sigma^2_{BMB} = \left(\frac{E_2}{E_1}\right)^2 \left(\frac{R_2}{R_1}\right)^2 \left(\left(\frac{G_{MB}}{T_1}\right) + \left(\frac{B_{MBC}}{T_2}\right) \right) + B^2_{MB} \Sigma^2_{i=1} \left(\left(\frac{\sigma_E}{E}\right)^2_i + \left(\frac{\sigma_R}{R}\right)^2_i \right)$$

[I = 1 for the blank chamber and I = 2 for the sample chamber] and,

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$$B_{MB} = \left(G_{MB} - B_{MBC}\right)\left(\frac{E_2}{E_1}\right)\left(\frac{R_2}{R_1}\right)$$

where,

$(\sigma_E/E)_1$ = the relative error for the method blank counter efficiency,
$(\sigma_E/E)_2$ = the relative error of the sample counter efficiency,
$(\sigma_R/R)_1$ = the relative error for the tracer/chemical recovery of the method blank, $(\sigma_R/R)_2$ = the relative error for the tracer/chemical recovery of the sample, and
σ_{E1} = Uncertainty in the calculated value of the blank chamber efficiency;
σ_{R1} = Uncertainty in the tracer/chemical recovery value for the blank analysis;
σ_{E2} = Uncertainty in the calculated value for the efficiency of the sample chamber;
σ_{R2} = Uncertainty in the tracer/chemical recovery for the sample analysis;
B_{MB} = Count Rate of Blank if counted in the ith sample chamber;
G_{MB} = Method blank gross count rate;
B_{MBC} = Method blank counter background count rate;
E_1 = Method blank counter efficiency;
E_2 = Sample counter efficiency;
R_1 = Tracer chemical recovery of method blank;
R_2 = Tracer chemical recovery of sample;
B_{SC} = Sample counter background count rate;
T_1 = Sample count time; and
T_2 = Background count time.

D.12.4 Detection Limits and Sample Results

D.12.4.1 Criteria.

MDCs are FEMP laboratory SOW defined detection limits for blank corrected results. Any result above the associated MDC is considered to be a detect, unless otherwise qualified.

D.12.4.2 Guidance.

A. Verify calculations for concentration, total propagated uncertainty (TPU), IDLC, and MDC. If errors are found, the laboratory shall correct and resubmit the associated data.

NOTE

All errors found are to be corrected by laboratory, not the validator.

B. Any result below IDLC/MDC is considered undetected (U).

C. Any result greater than IDLC/MDC, but with TPU ≥ 50 percent of the result is considered to be estimated (J). The result and TPU are reported with the (J) qualifier.

D. If the result is greater than IDLC/MDC and the TPU is less than the result, the result and TPU are reported with no qualifications.

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E. If the result is below the IDLC/MDC and the IDLC/MDC is greater than the HAMDC. The IDLC/MDC is considered undetected estimated (UJ), with the IDLC/MDC being reported for this undetected result.

D.12.4.3 **Supplemental Sample Results/Detection Limits Requirements for Gamma Spectrometry Analyses.** If the percent error reported for the net peak area for one or more of the peaks used to calculate the result is greater than 50 percent, and/or the detector dead time for the sample is greater than 20 percent, qualify the associated data as estimated (J).

D.12.5 Radiometric and Gravimetric Yields Evaluation Criteria.

D.12.5.1 **Criteria.** A radiochemical tracer, spike, or carrier must be added to each sample undergoing analysis, including the blank. The tracer, spike, or carrier must have chemical and radioactive characteristics appropriate for the sample matrix and analytical method. The following analyses are exceptions to this requirement and do not require the use of a tracer, spike, or carrier: gross alpha, gross beta, gamma spectrometry, and total uranium analysis by laser phosphorimetry.

D.12.5.2 **Guidance.**

A. If the laboratory failed to use an appropriate spike, tracer or chemical carrier as specified by the SOW or analytical method, qualify all associated results as unusable (R).

B. Tracer percent recovery or chemical yield should be within the control limits specified in Table G-4, Appendix G or the FEMP laboratory SOW. Verify that the percent recoveries or yield were correctly calculated. If not, submit an RIR form to laboratory for the correction of the noted error(s).

C. If the tracer recovery is greater than 130 percent, qualify the data as estimated (J) if the QC samples are acceptable or as unusable (R) if the QC results are poor.

D. If the tracer recovery is between 110-130 percent, qualify the data as estimated (J).

E. If the tracer recovery is between 20 percent and the lower range specified in Table G-4 or the SOW, qualify the data as estimated (J).

F. If the tracer recovery is less than 20 percent, qualify the data as estimated (J) if the QC samples are acceptable or as unusable (R) if the QC results are poor.

D.12.6 Duplicate Sample Analysis Evaluation Criteria

D.12.6.1 **Criteria.** Duplicates must be analyzed as required in Appendix G or as required in the laboratory SOW.

D.12.6.2 **Guidance.**

A. If the number of duplicate analyses is not satisfactory, evaluate all other QC data. Document the failure to comply with the requirement for duplicate samples. Professional judgement may be used to qualify all associated results as estimated (J).

B. Samples identified as field blanks (look at chain of custody documents) may not be used for duplicate sample analysis. Confirm that the field blank was not used for the duplicate analysis.

C. If the field blank was used for duplicate analysis, all other QC data must be carefully checked and professional judgement exercised when evaluating the data. Document if the field blank was used, but don't qualify data on this alone.

D. Relative error ratio (RER) between the sample and duplicate analysis sample results must be less than or equal to 2.0

$$RER = \frac{|C_1 - C_2|}{\left|(TPU_1)^2 - (TPU_2)^2\right|^{1/2}}$$

Where:

C_1 and C_2 are the two resultant concentrations and TPU_1 and TPU_2 are the two associated 1 sigma total propagated uncertainties (TPU).

NOTE

Divide reported 2 sigma TPUs from laboratory by 2 to obtain the 1 sigma TPU to be used to verify the reported RER.

E. If the RER is greater than 2.0 when comparing liquid sample results, qualify the results for all samples in the same batch with a similar matrix as estimated (J) and qualify non-detects as estimated (UJ). If the RER is greater than 2.0 when comparing solid samples, qualify the results for all samples in the same batch with a similar matrix as estimated (J) and qualify non-detects as estimated (UJ). If matrices are not similar, qualify only those two samples compared as estimated (J) and non-detects as estimated (UJ).

D.12.7 Laboratory Control Samples Evaluation Criteria

Laboratory control samples may be prepared by the same laboratory performing the analyses or by a reference laboratory or agency. Laboratory control samples are equivalent to internal or external control samples. Laboratory control samples, or their equivalents, may be identified as QC samples, as samples from a particular agency, or as LCS.

D.12.7.1 <u>General Criteria</u>. At least one LCS must be analyzed with a sample delivery group. All LCS results must be within the control limits specified in Table G-4, Appendix G. Review the data package and verify that all LCS results have been correctly calculated and reported and fall within the specified control limits.

LCS Percent Recovery (LCS %) is calculated as follows:

$$LCS\ \%R = \frac{LCS_{measured}}{LCS_{true}} \times 100$$

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Where:

$LCS_{measured}$ = concentration or activity for each radionuclide measured in the LCS

LCS_{true} = concentration or activity of each radionuclide in the LCS.

D.12.7.2 General Guidance.

A. For radionuclides that are outside control limits listed in Table G-4, Appendix G, qualify affected sample results as estimated (J) and/or detection limits (IDLC/MDC) as undetected estimated (UJ).

NOTE

LCS - TEST for bias: Use the following mathematical relationship to test that the expected and the measured results of the LCS do not differ significantly when compared to their respective TPU.

$$LCS\ Normalized\ Difference = \frac{|LCS_{meas} - LCS_{exp}|}{(TPU^2_{meas} + TPU^2_{exp})^{1/2}}$$

Where:

$TPU_{measured}$ = the one sigma total propagated uncertainty of the measured result;

$TPU_{expected}$ = the one sigma total propagated uncertainty of the expected result.

B. For radionuclides that are outside control limits listed in Table G-4, Appendix G, qualify sample results (results >IDLC/MDC) estimated (J), If the normalized absolute difference is greater than 2.0.

C. For radionuclides that are outside control limits listed in Table G-4, Appendix G, qualify undetected results (results <IDLC/MDC) undetected (UJ), If the normalized absolute difference is greater than 2.0

D. If the required LCS are not analyzed, qualify all results as estimated (J) and all detection limits as undetected estimated (UJ).

D.12.8 Holding Time/Preservation Requirements Evaluation Criteria

D.12.8.1 General Criteria. Samples shall be analyzed within the period of 5 half-lives of the radionuclide of interest or within the holding time specified in Table 6-1 (Appendix A), whichever comes first. Samples shall be properly contained and preserved (e.g., acidified) in accordance with laboratory standard guidance or SCQ guidance tables to ensure that sample

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integrity is maintained. Holding times for each radionuclide are established by comparing the sampling date on the chain of custody record with the dates of analysis found in the data package.

Analysis date - sample date = radionuclide holding time

D.12.8.2 General Guidance.

A. Review the chain of custody documents to determine if the samples were properly preserved and whether sample hold times were met.

B. If preservation requirements were not met, qualify associated data as estimated (J) and results less than the detection limits (IDLC/MDC) as undetected estimated(UJ).

NOTE

Aqueous samples not acid preserved in the field must be preserved within 5 hours of sampling and shall be held at least 16 days prior to analysis.

C. If the hold time for liquid matrix samples exceeded SCQ and the FEMP laboratory SOW acceptance limits but was less than twice the acceptable hold time limit, qualify associated results as estimated (J) and results less than the detection limits (IDLC/MDC) as undetected estimated (UJ).

D. If the hold time for liquid matrix samples exceeded SCQ and the FEMP laboratory SOW acceptance limits by more than twice the acceptable hold time limit and no other QC data is available to evaluate impact of possible evaporation, qualify associated results and/or detection limits as unusable (R).

E. If the hold time for solid matrix samples exceeded SCQ and FEMP laboratory SOW acceptance limits qualify associated data as estimated (J) and qualify results less than the detection limits (IDLC/MDC) as undetected estimated (UJ). Do not qualify as unusable (R) unless there is specific information/data to support such a professional judgement.

D.12.9 Matrix Spike Sample Analysis Evaluation Criteria

Samples to be spiked for matrix spike QC are to be specified by the FEMP. These samples should not be field QCs. If field QCs are used as the matrix spike sample, professional judgement should be used to determine whether the matrix spike validation criteria should be applied.

D.12.9.1 Criteria. All matrix spike recoveries should be within the control limits specified in Appendix G, Table G-4, or the FEMP laboratory SOW. Verify that matrix spike results and recoveries have been properly calculated.

D.12.9.2 Guidance.

A. If a required matrix spike sample was not analyzed, exercise professional judgement to qualify all results in the analysis batch as estimated (J).

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B. If the liquid matrix spike recovery was not within acceptance limits specified in Appendix G, Table G-4 and/or the FEMP laboratory SOW, and if the matrix spike normalized difference (MSND) as defined below is greater than 2.0, qualify similar liquid matrix sample results in the same batch, as estimated (J).

Matrix Spike: Test for matrix-induced bias

Use the following mathematical relationship to test the null hypothesis that the expected and measured results of the MS do not differ significantly when compared to their respective TPU.

$$MS\ Normalized\ Difference = \frac{|(SSR-SR)-ER|}{\left[TPU^2_{SSR}+TPU^2_{SR}+TPU^2_{ER}\right]^{1/2}}$$

Where:

SSR	=	Spiked sample result
SR	=	Sample result (unspiked)
ER	=	Expected result (spike amount for standard certificate)
TPU_{ssr}	=	One sigma total propagated uncertainty
TPU_{sr}	=	One sigma total propagated uncertainty of sample result
TPU_{er}	=	One sigma total propagated uncertainty of expected result

C. Qualify positive sample results (results >IDLC/MDC) of similar matrices as estimated (J) if the normalized absolute difference is greater than 2.0.

D. Qualify only the two samples compared for MS evaluation if the other samples do not have similar matrices. If the solid matrix spike recovery was not within acceptance limits specified in Appendix G, Table G-4 and/or the FEMP laboratory SOW and the MSND is greater than 2.0 (see above) qualify only the samples compared as estimated (J).

D.12.10 Alpha Region of Interest (ROI) Evaluation Criteria

Alpha spectrometry results must be examined to ensure that resolution, consistency in ROI selection, peak tailing/overlap, and interferences were properly assessed. Professional judgement based on radiochemical experience will be required to perform these evaluations.

D.12.10.1 <u>Criteria</u>.

A. Check tracer peaks resolution to determine whether:

1. FWHM ≤ 100 keV for all except thorium and radium tracers.

2. FWHM ≤ 125 keV for thorium tracer.

3. FWHM ≤ 150 keV for radium tracer.

B. Check of analyte ROI widths:

1. If Pu-242 or Pu-236 tracer is used, the Pu isotopic ROI widths should be the same, except for Pu-239/240 width which should be approximately 12 keV wider than other Pu isotopic ROIs.

2. If U-232 tracer is used, the isotopic uranium ROI widths should be the same, except for U-235/236 width which should be approximately 100 keV wider than other uranium isotopic ROIs.

3. If Th-229 tracer is used, the Th isotopic ROI widths should be the same, except for Th-229 which should be approximately 25 percent wider than other Th isotopic ROIs.

4. All peaks used to quantify Np-237 should be included in Np-237 ROI.

5. If Po-208 or Po-209 tracer is used, the Po-210 ROI should be the same width.

6. If Am-243 tracer is used, the Am-241 ROI should be the same width.

7. Radium isotopic ROI in alpha spectra may be set approximately 50 percent wider than the ROI for other radionuclides.

C. Evaluate the degree of peak tailing or overlapping by comparing the height of the valley (the minimum point between the two peaks) to the height of the peaks.

D. Check for interfering or contaminating peaks by assessing the spectrum for presence of interfering or contaminating peaks arising from either the ingrowth of decay progeny or the possible breakthrough of other alpha-emitting radionuclides contained in the sample.

D.12.10.2 <u>Guidance</u>.

A. Resolution of tracer peaks:

1. If the expected resolution of a tracer peak is 100 keV or less, qualify the associated results/detection limits as estimated (J/UJ) if the resolution of the tracer peak is greater than 100 and less than or equal to 125 keV. Qualify results as unusable (R) if the tracer peak resolution is greater than 125 keV.

2. If the expected resolution of a tracer peak is greater than 100 keV, but less than 125 keV, then qualify the associated results/detection limits as estimated (J/UJ) if the resolution of the tracer peak is greater than 125 keV and less than or equal to 225 keV. Qualify results as unusable (R) if the tracer peak resolution is greater than 225 keV.

3. If the expected resolution of a tracer peak is greater than 125 keV, but less than 150 keV, qualify associated results/detection limits as estimated (J/UJ), if the resolution of the tracer peak is greater than 150 keV and less than or equal to 275 keV. Qualify results as unusable (R) if the tracer peak resolution is greater than 275 keV.

B. Check of analyte ROI Widths:

1. If the ROI is less than 80% or greater than 120% of the expected width and the ROI contains at least 80% of the total peak counts, then qualify the associated

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results as estimated (J) or, if the results are below the detection limit, as estimated detection limit (UJ).

2. If the ROI is 80-120% of the expected width and the ROI contains less than 80% of the total peak counts, then qualify the associated results as estimated (J) or, if the results are below the detection limit, as estimated detection limit (UJ).

3. Professional judgement may be used to make exceptions to the above criteria in cases where the ROI contains greater than 80% of the total peak counts.

4. In cases where the ROI is less than 80% or more than 120% of the expected width and the ROI contains less than 80% of the total peak counts, use professional judgement to qualify the associated results as estimated (J) or unusable (R).

C. Check of peak tailing/overlap:

1. If valley height is between 10-50 percent of peak height, then qualify the associated results as estimated (J) and non-detected detection limits as estimated (UJ).

2. If valley height is > 50 percent of peak height, then qualify the associated results as unusable (R).

D. Check for interfering or contaminating peaks:

1. If the contribution of interfering or contaminating peaks has not been stripped out by the laboratory and the contribution to gross peak counts from these interfering or contaminating peaks is between 25-50 percent of the total gross peak count, then qualify the associated results as estimated (J) and the non-detected detection limits as estimated (UJ).

2. If the contribution of interfering or contaminating peaks has not been stripped out by the laboratory and the contribution to gross peak counts by those peaks is greater than 50 percent of the total gross peak count, then qualify the associated results as unusable (R).

3. If the contribution of interfering or contaminating peaks has been stripped out by the laboratory and the contribution to gross peak counts by these interfering/contaminating peaks is between 33-67 percent of the total gross peak count, then qualify the associated results as estimated (J) and the non-detected detection limits as estimated (UJ).

4. If the contribution of interfering or contaminating peaks has been stripped out by the laboratory and the contribution to gross peak counts by these interfering/contaminating peaks is greater than 67 percent of the total gross peak count, then qualify the associated results as unusable (R).

D.12.11 Other Quality Control

Other QC checks give the data reviewer an opportunity to provide additional documentation that may be applicable to a particular SDG or useful to data users. The reviewer can also express comments on the overall data quality for an SDG. Areas that may be addressed under other QC include, but are not limited to, documentation of the following:

A. Trends observed in the performance of an instrument, method, or the laboratory over the course of the SDG or past history;

B. Anomalies associated with the chain of custody documentation;

C. Anomalies associated with the shipment or receipt of samples;

D. Extreme differences between U total and summation of U isotopic results for same samples, converted if necessary to same units of concentration;

E. Laboratory transcription errors;

F. Acceptability of standards used for QC purposes.

It is left to the discretion of the reviewer to evaluate the nature of any problems observed and to attach any qualification which may be necessary to describe the quality of the data. All anomalies and any action taken shall be clearly documented.

D.12.12 Field QC Evaluation Criteria

If there are field QC samples associated with the data being analyzed and subsequently validated, the FEMP group that generated the samples shall supply the necessary information so that the reviewers can associate the QC samples with the samples collected.

D.12.12.1 <u>Field QC Criteria</u>.

A. Assess all indications of field sampling problems (see below) noted in the field data validation checklist.

B. Field blanks, rinsates, and/or duplicates must be clearly associated with other samples taken.

C. Field blanks and/or rinsate samples should contain no detectable (< IDLC or MDC) radionuclides of concern.

D. A field duplicate and its associated sample should have an RER $\leq$ 2.0.

D.12.12.2 <u>Field QC Guidance</u>.

A. If there are any indications of field sampling problems (e.g., broken samples, elevated temperatures of samples, COC problems, etc.) the validator is to note these and use professional judgement to determine whether and how the data should be qualified.

B. Samples to be associated with specific field QC measurements must be clearly identified. Otherwise, the reviewer will perform no further evaluation, until the associations are clarified.

C. If the field blank or rinsate has no detectable concentration of the radionuclide(s) of concern, no further evaluation is necessary. However, if detectable concentrations of the radionuclide(s) of concern are found in field blank or rinsate, proceed as follows:

1. If the associated sample does not have detectable concentration of the radionuclide found in the associated field blank or rinsate, no further evaluation necessary.

2. If the concentration of the radionuclide of concern in the field blank or rinsate is greater than that in the associated sample, then qualify the sample result as undetected (U).

3. If the sample result is between 1-5 times the field blank or rinsate result, qualify sample results as estimated (J).

4. If the associated sample result is greater than 5 times the field blank or rinsate result, then no qualification is necessary.

NOTES

Before comparing data, ensure that units of concentration are the same.

Only data directly associated with field blanks or rinsate samples will be evaluated against them and qualified.

D. RER is to be calculated for field duplicate and its associated sample. If RER is greater than 2.0, the results of both field duplicate and associated sample ONLY are to be qualified as estimated (J); qualify undetected detection limits as estimated (UJ).

D.12.13 Overall Assessment of Data for a Case

The data reviewer shall make professional judgements, express concerns, and comment on validity of the overall data package. This is particularly appropriate when there are several QC criteria out of specification. If necessary, data may be compared to historical values for a particular sampling point or known naturally-occurring values for this geographical area.

The additive nature of QC factors out of specification is difficult to assess in an objective manner, but the reviewer has a responsibility to inform users concerning data quality and limitations. Availability of DQOs and PSP may be needed for this review. The information will help the user avoid inappropriate use of data and yet not preclude all consideration of the data.

Appendix E

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APPENDIX E

ANALYTICAL LABORATORY PERFORMANCE REQUIREMENTS

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APPENDIX E ANALYTICAL LABORATORY PERFORMANCE REQUIREMENTS

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APPENDIX E

ANALYTICAL LABORATORY PERFORMANCE REQUIREMENTS

E.1 INTRODUCTION

As specified in Section 3.1.5.2, FDF shall maintain a list of laboratories approved for FEMP sample analysis and testing. Analytical performance requirements shall be used as guidelines for evaluating laboratory capability to provide specific analytical services to the FEMP. Ability to meet these requirements shall be audited prior to contract award as described in Section 12. Subsequent annual post-contract-award audits shall be performed to verify laboratory performance using the performance-evaluation sample results specified in Section E.2. Note that industrial hygiene and process control analyses are outside the scope of this document.

E.1.1 Purpose

This appendix establishes performance requirements for laboratories doing analytical work for the FEMP. Laboratories shall use organic and inorganic methods specified in Tables G-1 and G-2. Radiochemical analyses shall meet performance specifications identified in Tables G-3 and G-4. Geotechnical methods and performance requirements are specified on a project-specific basis.

E.1.2 Scope

General requirements for laboratories performing analysis for the FEMP are provided in the following sections:

A. Laboratory approval (Section E.2);

B. Equipment (Section E.3);

C. Sample receipt and documentation (Section E.4);

D. Preparation, analysis, and identification of analytes (Section E.5);

E. Quality assurance/quality control procedures (Section E.6);

F. Reports and deliverables (Section E.7).

E.2 LABORATORY APPROVAL

E.2.1 Requirements for an Approved Laboratory

NOTE

USEPA, along with other appropriate government entities, conducts investigations of laboratory fraud. A laboratory under subcontract with FDF shall notify FDF if it is the subject of such an investigation.

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A laboratory which demonstrates compliance with the following requirements shall be considered approved to perform work for the FEMP for the ASL and types of analyses evaluated. An approved laboratory:

A. Has been audited by FEMP personnel to ensure compliance with these requirements and to document the compliance;

B. If appropriate, has a system and SOP for tracking the current amount of radioactivity in the laboratory so as not to exceed licenses;

C. Has the necessary licenses and/or certifications to handle and process FEMP samples;

D. Has SOPs in place which address sample receiving, log in, storage, analysis, and disposal. Analysis SOPs shall meet the applicable requirements of Appendix G. Other specific SOPs shall also be required depending on the ASL involved, as dictated by the SCQ;

E. Has adequate building security and chain of custody system with applicable SOPs;

F. Has a document control system which addresses all SOPs and the quality assurance manual;

G. Has a QA program which addresses the applicable requirements of the FEMP SCQ;

H. Can document personnel and laboratory experience in the analysis category (inorganic, organic, asbestos, radiochemical, geotechnical), including acceptable performance in performance evaluation programs. Analytical performance and financial stability will have been verified via reference checks with previous and/or current customers;

I. Can demonstrate the ability to comply with all applicable QC requirements of the SCQ and RM-0012;

J. Can demonstrate the ability to comply with all applicable reporting requirements of the SCQ;

K. Can demonstrate the ability to comply with all other contractual requirements as will be set forth in technical Statements of Work. This shall include the statement that "All contractual requirements shall be met, except for the following: . . ." in all contract proposals. Any exceptions must be agreed upon by the individuals signing the contract. These exceptions shall in no case supersede the requirements of the SCQ;

L. Has a program management description which identifies the single point of contact at the laboratory, how FEMP samples will be tracked and processed on a daily basis, and how the laboratory will ensure compliance with all of the relevant SCQ requirements including QC and reporting;

M. Has laboratory and administrative programs in place which comply with the OSHA requirements of 29 CFR 1910.1450, and 10 CFR 835 (as applicable), and has a hazardous waste management program.

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E.2.2 Laboratory Performance Review

To assure data comparability, each laboratory must participate in the Interlaboratory Data Comparability (IDC) program. This program consists of analysis by each laboratory of blind QC samples, such as split samples, matrix spikes, matrix spike duplicates, duplicate samples, or traceable standards (i.e., USEPA, National Institute of Standards and Technology) prepared by FDF. The reported results are compared to the performance of all participating laboratories for the past twelve month period. Reported results must be within the acceptance range of ±3 standard deviations. The FEMP will issue a Nonconformance Report (see Section 15.1.2.1) to a laboratory that fails to meet these acceptance criteria.

The group administering the IDC program shall supply a monthly report to the subcontract technical representative (STR), summarizing laboratory performance on FEMP-supplied blind samples during the month and over the life of the contract. This report shall include a narrative summary and copies of IDC program results, and a performance analysis. The STR may stop shipping FEMP samples to laboratories that repeatedly fail to meet these acceptance criteria. Participation in the IDC program is not a requirement for geotechnical laboratories, due to the limited availability of standard materials and due to the fact that analyses are not performed by multiple laboratories.

All documentation received with contract proposals and during site visits shall be maintained in a laboratory specific file. The QA organization shall ensure that all checklists, reports, and corrective action verification resulting from follow-up audits (which are performed subsequent to award, at least annually, and consistent with Section 12 of the SCQ) are maintained in the appropriate file. More frequent audits will be conducted as dictated by the laboratory's performance and/or the importance or number of analyses being performed.

Monthly performance reports will be submitted to the STR by all subcontract laboratories; geotechnical laboratories will submit reports as required on a project-specific basis. The STR will review these reports, follow-up as necessary, document all resultant conversations with the laboratory, and file this information. The QA organization will evaluate the reports for quality of performance issues. These reports will include:

A. A discussion of any problems encountered during the month, as related to the processing of FEMP samples;

B. A review of samples processed with an indication of holding time compliance, including identification of samples received, reported on time, reported late, and in process;

C. Mention of any reduced (or enhanced) ability to perform under the terms of the contract. This shall include new analysis capabilities, additional or reduced sample capacity, and personnel changes;

D. Documentation of at least annual face-to-face contacts between the STR or designee and subcontract laboratory personnel. This requirement can be met by the annual audit, a visit to the laboratory to check on samples, announced or unannounced, or a visit to the FEMP by laboratory personnel;

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E. Documentation of weekly (at a minimum) phone calls between the STR and each laboratory processing samples.

The STR will review these reports, follow-up as necessary, document all resultant conversations with the laboratory, and file this information. Data packages received from the laboratories will be reviewed according to standardized checklists. Compliance with regulatory and contractual requirements shall be confirmed in each case.

E.2.3 Approved List of Laboratories

The approved laboratory list will include all current and formerly approved laboratories. Only currently approved laboratories may perform work for the FEMP.

This list will contain the following information:

A. Date of issuance of the list;

B. Revision number of the list;

C. Laboratory name and location;

D. Analysis category;

E. ASLs for which the laboratory has been approved;

F. Approval status (Examples are: currently approved and contracted, currently approved but not contracted, and not currently approved. A "not currently approved laboratory" is one whose approval has been discontinued or has lapsed. The details for this will include those listed in Step 1 below);

G. Period of performance;

H. Date of last audit;

I. Date of next scheduled audit;

J. Remarks.

The approved laboratory list is expected to change over time due to changing project needs, management or contract changes, or other unforeseen circumstances. The list will be revised each time a change is necessary, but no more frequently than monthly. Revision of the approved laboratory list will be accomplished as follows.

Step 1: The STR responsible for the contract in question submits a letter to the FEMP QA organization. The letter is entitled "Recommendation to Revise the Approved List of Laboratories to Perform Work for the FEMP" and includes the required changes as well as concurrence lines for the manager of the sample management group and a representative of the designated FEMP QA organization. The letter must also include a listing of the applicable ASLs, and the appropriate category of analyses.

Additions must include justifications and all applicable documentation (e.g., audit reports and licenses) that demonstrate compliance with all of the thirteen requirements specified in E.2.1.

Deletions (designations of discontinued approval) must include justifications. These include lapsed contract, audit not performed per frequency requirement, and poor performance. Poor performance can include disapproval, by the EPA, of work performed under non-FEMP contracts. A "poor performance" statement must include details.

Step 2: The manager of the FEMP sample management group and the QA representative sign the concurrence line.

Step 3: QA personnel, by copy of the letter, revise the list.

Step 4: QA personnel distribute controlled copies of the list. DOE's copy includes all attachments and a cover letter which indicates the changes that were made.

This approach to maintaining a list of approved laboratories shall be reviewed as necessary. Approved changes to this approach will be incorporated into the SCQ as appropriate.

E.3 EQUIPMENT

Each laboratory must have equipment which is in working order and capable of performing the analyses for which the laboratory has been contracted.

E.4 SAMPLE RECEIPT AND DOCUMENTATION

Following are general requirements for sample receipt and preparation. Specific procedures for receipt and preparation of samples are provided in Section 7.

E.4.1 Chain of Custody

The laboratory must maintain and document sample custody from time of receipt to final laboratory disposition. Sample custody requirements shall also apply to sample extracts and digestates. Laboratory custody procedures will be reviewed as part of the pre-award laboratory survey and subsequent performance audits to insure that they comply with the requirements of the SCQ. These procedures shall be consistent with Section 7.

Laboratory custody procedures shall be documented and implemented so that the following conditions are met for samples at all times prior to and during analysis.

A. The sample shall remain in one person's possession; or

B. The sample shall be in that custody holder's view after being in holder's possession; or

C. The sample shall be in custody holder's possession and placed in a secure, controlled-access storage area by holder; or

D. The sample shall be in a designated secure area accessible to authorized personnel only.

E.4.2 Document Control

Document control ensures that data for specified sample sets are accounted for after completion of a project. The laboratory shall have written document control measures that shall be specified in the laboratory quality assurance plan in accordance with SCQ Sections 4 and 11. The following document control forms are required:

A. Data sheets (e.g., calculations, CLP Form I's, analytical results);

B. Logs or daily log forms (e.g., instrument run logs, calibration logs, preparation logs).

E.4.3 Standard Operating Procedures

The laboratory shall have written standard procedures for sample receipt, log-in, and storage. These procedures may be subject to FEMP approval and shall comply with the requirements of the SCQ.

E.5 PREPARATION, ANALYSIS, AND IDENTIFICATION OF ANALYTES

The laboratory shall demonstrate capability of preparing and analyzing samples and identifying constituents of concern by specified methods and/or performance specifications in Appendix G. Quantitation limits for analyte targets are provided in the specified method or performance criterion.

E.6 QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES

The laboratory shall be responsible for performing Quality Assurance/Quality Control (QA/QC) procedures in strict accordance with Sections 4, 10, and 11 and with the laboratory-specific contract, including specified holding times and other criteria. Quality Control samples for laboratory analysis are defined in Section 4.1.2 and listed in Table 2-2 in Appendix A.

Analytical laboratories shall be required to have an internal quality assurance plan and applicable standard operating procedures in place as specified in Section 12.4.6. Adherence to the elements of the plan shall be documented in audits.

The SCQ shall be a contract-specified attachment to the laboratory-specific quality assurance plan. Compliance with the SCQ shall be verified through project performance audits. Additional QA/QC requirements may be specified in individual contract statements of work.

E.7 REPORTS AND DELIVERABLE ITEMS

Requirements for reports and deliverable items depend upon the specified Analytical Support Level (ASL) and the applicable laboratory statement of work. Reporting requirements are listed in Section 11.

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APPENDIX F

DATA MANAGEMENT

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Appendix F

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DATA MANAGEMENT

F.1 INTRODUCTION

This appendix describes the FEMP data management systems that will be implemented to provide a centralized, consistent, accurate, and flexible data repository for environmental data at the FEMP. The following will describe each subsystem of the data management system, linkages between subsystems, overall hardware and software environments, and general guidelines for future development of data management systems. It will also describe how information is entered into the system from the initial decision to sample, through sample collection and analysis, to the final entry and storage of validated analytical results.

F.2 ROLE OF DATA MANAGEMENT

Environmental data generated at the FEMP are significant and necessary for the proper implementation of response actions required by CERCLA. A well-structured data management program helps to ensure ready access to the analytical data needed to make reliable environmental remediation and waste management decisions.

Effective management of sampling and analysis activities is critical to the success of the environmental management programs at the FEMP. Such programs require effective planning to facilitate control of sample collection and analysis costs, which form a significant fraction of the total environmental management program cost. Well designed environmental data may be used to support decisions other than that for which it was originally intended. The FEMP's central computerized data repository helps to ensure that environmental data are accurately and completely maintained and that appropriate data are accessible for multiple, concurrent remediation and compliance efforts.

F.2.1 Volume of Data

On large, complex sites like the FEMP, the increasing volume of data becomes a significant management issue. The vast amount of data is growing rapidly with the rising number of ongoing characterization and monitoring programs. Data volume may also increase as new environmental regulations are promulgated. Manual filing and management systems are not adequate for handling the amount of data anticipated for the FEMP.

F.2.2 Compliance With Regulatory Controls

Environmental data generated at the FEMP are significant and necessary for the proper implementation of response actions required by CERCLA. Data generated in support of other site programs are significant and potentially necessary for removal actions, RCRA closures, and other determinations necessary to ensure compliance with federal and state laws and regulations. These data may also provide supportive information for environmental closure activities.

Data generated in accordance with the SCQ are intended to integrate the requirements of all regulatory programs that apply to the FEMP in order to produce comparable data useable on a sitewide level.

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One central computerized data repository helps to ensure that FEMP environmental data are accurately and completely maintained and that appropriate data are accessible for multiple, concurrent remediation and compliance efforts.

F.2.3 Flexible and Timely Response to Data Queries

FEMP environmental studies require that project data be examined in numerous ways, frequently within a very short time frame. Typically, sets of environmental data that are of interest for examination and preview cannot all be predefined at the outset of the project. The FEMP data management system uses relational data management software, thus it is supportive of the ad hoc nature of requests and short time constraints usually involved.

The FEMP environmental data management system was designed to address these needs through individual modules and collective integration. The goal is to provide a centralized data repository for a very large quantity of data of known quality that satisfy regulatory requirements and project DQOs and that can support a wide range of ad hoc and routine data requests for assessment and reporting in a timely manner.

Data qualifiers resulting from the data validation process (Appendix D) shall be present in the data repository and referenced whenever FEMP environmental data are used. The FEMP environmental data management system will allow attachment of data qualifiers to each piece of data, which can then be related to ASLs or DQOs. Qualifiers can be used to screen data when retrieval for a particular application is considered.

F.3 LIFE CYCLE OF FEMP ENVIRONMENTAL DATA

Guidelines for establishing DQOs and developing sampling plans, data transfer and handling procedures, sample analysis requirements, and data validation procedures are detailed in other parts of the SCQ. Each activity directly related to the generation and management of environmental data is summarized in a chronological sequence in the following paragraphs to illustrate the overall data flow.

F.3.1 Planning

When a project manager has identified the need to collect samples to acquire environmental data, a DQO and PSP are prepared in compliance with SCQ requirements. These planning documents specify the type and number of samples to be collected in order to provide the desired data. Typically, a scheduler will review the PSP and assign individual sample numbers from the FACTS database.

F.3.2 Collection of Samples

Samples shall be collected in accordance with the PSP and SCQ. Field sampling teams collect physical samples (e.g., soil or groundwater) and package them for transfer to a sample receiving group under chain of custody. Required field observations (e.g., temperature, pH, and specific conductance) are also measured and recorded as part of the field data package. Each sample or piece of recorded data is referenced to an onsite or offsite location through the state of Ohio planar coordinate system. The northing and easting of each sample location are entered into the FEMP environmental data management system (see F.4) and linked with all information for that sample, including sampling information, QC records, and analytical results.

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F.3.3 Transfer and Handling of Samples

Samples collected onsite for laboratory analysis are identified with a sample number, packaged, and transported to a sample receiving group. When the samples are received, the sample receiving group completes the chain of custody, assigns a release number from FACTS, and enters other appropriate tracking data into the FACTS system. They then package and transport the samples to the designated laboratory for analysis.

F.3.4 Laboratory Analysis and Reporting

Sample analysis is performed at an onsite or offsite analytical laboratory. Analysis results, along with supplemental information on analytical techniques, dilutions, and chain of custody records, are documented and organized into a data package. Data packages are transferred to the FEMP in standard hard copy and/or in electronic formats. The receipt of data packages from offsite and onsite laboratories is tracked in WISDM. The resultant analytical data are then entered into FACTS.

F.3.5 Completeness Verification

Data packages are examined to ensure that they meet the specified deliverable requirements. Data package requirements are dependent on the specified Analytical Support Level (ASL) of the samples and the relevant laboratory contract.

F.3.6 Data Validation

Data validation is an independent assessment of data against established criteria to determine technical reliability of the reported analytical results. Data validators review the data package and, if necessary, assign qualifiers. These data qualifiers are entered into the FACTS database.

F.3.7 Data Repository

The FEMP Sitewide Environmental Database (SED) supports direct loading of validated data from electronic media as well as manual data entry. The SED is maintained using relational database management software. Validated data are loaded into the data repository, which is the heart of the FEMP environmental data management system. It is what most data users consider when thinking of the environmental database.

Manual data entry into the SED shall be performed in duplicate and the two sets of entered data shall be electronically compared. Discrepancies between the two sets will be resolved by comparison to the original data sheets and corrections made as necessary to entered data.

F.3.8 Data Analysis Reports

Analysis results data are retrieved and reported to support a wide range of activities including modeling, statistics, mapping and visual display, and summary tabular data listings. Some data analysis reports include an assessment of the useability of existing data for current applications. The assessments may lead to definition of a need for additional sampling efforts, which connects the data analysis phase of the data life cycle to data requirements and sampling plan phases.

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F.3.9 Records Management

Records management actually begins when the need for data collection is identified. It concludes when all appropriate documentation has been received in the Central Data Files (CDF) or the RCRA Operating Record (OR). Accurate and complete records are tracked and collected in a systematic and methodical manner that satisfies guidelines imposed upon the FEMP by site, local, state, and federal agencies and regulators. These records become part of the evidence files or RCRA OR used to support FEMP activities and decisions made in the remediation of the site.

F.3.10 Data Archiving and Storage

Each piece of data in the FEMP SED is linked to the original hard-copy documents produced by analytical laboratories. Hard copies are kept in permanent storage. The electronic databases that track the data covered by the SCQ will be archived under the guidance of the National Archives and Records Administration in effect at the time the databases are no longer in active use. The file format, storage media, and documentation used will be determined at the that time to facilitate the long term usefulness of the data in supporting the project activities.

F.4 FEMP ENVIRONMENTAL DATA MANAGEMENT SYSTEM

A collection of integrated environmental data management systems has been designed for the FEMP to support the range of data-related activities previously outlined. These systems are designed to manage the complete set of sampling, project scheduling, QA/QC, and analytical results data, along with site maps and other spatially oriented data.

The database that stores analytical and field observation results, related QA/QC information, sampling station information, and cross references to original hard copy documents is central to the FEMP environmental data management system. Each of the other systems interface with this central repository either by using repository data as input or by serving as a data input point to the repository.

In the FEMP system, data are shared among applications. The redundant storage of a piece of data in more than one location in the database is avoided when possible. The following paragraphs contain brief descriptions of each computerized system commonly used for environmental data at the FEMP.

F.4.1 FACTS System

The Fernald Analytical Computerized Tracking System (FACTS) supports sampling, laboratory analysis, and analytical reporting activities (see Appendix A, Figure F-1). Most data entry is performed through FACTS. FACTS includes the following subsystems:

A. **Field Sampling System** - Is used by sampling crews to automate, collect, and verify collection of key data fields including sample location identifier, collector initials, sample volume requirements, sample preservation, sample date and time, and chain of custody information;

B. **Laboratory Information Management System (LIMS)** - Is used by the FEMP laboratory to document analytical results and generate management reports, hard copy summary reports, and data files suitable for direct import into the SED;

C. **Sample Tracking System** - Is used to track the life history of samples through initial planning, sample collection, laboratory analysis, validation, and the input to the SED. The subsystem also monitors schedule status of both routine and non-routine sampling activities on an ongoing basis. A key function of the sample tracking subsystem is the issuance of a sample identification number unique to each analytical sample taken. This identification is used in all other FEMP environmental data systems to cross-reference sample results.

F.4.2 Data Validation System

Data validation for commonly used analytical methods may be performed electronically, when applicable. Data from analytical laboratories may be obtained in electronic and hard copy formats. Electronic data shall undergo a computerized data review that assigns the majority of data validation flags.

F.4.3 Sitewide Environmental Database

The Sitewide Environmental Database (SED) system is composed of ORACLE® or ORACLE®-compatible programs which serve as the repository for analytical results data, related QA/QC information, sampling station descriptions, field observations, and data qualifiers collected in support of the environmental projects. The SED is comprised of the following subsystems.

A. **Executive Menu** - Ties SED subsystems into a single, easy-to-use system with similar keystroke conventions, screen layouts, error messages, and menu layouts used in each subsystem.

B. **Data Entry Screens** - Facilitate manual data entry of results data.

C. **Data Import Programs** - Facilitate loading of results data received electronically.

D. **Data Edit Screens** - Facilitate modifications to selected fields in the SED (e.g., data qualifier fields).

E. **Standard Output Reports** - Provide hard copies of results data and associated information in several predefined formats. Reports may be generated for subsets of the SED through use of standard data queries.

F. **Ad Hoc Queries** - Facilitate queries on results data via the ORACLE® Structure Query Language (SQL), which provides a flexible, powerful means of selecting subsets of data from the SED for viewing and analysis.

G. **Data Views** - Allow users to define windows into the SED that combine selected data elements from disparate tables into a view that looks like a single table of data.

H. **Linkages to External Data Analysis Software Packages** - Many easy-to-use third-party software packages are used that directly read ORACLE® data tables. Several external data analysis systems use the SED directly as a source of input data. A file import/export facility allows copies of results data to be extracted from ORACLE®

tables into files that can be input to software packages without being able to read ORACLE® tables directly.

I. **Data Security and Password Protection** - Provide, via built-in ORACLE® functions, different levels of data access rights to users, ensuring that only selected data-center personnel can modify data and only in very clearly defined circumstances.

F.4.4 SWIFTS

The Sitewide Waste Information, Forecasting, and Tracking Systems (SWIFTS) is an ORACLE® database used to assist FEMP personnel with forecasting, characterizing; tracking, and shipping waste generated at the FEMP. SWIFTS is the single repository and linkage for the three modules that make up the database. The inventory module is used for waste tracking shipment. The MEF module is used for waste characterization. The forecasting module is used to forecast storage, treatment and shipping requirements for waste generated at the FEMP.

F.4.5 Geotechnical Information Systems

The engineering group is responsible for maintaining geotechnical data on a project by project basis in databases which provide reliable access to all data collected in support of environmental projects at the FEMP.

F.4.6 Geographic Information Systems

The SED (F.2.4) acts as an electronic file cabinet for FEMP environmental data to facilitate access to these data and to ensure that data are of known quality. ORACLE® can be used to analyze results data to a limited extent. When used by trained personnel, SQL can be used to provide useful data summaries from the SED to support data analysis.

For more extensive data analysis, external software packages are generally employed. The primary environmental data analysis subsystem in use at the FEMP is the Intergraph Environmental Resource Management and Analysis (ERMA) system. Brief descriptions of ERMA subsystems follow:

A. **Microstation CADD Software** - One foundation of ERMA. Graphics-related data used by ERMA are stored in Microstation design files, which can be enhanced in appearance using standard Microstation Computer Aided Design and Drafting (CADD) menu commands.

B. **Relational Database Linkages to SED** - Via the Intergraph Relational Interface System (RIS) that provides linkage between ERMA and the SED.

C. **Statistical Analysis Capabilities** - Within ERMA and directly interfaced with the SED.

D. **Geographic Information System Capability** - Within ERMA via Intergraph MGE software and used to facilitate spatially-related queries against the SED and to plot results on an appropriate site map.

E. **Hydrogeologic Analysis** - Supported in ERMA via direct linkages to software used to generate stratigraphic cross sections, correlation panels, thickness maps, structure

maps, and distribution maps. Interfaces are also provided between ERMA and popular commercial contouring packages.

F. **Modeling** - Supported in ERMA via interfaces with groundwater models such as the U.S. Geological Survey modular finite-difference groundwater flow model (MODFLOW).

G. **Block Modeling** - Voxel Analyst® and Kriging software products are used to develop block models of subsurface contamination in the soil and groundwater. These tools provide easy to understand representation of the nature and extent of contamination.

F.5 FEMP SOFTWARE ENVIRONMENT

The core of the FEMP environmental data management system is the ORACLE® relational database management system. The FEMP environmental data management system uses ORACLE® for data storage and retrieval. The following general software characteristics are employed in environmental software applications.

F.5.1 Sitewide ORACLE® Databases

ORACLE® databases are maintained sitewide by various organizations. These include numerous data tables and data elements. A data dictionary that describes each ORACLE® data table, data elements in each table, keyed data elements, definitions of each data table and each data element, and field characteristics for each data element is also maintained. In addition, entity relationship diagrams describe relationships among the ORACLE® tables.

The ORACLE®-based SED (see F.4.4.) is the repository for FEMP environmental software modules. It is the central repository, not only for environmental data, but also for information models that guide functional requirements and design decisions for future software applications developed for FEMP. The SED provides a clear and concise definition of environmental data that can be easily communicated to multiple software application maintenance teams and data users.

The SED is designed to minimize data redundancy to the highest practical degree except when performance factors on key software applications require addition of redundant data elements to some data tables. This approach minimizes confusion and possibility for error when multiple groups of users access the same data elements in different applications.

F.5.2 Menus

When possible, ORACLE® software will be used to develop executive menus for environmental software to provide users with similar "look and feel" across applications.

F.5.3 Data Input Standards

An absolute standard for data input modules was not employed for environmental software systems. Rather, certain general standards are enforced, recognizing that each specific application may have some unique data input needs requiring some deviation from other applications. The data input standards philosophy, then, is to apply the following general input standards:

A. **Software Platform** - ORACLE® software is used as the development platform for FEMP environmental software modules when possible.

B. **Data Editing and Verification** - Predefined field edits (templates) are used when possible to help screen data for valid entries on input screens.

C. **Use of Predefined Codes and Look-up Tables** - Look-up tables with predefined lists of valid codes are used when possible for coded data elements to help screen data for valid entries by forcing use of standard codes.

D. **Required Fields and Field Completeness** - To the maximum extent possible, data elements are verified during data input for completeness, and required fields must be entered for a screen entry to be accepted into FACTS or SED.

E. **Error Messages** - ORACLE® software with an error-message-handling feature provides a clear and concise error message in a consistent fashion on input screens to inform users of input errors.

F. **Data Verification** - Analytical results data entered manually into the ORACLE® SED or imported into the SED from another system (such as FACTS) shall be reviewed for accuracy. This review may be done manually, by an individual other than the person keying in the data, or via computer verification.

F.5.4 Data Output Standards

Data reporting modules implemented in data systems are flexible and easy to use. They incorporate standard, high-level ORACLE® query capabilities including searches, sorts, control breaks, and reformatting. Standard and customized program modules allow for both regular production reports and ad hoc (on demand) reports.

Standardized production reports use predefined query forms, are numbered to allow for easy user reference, and may be initiated from system menus. SQR and SQL software packages to generate ad hoc reports from FACTS or SED.

Other third-party software packages are used to extract data from FACTS or SED and format ad hoc reports.

F.5.5 Data Interface Standards

Data interface between separate environmental software systems is facilitated by sharing the common ORACLE® relational database management system. This system provides a seamless interface that does not require a multistep data export/import process to move data from one application system to the next. However, certain basic data interface capabilities between ORACLE®-based systems and stand-alone or "orphan" systems, which exist primarily on microcomputers within specific FEMP organizations, are supported in the following manner:

A. **ASCII File Creation** - Software tools produce ASCII data files extracted from the ORACLE® databases. The delimiter used between fields in these files may be

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user-defined, and character fields can be enclosed in quotes, dependent on data input requirements of the receiving software.

B. **Spatial Data Link** - Primary linking fields for exporting spatial data from the SED to external orphan software are the station identification (ID) number and location X and Y coordinates.

C. **Temporal Data Link** - Primary linking fields for exporting temporal data from the SED to external orphan software packages are the sample ID number, date, and time.

F.6 HARDWARE REQUIREMENTS

The hardware environment for new systems development shall be compatible with existing site computer equipment. Current base hardware is a Digital Equipment Corporation VAX cluster comprised of a VAX 8550 and a VAX 7610 running under a VAX/VMS. Short and long term upgrades include installation of Multiple Processing Technology (MPX) and memory, storage, and various other peripheral upgrades.

F.6.1 Operating System

The current VAX cluster operates under VAX/VMS. Software systems shall be fully compliant with upgrades in the operating system.

F.6.2 Network Support

New system functionality shall co-exist successfully with existing network software as well as provide functional capacity to support future networking software.

F.6.3 Terminal Support

Systems will function, at a minimum, in a character-based environment with future migration capabilities to a Graphical User Interface (GUI) form.

F.6.4 Security

Security provisions for systems development shall conform to established site security guidelines. The system also considers integration of VAX/VMS security capabilities as well as other internal system-dependent security. For legal and financial reasons, security of data is essential. The entire sphere of data security is governed by the following major points.

F.6.4.1 <u>Data Access</u>. Users of the system shall be authorized and given limited access to data. When a user is removed from the project, their access rights shall be withdrawn.

F.6.4.2 <u>Document Procurement</u>. Documents associated with data gathered at the site are restricted from access by the public unless authorized by DOE. When documents are produced concerning data, access restrictions shall apply unless waived by DOE.

F.6.4.3 <u>Passwords</u>. Passwords shall be assigned to each user, data screen, and database and shall be controlled by the database administrator. There are multiple levels of passwords, depending upon the degree of security necessary.

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F.7 SOFTWARE DEVELOPMENT STANDARDS

New software developed in support of environmental data management activities shall follow a standard, structured software development life-cycle methodology, which shall include the following phases:

A. Project initiation;

B. Requirements definition;

C. Feasibility;

D. Analysis and design;

E. Generation;

F. Implementation;

G. Maintenance.

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APPENDIX G

ANALYTICAL METHODS AND PERFORMANCE CRITERIA

APPENDIX G ANALYTICAL METHODS AND PERFORMANCE CRITERIA

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Appendix G

ANALYTICAL METHODS AND PERFORMANCE CRITERIA

G.1 INTRODUCTION

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This appendix gives the methods and/or performance criteria for all analyses performed for the FEMP. Table G-1, the Methods Selection Table, lists the standard methods which may be used for organic and inorganic analyses. The performance criteria associated with the methods in Table G-1 are presented in Table G-2. Table G-3 lists the highest allowable minimum detectable concentrations for radiochemical analyses that have performance criteria. Table G-4 gives the performance specifications for radiochemical analyses.

G.2 ABBREVIATIONS

AAS	-	Atomic Absorption Spectrometry
AD	-	Absolute Difference
ADC	-	Analog to Digital Converter
BOD	-	Biochemical Oxygen Demand
CC	-	Continuing Calibration
CBOD	-	Carbonaceous Biochemical Oxygen Demand
CCB	-	Continuing Calibration Blank
CCC	-	Continuing Calibration Check
CCV	-	Continuing Calibration Verification
COD	-	Chemical Oxygen Demand
CRDL	-	Contract Required Detection Limit
CRQL	-	Contract Required Quantitation Limit
Cs	-	Cesium
DUP	-	Duplicate
DWB	-	Dilution Water Blank
ECV	-	Energy Calibration Verification
EDXRF	-	Energy Dispersive X-Ray Fluorescence
FCV	-	Final Calibration Verification
GAC	-	Glucose-Glutamic Acid Check
GC	-	Gas Chromatography
GC/MS	-	Gas Chromatography/Mass Spectrometry
GFAA	-	Graphite Furnace Atomic Absorption Spectrometry
HAMDC	-	Highest Allowable Minimum Detectable Concentration
IAP	-	Ion Abundance Pattern
IC	-	Initial Calibration
ICB	-	Initial Calibration Blank
ICP	-	Inductively Coupled Plasma
ICP/MS	-	Inductively Coupled Plasma/Mass Spectrometry
ICS	-	Interference Check Standard
ICV	-	Initial Calibration Verification
IDL	-	Instrument Detection Limit
IS	-	Internal Standards
LCS	-	Laboratory Control Sample (second source verification)
LFB	-	Laboratory Fortified Blank
LRB	-	Laboratory Reagent Blank
MB	-	Method Blank
MBAS	-	Methylene Blue Active Substances
MDC	-	Minimum Detectable Concentration
MDL	-	Method Detection Limit
MS	-	Matrix Spike
MSA	-	Method of Standard Additions
MSD	-	Matrix Spike Duplicate
pCi	-	PicoCuries
PCBs	-	Polychlorinated Biphenyls

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PQL	-	Practical Quantitation Limit
RDL	-	Reported Detection Limit
RER	-	Relative Error Ratio
RMV	-	Reference Monitor Verification
RPD	-	Relative Percent Difference
RSD	-	Relative Standard Deviation
TDS	-	Total Dissolved Solids
Th	-	Thorium
TKN	-	Total Kjeldahl Nitrogen
TMS	-	Thermal Mass Spectrometry
TOC	-	Total Organic Carbon
TPH	-	Total Petroleum Hydrocarbons
TSS	-	Total Suspended Solids
U	-	Uranium
VOC	-	Volatile Organic Compounds

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TABLE G-1
SCQ ANALYTICAL METHODS SELECTION TABLE FOR STANDARD AND HISTORICAL METHODS (ORGANIC, INORGANIC, AND ISOTOPIC)

Analyte or Class of Analytes	ASL	Matrices and Methods Water and Wastewater		Matrices and Methods Soil and Solids	
with performance criteria numbers		Prep Method(s)[1,2]	Analytical Method(s)	Prep Method(s)[1,2]	Analytical Method(s)
1a. VOCs	B	W	SW 846-8260B	W	SW 846-8260B
	C, D	W	CLP[8]	W	CLP[8]
1b. VOCs (Drinking Water)	C, D	W	CLP[11]	NA	NA
2. Semi-Volatile Organic Compounds	B	SW 846-3520C or 3510[9]	SW 846-8270C	SW 846-3550B[10]	SW 846-8270C
	C, D	W	CLP[8]	W	CLP[8]
3. Pesticides and PCBs	B	SW 846-3520C or 3510[9]	SW 846- 8081A or 8082	SW 846-3550B[10]	SW 846-8081A or 8082
	C, D	W	CLP[8]	W	CLP[8]
4. Organophosphorus Pesticides	B	SW 846-3520 or 3510[9]	SW 846-8141A	SW 846-3550B[10]	SW 846-8141A
5. Herbicides	B	W	SW 846-8151A	W	SW 846-8151A
6. Aromatic Volatile Organics	B	SW 846-5030B	SW 846-8021B	SW 846-5030B	SW 846-8021B
7. Halogenated Volatile Organics	B	SW 846-5030B	SW 846-8021B	SW 846-5030B	SW 846-8021B
8. Purgeable Organic Halogens	B	W	SW 846-9021	W	SW 846-9021
9. Metals by GFAA	B	SW 846-3020A, 7060A[6], 7740[6] or 7761[6]	SW 846-7000A series or 3113B[4]	SW 846-3050B, 3031[4], or 7761[6]	SW 846-7000A series or 3500[4] series
	C, D	W	CLP[8]	W	CLP[8]
10. Metals by AAS (Flame)	B	SW 846-3010A or 7760A[7]	SW 846-7000A series or 3111B or C[4]	SW 846-3050B, 3031[4], or 7761[6]	SW 846-7000A series or 3500[4] series
	C, D	W	CLP[8]	W	CLP[8]
11. Metals by ICP	B	SW 846-3010A or 7760[7]	SW 846-6010B or 3120B[4], or 200.7[3]	SW 846-3050B or 7760[7]	SW 846-6010B or 3500[4] series
	C, D	W	CLP[8]	W	CLP[8]
12. Mercury by Cold Vapor AAS	B	W	SW 846-7470A, 3112B[4], or 245.2[3]	W	SW 846-7471A
	C, D	W	CLP[8]	W	CLP[8]
13. Cyanide (Total)	B	W	SW 846-9010B or 9012A 335.2[3], 335.3[3]	W	335.2[3]
	C, D	W	CLP[8]	W	CLP[8]
14. Soil pH	B	NA	NA	W	SW 846-9045C
15. pH (electrometric)	B	W	SW 846-9040B or 4500-H+ B[4]	NA	NA
16. Nitrogen, Nitrate/Nitrite	B	W	353.1[3], 353.2[3], 4500D[4],E[4]	NA	NA
17. Conductivity	B	W	120.1[3] or 2510B[4]	NA	NA
18. TKN	B	W	351.2[3]	NA	NA

TABLE G-1
(Continued)

Analyte or Class of Analytes	ASL	Matrices and Methods Water and Wastewater		Matrices and Methods Soil and Solids	
with performance criteria numbers		Prep Method(s)[1,2]	Analytical Method(s)	Prep Method(s)[1,2]	Analytical Method(s)
19. TOC	B	W	SW 846-9060	NA	NA
20. Alkalinity	B	W	310.1[3] or 2320B[4]	NA	NA
21. Chloride	B	W	325.2[3], 300.(all)[3] or 4500B[4]	NA	NA
22. Sulfide	B	W	376.1[3] or SW 846-9030B	NA	SW 846-9030B
23. Ammonia	B	W	350.1[3], 350.3[3], 4500C & F[4]	NA	NA
24. Hexavalent Chromium	B	SW 846-3060A, W	SW 846-7195 or 7196A, 3500-CrD[4]	SW 846-3060A, W	SW 846-7195 or 7196A
25. Oil & Grease	B	W	SW 846-9070, 5520B[4], or 413.1[3]	W	SW 846-9070 or 9071A
26. Temperature	B	W	170.1[3]	W	170.1[3]
27. Percent Solids Moisture)	B	W	160.3[3]	W	160.3[3]
28. TPH	B	W	418.1[3]	W	SW 846-8440
29. Total Dissolved Solids	B	W	160.1[3] or 2540C[4]	NA	NA
30. Phosphorus	B	W	365.(all)[3] or 4500E[4]	NA	NA
31. Surfactants (MBAS)	B	W	5540C[4]	NA	NA
32. Phenolics, Total Recoverable	B	W	SW 846-9065 or 9066	W	SW 846-9065 or 9066
33. Sulfate	B	W	375.2[3], 300.0[3] or 4500E[4]	NA	NA
34. Fluoride	B	W	340.2[3], 300.0[3] or 4500C[4]	NA	NA
35. Total Organic Halides	B	W	SW 846-9020B	NA	NA
36. Color	B	W	110.2[3]	NA	NA
37. Red/Ox Potential	B	W	ASTM-1498	NA	NA
38. Total Suspended Solids	B	W	160.2[3] or 2540D[4]	NA	NA
39. Paint Filter Test	B	W	SW 846-9095A	W	SW 846-9095A
40. COD	B	W	5220D[4]	NA	NA
41. BOD_5 & $CBOD_5$	B	W	5210B[4]	NA	NA
42. Total Fecal Coliforms	B	W	9222D[4]	NA	NA
43. Reactivity	B	W	SW 846-parts 7.3.3 & 7.3.4	W	SW 846- parts 7.3.3 & 7.3.4
44. Corrosivity	B	W	SW 846-9040B	W	SW 846-9040B
45. Ignitability	B	W	SW 846-1010	W	SW 846-1010
46. Sulfide, Extractable	B	W	SW 846-9031	W	SW 846-9031
47. Dissolved Oxygen	B	W	4500-O G[4]	NA	NA

TABLE G-1
(Continued)

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Analyte or Class of Analytes	ASL	Matrices and Methods Water and Wastewater		Matrices and Methods Soil and Solids	
with performance criteria numbers		Prep Method(s)[1,2]	Analytical Method(s)	Prep Method(s)[1,2]	Analytical Method(s)
48. Total Residual Chlorine	B	W	4500-Cl G[4]	NA	NA
49. Total Hardness	B	W	2340C[4]	NA	NA
50. Dioxins by GC/MS	B	W	SW 846-8290	W	SW 846-8290
51. Uranium, Low (ppm) - Level	B	W	5512[5]	W	5512[5]
52. Uranium, High Level	B	W	5504[5]	W	5504[5]
53. Total Uranium and Isotopic Uranium Analysis by ICP/MS	B, C, D	W	5501[5]	W	5501[5]
54. Rapid Determination of Metals and Total Uranium by ICP-MS	B,C,D	W	5502[5]	W	5502[5]
55. Air Particulates	B	NA	NA	W	5515[5]
56. Radon[12]	B	NA	NA	NA	NA

[1]SW 846-1311 (TCLP) could be a prep; however, it is not necessary in all cases.
[2]"W" signifies that preparation is contained in the analytical method.
[3]*Methods for Chemical Analysis of Water and Wastes*, EPA 600/4-79-020. These methods are used for NPDES analyses.
[4]*Standard Methods for the Analysis of Water and Wastewater, 17th ed.* These methods are used for NPDES analyses.
[5] *FEMP Laboratory Method Number.*
[6]7060 contains the preparation for As, 7740 for Se, and 7761 for Ag.
[7]7760 contains the preparation for Ag.
[8]USEPA Contract Laboratory Program Statement of Work, Multi-Media, Multi-Concentration, most recent revision. The applicable CRDLs will be those listed in the method or the final remediation levels, whichever is lower.
[9]SW 846-3520 is the preferred method; however, some foamy or small samples may require the use of Method 3510.
[10]SW 846-3550 is used for uniform soil samples. SW 846-3540 is recommended for special matrices (e.g. oil soaked soil, etc.).
[11]USEPA Contract Laboratory Program Statement of Work for Organic Analyses, Low Concentration Water, most recent revision. The applicable CRDLs will be those listed in the method or the final remediation levels, whichever is lower.
[12]Radon-222 is measured in ambient air only.

Note: If ASL D acceptance criteria are not specified for a contaminant of concern that must be certified, ASL D acceptance criteria shall be developed according to the specific needs of the project, taking into consideration the Final Remediation Levels, sample matrices, and any other relevant factors.

Note: The analytical and prep methods in Table G-1 are current as of 1/23/98. The most current promulgated methods shall be used.

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TABLE G-2
ORGANIC, INORGANIC, AND ISOTOPIC PERFORMANCE CRITERIA

CRITERION: 1a		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: GC/MS for Volatile Organics (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. IAP (Tune)	Start each 12 hr period	Per method Table 4	Retune
2. IC	Begin, following tune	Per method Section 7.3	Recalibrate
3. CC	Every 12 hrs, following tune	Per method Section 7.4	Recalibrate
4. LCS	Start and 1/20	75% - 125%	Reanalyze
5. Method Blank	Every 12 hours	< PQL	Reanalyze
6. MS/MSD	1/20 or 1/batch	Per method Section 8.6	Advisory
7. Surrogates	All samples	Per method Table 9	Reextract and reanalyze
8. Internal Standard	All samples	Per method Section 7.4.5	Reanalyze
9. Detection limits ..... Per method tables 1,2 & 3			
10. Analyte lists ..... Per method table 1			
11. Standards concentrations IAP ..... Per method Section 5.11 Internal Standard ..... Per method Section 5.10 MS ..... Per method Section 5.13 Surrogate ..... Per method Section 5.9			
12. Calibration points & ranges IC ..... Per method Section 5.12 CC ..... Per method Section 7.4.2			

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TABLE G-2
(Continued)

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CRITERION: 2		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: GC/MS for Semivolatile Organics (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. IAP (Tune)	Start each 12 hr period	Per method Table 3	Retune
2. IC	Begin, following tune	Per method Section 7.3	Recalibrate
3. CC	Every 12 hrs, following tune	Per method Section 7.4.3 and 7.4.4	Recalibrate
4. LCS	1/batch or 1/20, whichever is more frequent	Per method Table 6	Reanalysis per method requirements
5. Method Blank	Each batch	< PQL	Reanalyze
6. MS/MSD	1/20 or 1/batch	Per method Sections 8.6.2 and 8.6.3	Advisory
7. Surrogates	All samples	Per method Table 8	Reanalyze
8. Internal Standard	All samples	Per method Section 7.4.5	Reanalyze
9. Detection limits ..... Per method table 2			
10. Analyte lists ..... Per method table 2			
11. Standards concentrations IAP ..... Per method Section 5.5 Internal Standard ..... Per method Sections 5.4 MS ..... Per method Section 5.8 Surrogate ..... Per method Section 5.7			
12. Calibration points & ranges IC ..... Per method Section 5.6 CC ..... Per method Section 7.4.2			

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TABLE G-2
(Continued)

CRITERION: 3		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: GC for Organochlorine Pesticides and PCB's (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. Degradation check sample	Start each 12 hours	Per method Section 7.4.5	Reanalyze
2. IC	Begin	Per method	Recalibrate
3. CCV	Start, 1/10 samples and end of sequence	Per method Section 7.3[1]	Recalibrate
4. LCS	1/batch or 1/20, whichever is more frequent	Per method Table 3	Recalibrate
5. Method Blank	Each batch	< PQL	Reanalyze
6. MS/MSD[2]	Every 20 samples	Per CLP SOW[3]	Advisory
7. Surrogates	All samples	Per method Section 8.3	Reanalyze
8. Detection limits ..... Per method table 2			
9. Analyte lists ..... Per method table 1			
10. Standards concentrations MS ..... Per CLP SOW[2] Surrogate ..... Per method Section 5.7			
11. Calibration points & ranges ICV ..... Per method Section 5.5 CCV ..... Per method Section 7.4.2[1]			

[1] Refer to Method 8000 (1994), Section 7.4
[2] Since Method 8080A has no concentrations, USEPA OLM03.1, Section 7.2.4.2, pp D-14-15/Pest is used as guidance.
[3] Since Method 8080A has no limits, USEPA OLM03.1, Table 3, page D-84/Pest is used as guidance.

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TABLE G-2
(Continued)

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CRITERION: 4		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: GC for Organophosphorus Pesticides by Capillary Column (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. IC	Begin	Per method Section 7.3	Recalibrate
2. CCV	Start, 1/10 and at end of sequence	Per method Section 7.3	Recalibrate
3. LCS	1/batch or 1/20, whichever is more frequent	60-150%	Recalibrate
4. Method Blank	Each batch	< PQL	Reanalyze
5. MS/MSD	Every 20 samples	60-150%	Advisory
6. Surrogates	All samples	60-150%	Reanalyze
7. Detection limits ..... Per method table 2			
8. Analyte lists ..... Per method table 1			
9. Standards concentrations Internal Standard ..... Per method Section 5.4 MS ..... Per method Section 8.2 Surrogate ..... Per method Section 5.5			
10. Calibration points & ranges ICV ..... Per method Section 7.3[1] CCV ..... Per method Section 7.3[1]			

[1] Refer to Method 8000 (1994), Section 7.4.

CRITERION: 5		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: GC for Chlorinated Herbicides (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. IC	Begin	Per method Section 7.6[1]	Recalibrate
2. CCV	Start, 1/10 samples and end of sequence	Per method Section 7.6[1]	Recalibrate
3. LCS	1/batch or 1/20, whichever is more frequent	60-150%	Recalibrate
4. Method Blank	Each batch	< PQL	Reanalyze
5. MS/MSD	Every 20 samples	40-150%	Advisory
6. Surrogates	All samples	60-150%	Reanalyze
7. Detection limits .... Per method tables 1 & 2			
8. Analyte lists ..... Per method table 1			
9. Standards concentrations Internal Standard ..... Per method Section 5.13 MS ..... Per method Section 8.2.1 Surrogate ..... Per method Section 5.14			
10. Calibration points & ranges ICV ..... Per method Section 5.12 CCV ..... Per method Section 7.6[1]			

[1] Refer to Method 8000 (1994).

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TABLE G-2
(Continued)

CRITERION: 6		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: GC for Aromatic Volatile Organics (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. IC	Begin	Per method Section 7.6[1]	Recalibrate
2. CCV	Start, 1/10 samples, and at end of sequence	Per method Section 7.6[1]	Recalibrate
3. LCS	1/batch or 1/20, whichever is more frequent	Per method Table 3	Reanalyze
4. Method Blank	Each batch	< PQL	Reanalyze
5. MS/MSD	Every 20 samples	Per method Section 8.2[1]	Advisory
6. Surrogates	All Samples	80-120%	Reanalyze
7. Detection limits	Per method tables 1 & 2		
8. Analyte lists	Per method table 1		
9. Standards concentrations Internal Standard ..... Per method Section 5.6 MS ..... Per method Section 8.2[1] Surrogate ..... Per method Section 5.7			
10. Calibration points & ranges ICV ..... Per method Section 5.5 CCV ..... Per method Section 7.3[1]			

[1] Refer to Method 8000 (1994).

CRITERION: 7		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: GC for Halogenated Volatile Organics (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. IC	Begin	Per method Section 7.3[1]	Recalibrate
2. CCV	1/10 samples and end of sequence	Per method Section 7.3[1]	Recalibrate
3. LCS	Begin	Per method Table 3	Reanalyze
4. Method Blank	Each batch	< PQL	Reanalyze
5. MS/MSD	Every 20 samples	Per method Section 8.2[1]	Advisory
6. Surrogates	All samples		Advisory
7. Detection limits	Per method tables 1 and 2		
8. Analyte lists	Per method table 1		
9. Standards concentrations Internal Standard ..... Per method Section 5.7 MS ..... Per method Section 8.2[1] Surrogate ..... Per method Section 5.8			
10. Calibration points & ranges ICV ..... Per method Section 5.6 CCV ..... Per method Section 7.3[1]			

[1] Refer to Method 8000 (1994).

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TABLE G-2 (Continued)

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CRITERION: 8		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: Purgeable Organic Halogen (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. ICV	Begin	Per method Section 7.1	Recalibrate
2. CCV	1/10	Per method Section 7.1	Recalibrate
3. LCS	Begin	80-120%	Reanalyze
4. Method Blank	Each batch	< PQL	Reanalyze
5. MS/MSD	Every 10 samples	75-125%	Advisory
6. Detection limits .....Per method Section 9.1			
7. Standards concentrations .....Per method Section 5			
8. Calibration points & ranges ...Per method Section 7.1			

CRITERION: 9		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: METALS BY GFAA (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. ICV	Beginning	80-120%	Recalibrate
2. CCV	Every 10 Samples and at end	80-120%	Recalibrate
3. ICB/CCB	With ICV/CCV	±CRDL	Recalibrate/ Reanalyze last 10
4. Method Blank	Each Batch	< 5 x IDL	Redigest Batch
5. LCS	1/20[1]	80-120%	Redigest Batch
6. Duplicate	1/20[1]	Aqueous: RPD <20% for samples >5x CRDL or ±CRDL Solid: RPD <35% for samples >5x CRDL or ±2CRDL	Qualify Data
7. MS	1/20[1]	75-125%	Post Digestion Spike[2]
8. Recommended Detection Limit..... Per method 7000A, table 1			

[1] Or 1 per batch per matrix, whichever is more frequent.
[2] When sample concentration ≤ 4 x MS concentration, then:
If MS < 30% and MS << Post Digestion Spike recovery, redigest;
If MS 30-74%, Post Digestion Spike.

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TABLE G-2
(Continued)

CRITERION: 10		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: METALS BY FLAA (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. ICV	Beginning	80-120%	Recalibrate
2. CCV	Every 10 Samples and at end	80-120%	Recalibrate
3. ICB/CCB	With ICV/CCV	±CRDL	Recalibrate/Reanalyze last 10
4. Method Blank	Each Batch	< 5 x IDL	Redigest Batch
5. LCS	1/20[1]	80-120%	Redigest Batch
6. Duplicate	1/20[1]	Aqueous: RPD <20% for samples >5x CRDL or ±CRDL Solid: RPD <35% for samples >5x CRDL or ±2CRDL	Qualify Data
7. MS	1/20[1]	75-125%	Post Digestion Spike[2]
8. Recommended detection limits.....Per method 7000A, table 1			

[1] Or 1 per batch per matrix, whichever is more frequent.
[2] When sample concentration ≤ 4 x MS concentration, then:
If MS < 30% and MS << Post Digestion Spike recovery, redigest;
If MS 30-74%, Post Digestion Spike.
If Post Digestion Spike recovery is <85% or >115% and the sample absorbance or concentration is greater than 50% of the spike absorbance or concentration, the Method of Standard Additions is required.

CRITERION: 11		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: ICP-AES (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. ICV	Begin	90% - 110%	Recalibrate
2. CCV	Every 10 and at end	90% - 110%	Recalibrate
3. Method Blank	Each batch	< 5 x IDL	Redigest batch
4. ICB/CCB	With ICV/CCV	±CRDL	Recalibrate/ Reanalyze last 10
5. ICS	Begin & end or every 8 hrs.	80% - 120%	Reexamine background/ reanalyze
6. LCS	1/20[1]	80-120%	Redigest batch
7. MS	1/20[1]	75% - 125%	Post Digestion Spike[2]
8. DUP	1/20[1]	Aqueous: RPD <20% for samples >5x CRDL or ±CRDL Solid: RPD <35% for samples >5x CRDL or ±2CRDL	Qualify Data
9. Serial Dilution	1/20[1]	% Difference <10% for initial results >50x IDL	Qualify Data
10. Recommended Detection Limits.....Per method 6010A, table 1			

[1] Or 1 per batch per matrix, whichever is more frequent.
[2] When sample concentration ≤ 4 x MS concentration, then:
If MS < 30% and MS << Post Digestion Spike recovery, redigest and reanalyze once, then report results;
If MS 30-74%, Post Digestion Spike.

000397

TABLE G-2
(Continued)

1720

CRITERION: 12		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: Mercury by Cold Vapor AAS (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. ICV	Begin	90% - 110%	Recalibrate
2. CCV	1/10 and at end	90% - 110%	Recalibrate
3. Method Blank	Each batch	< 5 x IDL.	Redigest batch
4. ICB/CCB	With ICV/CCV	±CRDL	Recalibrate/Reanalyze last 10
5. LCS	1/20[1]	80-120%	Confirm outliers and reanalyze affected compounds
6. MS	1/20[1]	75% - 125%	Redigest batch
7. Duplicate	1/20[1]	Aqueous: RPD <20% for samples >5x CRDL or ±CRDL Solid: RPD <35% for samples >5x CRDL or ±2CRDL	Qualify Data
8. Detection Limits.....0.0002 mg/L			
9. Standards Concentrations...Per Section 7.2 of 7470A or Section 7.3 of 7471A			

[1] Or 1 per batch per matrix, whichever is more frequent.

CRITERION: 13		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: Cyanide, Total (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. ICV	Begin	90-110%	Recalibrate
2. CCV	1/20	90-110%	Recalibrate
3. LCS	1/20[1]	80-120%	Reanalyze samples since last LCS
4. Method Blank	1/20[1]	< 5 x IDL	Redigest/Reanalyze
5. Matrix Spike	1/20[1]	75-125%	Qualify data
6. Duplicate	1/20[1]	Aqueous: RPD <20% for samples >5x CRDL or ±CRDL Solid: RPD <35% for samples >5x CRDL or ±2CRDL	Qualify data
7. Detection Limit.....1.0 mg/L			

[1] Or 1 per batch per matrix, whichever is more frequent.

CRITERION: 14		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: Soil pH (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. ICV	Begin	± 0.5 pH units	Recalibrate
2. CCV	1/20	± 0.5 pH units	Reanalyze samples since last CCV
3. Duplicate	1/20	± 0.1 pH units	Qualify data

000398

TABLE G-2
(Continued)

CRITERION: 15		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: pH, Electrometric (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. ICV	Begin	±0.5 pH units	Recalibrate
2. CCV	1/20	±0.5 pH units	Reanalyze samples since last CCV
3. Duplicate	1/20	±0.1pH units	Qualify data

CRITERION: 16		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: Nitrogen, Nitrate/Nitrite (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. ICV	Begin	90-110%	Recalibrate
2. CCV	1/10	90-110%	Recalibrate and reanalyze all since last CCV
3. LCS	1/20[1]	80-120%	Reanalyze samples since last LCS
4. Method Blank	1/20[1]	< 5x IDL	Redigest/Reanalyze
5. Matrix Spike	1/20[1]	75-125%	Qualify data
6. Duplicate	1/20[1]	RPD <20% for samples >5x RDL	Qualify data
7. Detection Limit.....0.01 mg/L			

[1] Or 1 per batch per matrix, whichever is more frequent.

CRITERION: 17		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: Conductivity (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. ICV	Begin	90-110%	Recalibrate
2. CCV	1/20	90-110%	Reanalyze samples since last CCV
3. Blank	1/batch	N/A	Qualify data < 5x blank result
4. Duplicate	1/20[1]	RPD <20% for samples >5x RDL	Qualify data

[1] Or 1 per batch per matrix, whichever is more frequent.

000399

TABLE G-2
(Continued)

1720

CRITERION: 18		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: Total Kjeldahl Nitrogen (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. ICV	Begin	90-110%	Recalibrate
2. CCV	1/20	90-110%	Recalibrate
3. LCS	1/20[1]	80-120%	Reanalyze samples since last LCS
4. Method Blank	1/20[1]	< 5 x RDL	Redigest/Reanalyze samples <5x the blank value
5. Matrix Spike	1/20[1]	75-125%	Qualify data
6. Duplicate	1/20[1]	RPD <20% for samples >5x RDL	Qualify data
7. Detection Limit.....0.1 mg/L			

[1] Or 1 per batch per matrix, whichever is more frequent.

CRITERION: 19		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: Total Organic Carbon (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. ICV	Begin	80-120%	Recalibrate
2. CCV	1/15	80-120%	Reanalyze samples since last CCV
3. Method Blank	1/20[1]	< 5 x RDL	Redigest/Reanalyze samples <5x the blank value
4. MS/MSD	1/10[1]	75-125%	Qualify data
5. Duplicate	1/20[1]	RPD <20% for samples >5x RDL	Qualify data
6. LCS	Begin	80-120%	Reanalyze
7. Detection Limit..... 1.0 mg/L			

[1] Or 1 per batch per matrix, whichever is more frequent.

CRITERION: 20		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: Alkalinity (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. LCS	1/20	80-120%	Reanalyze samples since last LCS
2. Duplicate	1/20[1]	RPD <20% for samples > 5x RDL	Qualify data
3. Detection Limit.....10 mg/L as $CaCO_3$			

000400

[1] Or 1 per batch per matrix, whichever is more frequent.

TABLE G-2
(Continued)

CRITERION: 21		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: Chloride (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. ICV	Begin	90-110%	Recalibrate[2]
2. CCV	1/20	90-110%	Recalibrate[2]
3. LCS	1/20	80-120%	Reanalyze samples since last LCS[2]
4. Method Blank	1/20	< 5x RDL	Redigest/Reanalyze samples <5x the blank value
5. Matrix Spike	1/20[1]	75-125%	Qualify data
6. Duplicate	1/20[1]	RPD <20% for samples > 5x RDL	Qualify data
7. Detection Limit.....5.0 mg/L			

[1] Or 1 per batch per matrix, whichever is more frequent.
[2] And/or restandardize titrant.

CRITERION: 22		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: Sulfide (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. ICV	Begin	90-110%	Recalibrate
2. CCV	1/15	90-110%	Recalibrate
3. LCS	1/20	80-120%	Reanalyze
4. Method Blank	1/10	< 5 x RDL	Redigest/Reanalyze samples <5x the blank value
5. Matrix Spike	1/10	75-125%	Qualify data
6. Duplicate	1/10	RPD <20% for samples >5x RDL	Qualify data
7. Detection Limit.....1.0 mg/L			

CRITERION: 23		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: Ammonia (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. ICV	Begin	90-110%	Recalibrate
2. CCV	1/20	90-110%	Recalibrate
3. LCS	1/20[1]	80-120%	Reanalyze samples since last LCS
4. Method Blank	1/20[1]	< 5 x RDL	Redigest/Reanalyze samples <5x the blank value
5. Duplicate	1/20[1]	RPD <20% for samples >5x RDL	Qualify data
6. Detection Limit.....0.1 mg/L			

[1] Or 1 per batch per matrix, whichever is more frequent.

TABLE G-2 (Continued)

1720

CRITERION: 24		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: Hexavalent Chromium (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. ICV	Begin	80% - 120%	Recalibrate
2. CCV	1/20 and at end	80% - 120%	Recalibrate and Reanalyze samples since last CCV
3. Method Blank	Each batch[1]	< PQL	Reprep batch
4. LCS	1/20[1]	80-120%	Recalibrate/Reprep batch
5. MS	1/20[1]	75% - 125%	Reprep or MSA
6. Duplicate	1/20[1]	<20% RPD for samples >5x IDL	Qualify data
7. Detection Limits.....6 µg/L			

[1] Or 1 per batch per matrix, whichever is more frequent.

CRITERION: 25		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: Oil and Grease (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. LCS	1/20	70-110%	Rerun samples
2. Method Blank	1/20	< 5 x RDL	Redigest/Reanalyze samples <5x the blank value
3. MS/MSD (soil only)	1/10[1]	75-125%	Qualify data
4. DUP (soil only)	1/20[1]	RPD <20% for samples >5x RDL	Qualify Data
5. Detection Limit.....0.1 mg/L			

[1] Or 1 per batch per matrix, whichever is more frequent.

CRITERION: 26		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: Temperature (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
Quality control requirements are determined by the corresponding analytical methods or the project specific plan.			

CRITERION: 27		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: Percent Solids (Moisture) (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. Method Blank	1/20	< 5 x RDL	Reprep/Reanalyze samples <5x the blank value
2. Duplicate	1/20[1]	RPD <20%	Qualify data
3. Detection Limit.....1.0%			

[1] Or 1 per batch per matrix, whichever is more frequent.

000402

TABLE G-2
(Continued)

CRITERION: 28		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: Total Petroleum Hydrocarbons (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. ICV	Begin	Per Method Section 6.5	Recalibrate
2. CCV	Every 12 Hours	Per Method Section 6.5	Recalibrate/Reanalyze all samples since last CCV
3. LCS	1/20[1]	80-120%	Reanalyze
4. Method Blank	Each batch[1]	<PQL	Reanalyze samples <5x the blank value
5. MS/MSD	1/20[1]	75-125%	Advisory
6. DUP (soil)	1/20[1]	RPD <20% for samples >5x RDL	Qualify data
7. Detection Limit.....1.0 mg/L			

[1] Or 1 per batch per matrix, whichever is more frequent.

CRITERION: 29		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: Total Dissolved Solids (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. Duplicate	1/20[1]	RPD <20% for samples >5x RDL	Qualify data
2. Detection Limit.....10 mg/L			

[1] Or 1 per batch per matrix, whichever is more frequent.

CRITERION: 30		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: Phosphorus (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. ICV	Begin	90-110%	Recalibrate
2. CCV	1/20	90-110%	Recalibrate
3. LCS	1/20[1]	80-120%	Reanalyze samples since last LCS
4. Method Blank	1/20[1]	< 5 x RDL	Redigest/Reanalyze samples <5x the blank value
5. Matrix Spike	1/20[1]	75-125%	Qualify data
6. Duplicate	1/20[1]	RPD <20% for samples >5x RDL	Qualify data
7. Detection Limit.....0.10 mg/L			

[1] Or 1 per batch per matrix, whichever is more frequent.

000403

TABLE G-2
(Continued)

1720

CRITERION: 31		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: Surfactants (MBAS) (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. ICV	Begin	80-120%	Recalibrate
2. CCV	1/20	80-120%	Reanalyze samples since last CCV
3. Method Blank	1/20[1]	< 5 x RDL	Reanalyze samples <5x the blank value
4. Duplicate	1/20[1]	RPD <20% for samples >5x RDL	Qualify data
5. Detection Limit.....0.025 mg/L calculated as LAS			

[1] Or 1 per batch per matrix, whichever is more frequent.

CRITERION: 32		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: Phenolics, Total Recoverable (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. ICV	Begin	90-110%	Recalibrate
2. CCV	1/15	90-110%	Recalibrate
3. LCS	1/20[1]	80-120%	Reanalyze samples since last LCS
4. Method Blank	1/20[1]	< 5 x RDL	Redigest/Reanalyze samples <5x the blank value
5. Matrix Spike	1/20[1]	75-125%	Qualify data
6. Duplicate	1/20[1]	RPD <20% for samples >5x RDL	Qualify data
7. Detection Limit.....5.0 μg/L			

[1] Or 1 per batch per matrix, whichever is more frequent.

CRITERION: 33		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: Sulfate (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. ICV	Begin	90-110%	Recalibrate
2. CCV	1/20	90-110%	Recalibrate
3. LCS	1/20[1]	80-120%	Reanalyze samples since last LCS
4. Method Blank	1/20[1]	< 5 x RDL	Redigest/Reanalyze samples <5x the blank value
5. Matrix Spike	1/20[1]	75-125%	Qualify data
6. Duplicate	1/20[1]	RPD <20% for samples >5x RDL	Qualify data
7. Detection Limit.....1.0 mg/L			

[1] Or 1 per batch per matrix, whichever is more frequent.

000404

TABLE G-2
(Continued)

CRITERION: 34		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: Fluoride (see Table G-1	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. ICV	Begin	90-110%	Recalibrate
2. CCV	1/20	90-110%	Reanalyze samples since last CCV
3. LCS	1/20[1]	80-120%	Reanalyze
4. Method Blank	1/20[1]	< 5 x RDL	Redigest/Reanalyze samples <5x the blank value
5. Matrix Spike[2]	1/20[1]	75-125%	Qualify data
6. Duplicate	1/20[1]	RPD <20% for samples >5x RDL	Qualify data
7. Detection Limit.....0.1 mg/L			

[1] Or 1 per batch per matrix, whichever is more frequent.
[2] Matrix Spike analysis not required for Ion Selective Electrode method.

CRITERION: 35		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: Total Organic Halides (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. ICV	Begin	Per Method Section 7.2	Recalibrate
2. CCV	1/10 pyrolyses	Per Method Section 7.2	Recalibrate
3. LCS	1/20[1]	80-120%	Reanalyze
4. Method Blank	Each batch[1]	<PQL	Reanalyze samples <5x the blank value
5. MS/MSD	1/15[1]	75-125%	Qualify data
6. Duplicate	1/15[1]	RPD <20% for samples >5x RDL	Qualify data
7. Detection Limit.....5.0 µg/L			

[1] Or 1 per batch per matrix, whichever is more frequent.

CRITERION: 36		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: Color (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
Since Color is a semiquantitative measure, it is not necessary to analyze QC samples. Duplicate analyses are of little value since the sample result is based on visual comparison and is subject to individual variability.			

000405

TABLE G-2
(Continued)

1720

CRITERION: 37		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: Oxidation/Reduction Potential (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. ICV	Begin	90-110%	Recalibrate
2. CCV	1/20	90-110%	Recalibrate
3. Duplicate	1/20[1]	RPD <20% for samples >5x RDL	Qualify data

[1] Or 1 per batch, whichever is more frequent.

CRITERION: 38		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: Total Suspended Solids (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. Method Blank	1/20[1]	< 5 x RDL	Reprep/Reanalyze samples <5x the blank value
2. Duplicate	1/20[1]	RPD <20% for samples >5x RDL	Qualify data
3. LCS	1/20[1]	80-120%	Qualify data
4. Detection Limit..... 10 mg/L			

[1] Or 1 per batch per matrix, whichever is more frequent.

CRITERION: 39		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: Paint Filter Test (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. Duplicate	1/20[1]	Results must agree	Qualify data

[1] Or 1 per batch per matrix, whichever is more frequent.

CRITERION: 40		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: Chemical Oxygen Demand (COD) (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. ICV	Begin	90-110%	Recalibrate
2. CCV	1/20	90-110%	Reanalyze samples since last CCV
3. Method Blank	1/20[1]	< 5 x IDL	Qualify data
4. Duplicate	1/20[1]	RPD <20% for samples >5x RDL	Qualify data
5. LCS	1/20[1]	80-120%	Redigest & Reanalyze
6. Detection Limit.....5 mg/L COD			

[1] Or 1 per batch per matrix, whichever is more frequent.

000406

TABLE G-2
(Continued)

CRITERION: 41		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: Five Day Biochemical Oxygen Demand (BOD_5 and $CBOD_5$) (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. DWB	1/batch	<0.2 mg/L	Qualify data
2. GAC	1/batch	200 ±37 mg/L	Qualify data
3. Method Blank	1/20[1]	< 5x IDL	Qualify data
4. Duplicate	1/20[1]	RPD <20% for samples >5x RDL	Qualify data
5. Detection Limit.....2.0 mg/L			

[1] Or 1 per batch, whichever is more frequent.

CRITERION: 42		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: Total Fecal Coliforms (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. Method Blank	1/20[1]	1 colony	Qualify data
2. Duplicate	1/20[1]	RPD <20%	Qualify data

[1] Or 1 per batch, whichever is more frequent.

CRITERION: 43		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: Reactivity (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. LCS	1/20	>50% and <110%	Reanalyze batch
2. Duplicate	1/20[1]	RPD <20%	Qualify data

[1] Or 1 per batch per matrix, whichever is more frequent.

CRITERION: 44		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: Corrosivity (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. Duplicate	1/20	±0.5 mm/yr	Qualify data

CRITERION: 45		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: Ignitability (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. Duplicate	1/20[1]	±9 °F	Qualify data
2. Xylene Std.	1/20[1]	Per method	Qualify data

TABLE G-2
(Continued)

1720

CRITERION: 46		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: Sulfide, Extractable (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. Duplicate	1/20[1]	80-120%	Reanalyze samples since last LCS
2. Method Blank	1/20[1]	< 5 RDL	Redigest/Reanalyze samples <5x the blank value
3. Matrix Spike	1/20[1]	75-125%	Qualify data
4. Duplicate	1/20[1]	RPD <20% for samples >5x RDL	Qualify data
5. Detection Limits.....Liquids, 1.0 mg/L; Solids, 1.0 mg/kg			

[1] Or 1 per batch per matrix, whichever is more frequent.

CRITERION: 47		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: Dissolved Oxygen (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
Quality control requirements are determined by the corresponding analytical method or the project specific plan.			

CRITERION: 48		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: Total Residual Chlorine (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. Method Blank	1/20	< 5 x IDL	Reanalyze
2. Duplicate	1/20[1]	RPD <20% for samples >5x IDL	Qualify data
3. Detection Limit.....10 μg/L			

[1] Or 1 per batch, whichever is more frequent.

CRITERION: 49		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: Total Hardness (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. LCS	1/20	80-120%	Reanalyze samples since last LCS
2. Duplicate	1/20	RPD <20% for samples >5x IDL	Qualify data

TABLE G-2
(Continued)

CRITERION: 50		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: GC/MS for Polychlorinated Dibenzo-p-Dioxins and Polychlorinated Dibenzofurans (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. ICV	Begin	Per method Sections 6.3-6.7	Recalibrate
2. CCV	1/10	Per method Section 6.9	Recalibrate
3. LCS	1/batch or 1/20, whichever is more frequent	90-110%	Recalibrate
4. Method Blank	Each batch	< PQL	Reanalyze
5. MS/MSD	Every 20	Per method Section 7.5	Advisory
6. Internal Standard	All samples	Per method Section 10.5	Reanalyze
7. Detection limits ..... Per method Section 1.2			
8. Analyte lists ..... Per method table 1			
9. Standards concentrations Internal Standard ..... Per method Section 9.1			
10. Calibration points & ranges ICV ..... Per method Section 6.2 CCV ..... Per method Section 6.9			

CRITERION: 51		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: Uranium, Low (ppm) Level (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. ICV	Begin	90-110%	Recalibrate
2. CCV	1/10	90-110%	Recalibrate
3. LCS	1/20	80-120%	Reanalyze samples since last LCS
4. Method Blank	1/20	< 5 x IDL	Redigest/Reanalyze
5. Matrix Spike	1/20	75-125%	Qualify data
6. Duplicate	1/20	RPD <20% for samples >5x IDL	Qualify data
7. Detection Limit..... 0.1 mg/L, 1 ppm			

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TABLE G-2
(Continued)

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CRITERION: 52		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: Uranium, High Level (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. ICV	Begin	90-110%	Recalibrate
2. CCV	1/10	90-110%	Recalibrate
3. LCS	1/20	80-120%	Reanalyze samples since last LCS
4. Method Blank	1/20	< 5 x IDL	Redigest/Reanalyze
5. Matrix Spike	1/20	75-125%	Qualify data
6. Duplicate - solids	1/20	AD < 1%	Qualify data
7. Duplicate - liquids	1/20	AD < 5 g/L	Qualify data
8. Detection Limit..... Solids, 1.00%; Liquids, 10.0 g/L			

000410

TABLE G-2
(Continued)

CRITERION: 53		PROTOCOL: See Table G-1	
ASLs: B		METHOD: Uranium Analysis for a soil or aqueous matrix by ICP-MS (Reporting units in Relative wt%) (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
Items 1 - 3 apply to general instrument calibration.			
1. ICP-MS Tune	per Batch	cps > 200K for Bi, Ho, Th, U peaks	Adjust lens voltages
2. Mass Calibration	per Batch	< 0.1 amu from known U-238 mass	Recalibrate
3. Peak Resolution	per Batch	< 0.85 amu @ 10% Peak Ht for U-238	Adjust resolution settings
Items 4 -12 apply to Total U analyses.			
4. Calibration Curve - 4 pt.	per Batch	± 10% of known conc. < 10% RSD for 3 trials	Recalibrate
5. Memory Blank	1 per Batch	< CRDL or 1st standard of curve	Increase rinse time & reanalyze Std.
6. CCV	1 per Batch of 20 or less	± 10% of known conc. < 10% RSD for 3 trials	Recalibrate
7. CCB	1 per batch of 20 or less	< CRDL or 1st standard of curve	Increase rinse time & reanalyze Std.
8. Prep Blank	1 per Batch	< CRDL or 1st standard of curve	Redigest batch
9. LCS	1 per Batch	± 20% of certified U-238 value	Redigest batch
10. Samples	20 per Batch	< 10% RSD for 3 trials	Reanalyze sample
11. Duplicate	1 per Batch	RPD < 20%, < 10% RSD for 3 trials	Qualify data
12. Matrix Spike	1 per matrix	75 - 125 %R	Qualify data
Items 13 - 19 apply to isotopic uranium analysis			
13. Mass Bias	per Batch	0.9497 - 1.045	Reanalyze
14. Calibration Blank	1 per Batch	Isotopic peaks < 250 cps	Increase rinse time
15. CCV for ratios of interest	1 per Batch	± 5% of certified ratio values	Reanalyze batch
16. Memory Blank	1 per Batch	minor isotopes < 250 cps	Increase rinse time
17. Isotopic LCS	1 per Batch	± 5% of certified isotopic values	Redigest
18. Samples	20 per Batch	< 10% RSD for 3 trials for ratios	Reanalyze sample
19. Sample Dup	1 per Batch	RPD < 20%	Qualify data

TABLE G-2
(Continued)

1720

CRITERION: 53 (cont.)		PROTOCOL: See Table G-1	
ASLs: C and D		METHOD: Uranium Analysis for a Soil or Aqueous Matrix by ICP-MS (Reporting units in Relative wt%) (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
Items 1 - 3 apply to general instrument calibration.			
1. ICP-MS Tune	per Batch	cps > 200K for Bi, Ho, Th, U peaks	Adjust lens voltages
2. Mass Calibration	per Batch	< 0.1 amu for known mass of U-238	Recalibrate
3. Peak Resolution	per Batch	< 0.85 amu @ 10% Peak Ht for U-238	Adjust resolution settings
Items 4-13 apply to Total U analyses.			
4. Calibration Curve - 5 pt	per Batch	±10% of known conc. < 10% RSD for 3 trials	Recalibrate
5. Memory Blank	1 per Batch	< CRDL or 1st standard of curve	Increase rinse time & reanalyze Std.
6. CCV	1 every 10 samples	±10% of known conc. < 10% RSD for 3 trials	Recalibrate
7. CCB	1 every 10 samples	< CRDL or 1st standard of curve	Increase rinse time & reanalyze Std.
8. Prep Blank	1 per Batch	< CRDL or 1st standard of curve	Redigest batch
9. LCS	1 per Batch	±20% of certified U-238 value	Redigest batch
10. Samples	20 per Batch	< 10% RSD for 3 trials	Reanalyze sample
11. Sample Duplicate	1 per Batch	RPD < 20%, < 10% RSD for 3 trials	Qualify data
12. Matrix Spike	1 per Matrix	75 - 125 %R	Qualify data
13. Matrix Spike Dup	1 per Matrix	RPD < 20%,< 10% RSD for 3 trials	Qualify data
Items 14 - 21 apply to isotopic uranium analyses.			
14. Mass Bias	per Batch	0.9497 - 1.045 for 4 U isotopes	Reanalyze
15. Calibration Blank	1 per batch	Isotopic peaks < 250 cps	Increase rinse time
16. CCV for ratios of interest	1 every 10	±5% of certified ratio values	Reanalyze batch
17. Memory Blank	1 per Batch	minor isotopes < 250 cps	Increase rinse time
18. Isotopic LCS	1 per Batch	±5% of certified isotopic values	Redigest
19. Samples	20 per Batch	< 10% RSD for 3 trials for ratios	Reanalyze sample
20. Duplicate	1 per Bath	RPD < 20%	Recalibrate
21. Matrix Spike	Not Applicable for isotopic ratio measurements		

TABLE G-2
(Continued)

CRITERION: 54		PROTOCOL: See Table G-1	
ASLs: B, C, D		METHOD: Rapid determination of metals short list (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
Items 1 - 3 apply to general instrument calibration.			
1. ICP-MS Tune	per 12 hour shift	< 10% RSD for mass range of interest	Re-Tune
2. Mass Calibration	per 12 hour shift	< 0.1 amu from known mass	Re-Tune
3. Peak Resolution	per 12 hour shift	≤ 0.80 amu @ 10% Peak Ht for all masses	Re-Tune
Items 4 -12 apply to Total U analyses.			
4. Calibration Curve > 3 pts.	per Batch	±10% of known conc. < 10% RSD for 3 trials	Recalibrate
5. Memory Blank	1 per Batch	< CRDL or 1st standard of curve	Increase rinse time & reanalyze Std.
6. ICV	1 per Batch	± 10% of known, < 10%RSD for 3 trials	Recalibrate
7. CCV	1 every 10 samples	± 10% of known, < 10%RSD for 3 trials	Recalibrate-Reanalyze all samples after last acceptable ICV/CCV
8. CCB	1 every 10 samples	< CRDL or 1st standard of curve	Qualify Data
9. Prep Blank	1 per Batch	< CRDL or 1st standard of curve	Qualify Data
10. LCS	1 per Batch	± 20% of certified value	Redigest batch
11. Samples	20 per Batch	< 10% RSD for 3 trials	Reanalyze sample
12. Sample Duplicate	1 per Batch	RPD ± 20, ≤ 10% RSD for 3 trials	Qualify Data
13. Matrix Spike	1 per Matrix	Recovery 75-125%, < 10% RSD for 3 trials	Qualify Data

CRITERION: 55		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: Gravimetric Determination of Airborne Particles (See Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. Method Blank	1/20[1]	< 3% difference when tared	Check balance calibration, humidity, qualify data
2. Balance calibration check[2]	1/20[1]	±0.0005 g	Recalibrate balance
3. Detection Limit.....10 μg/L			

[1] Or 1 per batch, whichever is more frequent.

[2] Using three weight standards that bracket the range of samples

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TABLE G-2
(Continued)

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CRITERION: 56		PROTOCOL: See Table G-1	
ASLs: B only		METHOD: Alpha track-etch detectors (see Table G-1)	
REQUIREMENT	FREQUENCY	ACCEPTANCE LEVELS	CORRECTIVE ACTION
1. CC	Annually	Vendor determined	Recalibrate
2. LCS (Method Blank)	Batch	80-120% of background	Recalibrate
3. Internal Standard (spike)	3% or specified limit	80-120% of known exposure	Recalibrate
4. Duplicate measurements	10% minimum	<20% variability	Recalibrate
5. Blind blank	2-5%	None [1]	Adjust data for deviations
6. Blind spike	5-10%	None [2]	Adjust data for deviations
7. Location replicates	100%	IEMP agreement limits	Adjust data
8. Analyte list Rn-222			
9. Detection limit ..... LLD 0.2-1.0 pCi/L-month			
10. Calibration points and ranges: Several different radon concentrations (minimum of 3) including expected radon concentration range. A minimum of ten detectors are checked at each level.			

[1] Used as a qualitative determination of vendor's precision near the LLD. This data is used to verify integrity of packaging.
[2] Used as a quantitative determination of vendor's accuracy to a known exposure.

Note: The following analytical protocol is excerpted from USEPA 402-R-92-004 *Indoor Radon and Radon Decay Product Measurement Device Protocols*:

(1) The track-etch detector plastic is exposed to an unknown radon concentration environment.

(2) The alpha particles from decaying radon and its progeny damage the microscopic three dimensional structure of the plastic material.

(3) The exposed detectors are packaged and sent to a vendor for analysis.

(4) The vendor unpacks the detectors and places the plastic in a caustic solution that accentuates the damage tracks.

(5) The vendor then places the chemically treated plastic in an automated optical counting system or on a microscope for counting of the tracks.

(6) The background corrected (net) number of tracks per unit area (density) is proportional to the true integrated average radon concentration for the exposure period. The density is correlated to a radon concentration in air by using a conversion factor obtained from previously determined calibration data.

TABLE G-3

HIGHEST ALLOWABLE MINIMUM DETECTABLE CONCENTRATIONS (HAMDCs[4]) FOR RADIOCHEMICAL ANALYSES

Analyte or Class of Analytes (with performance criterion numbers)	ASL	MATRICES[3] Water pCi/L	Soil/Sediment pCi/g	Air Filters pCi/filter	Fly Ash pCi/g	Contaminated Liquid[1] pCi/L
1. U-234, U-235/236, U-238	B	0.4	0.2	9.0	0.4	1.0
2. U-234, U-235/236, U-238	C, D	0.2	0.1	4.0	0.2	0.5
3. Th-227, Th-228, Th-230, Th-232	B	0.4	0.2	9.0	0.4	1.0
4. Th-227, Th-228, Th-230, Th-232	C, D	0.2	0.1	4.0	0.2	0.5
5. Pu-238, Pu-239/240	B	1.0	0.4	4.0	0.4	1.0
6. Pu-238, Pu-239/240	C, D	0.5	0.2	2.0	0.2	0.5
7. Np-237	B	1.0	0.4	4.0	0.4	1.0
8. Np-237	C, D	0.5	0.2	2.0	0.2	0.5
9. Po-210	B	1.0	0.4	4.0	0.4	1.0
10. Po-210	C, D	0.5	0.2	2.0	0.2	0.5
11. Am-241	B	2.0	0.4	11	2.0	11
12. Am-241	C, D	1.0	0.2	5.0	1.0	5.0
13. Ra-226	B	2.0	0.6	4.0	0.4	2.0
14. Ra-226	C, D	1.0	0.25	2.0	0.2	1.0

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TABLE G-3 (cont.)

HIGHEST ALLOWABLE MINIMUM DETECTABLE CONCENTRATIONS (HAMDCs[4]) FOR RADIOCHEMICAL ANALYSES

		MATRICES[3]				
Analyte or Class of Analytes (with performance criterion numbers)	ASL	Water pCi/L	Soil/Sediment pCi/g	Air Filters pCi/filter	Fly Ash pCi/g	Contaminated Liquid[1] pCi/L
15. Ra-228	B	7.0	1.0	11	1.0	7.0
16. Ra-228	C,D	3.0	0.5	5.0	0.5	3.0
17. Pu-241	B	1.0	0.2	11	1.0	2.0
18. Pu-241	C,D	0.5	0.1	5.0	0.5	1.0
19. Pb-210	B	7.0	1.0	20	2.0	20
20. Pb-210	C,D	3.0	0.5	10	1.0	10
21. Sr-90	B	2.0	1.0	4.0	1.0	2.0
22. Sr-90	C,D	1.0	0.5	2.0	0.5	1.0
23. Tc-99	B	30	2.0	110	20	70
24. Tc-99	C,D	15	1.0	50	10	30
25. Gamma Emitting Isotopes	B	9.0	0.4	20	2.0	20
26. Gamma Emitting Isotopes	C,D	4.0	0.2	10	1.0	10
27. Total U[2] (laser)	B	0.5 µg/L	0.5 µg/g	10 µg/filter	0.5 µg/g	5.0 µg/L
28. Total U[2] (laser)	C,D	0.1 µg/L	0.1 µg/g	2.0 µg/filter	0.1 µg/g	1.0 µg/L
29. Gross Alpha	B	2.0	15	4.0	N/A	N/A
30. Gross Beta	B	4.0	30	30	N/A	30
31. Gross Alpha	A	20	150	40	N/A	N/A
32. Gross Beta	A	100	150	150	N/A	N/A
33. Rn-222[5]	B	N/A	N/A	N/A	N/A	N/A

1 Contaminated liquids are two phased systems containing about 90% water and 10% organic liquid.
2 Note the different units for this analyte.
3 Does not account for waste matrices. Performance criteria for waste matrices will be specified through the DQO process, documented in the PSP, and treated as ASL E.
4 The HAMDCs are representative values derived from input from seven radiochemical laboratories for routine operating conditions. These values may be refined, pending EPA review, on the basis of measurements of these or other laboratories on FEMP matrices under actual operating conditions.
5 LLD for Rn-222 in air is 0.2-1.0 pCi/L-month depending on sensitivity level at analysis.

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Table G-4 RADIOCHEMICAL PERFORMANCE CRITERIA					
CRITERION: 1	ANALYTICAL SUPPORT LEVEL (ASL) B				
ANALYTE: U-234, U-235/236, U-238	SAMPLE MATRIX				
PERFORMANCE PARAMETERS	WATER	SOIL/ SEDIMENT	AIR FILTERS(2)	FLY ASH	CONTAMINATED LIQUID(3)
Highest Allowable Minimum Detectable Concentration (HAMDC)(1)	0.4 pCi/L	0.2 pCi/g	9.0 pCi/Filter	0.4 pCi/g	1.0 pCi/L
Percent Overall Tracer/Chemical Recovery(5)	50-110%	45-110%	45-110%	45-110%	45-110%
Method Blank Concentration	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)
Laboratory Control Sample: Percent of Known Value (5)	85-115%	85-115%	85-115%	85-115%	85-115%

(1)

$$MDC = \frac{3.29 \cdot (S_{BLK})}{K} + \frac{2.71}{T \cdot K}$$

Where S_{BLK} is the standard deviation of the count rate of an appropriate method blank and, K is the correction factor that includes units conversion and typical values for the volume or weight of sample, decay correction factor, detector efficiency and the chemical recovery. T is the counting time of the sample.

(2) 8" X 10" filters.

(3) Two phase system containing about 90% Water + 10% Organic liquid.

(4) When the concentration of a radionuclide in a sample is significantly greater than the applicable HAMDC, the Radiochemical Analysis Performance Specifications for the HAMDC and Method Blank Concentration are waived. Counts may be terminated earlier than usual provided that the one sigma uncertainty in the net count-rate of the sample(s) in question is ten percent (10%) or less. The measured result for the blank must not exceed the HAMDC or five percent (5%) of the activity concentration of the least active sample in the batch.

(5) Recoveries or percentages of known values which are 15% above or below the ranges listed are acceptable on an infrequent basis, e.g., less than 15% of the time. These occurrences must be investigated and explained. If more than 15% of the recoveries are outside the ranges listed, take corrective actions and reanalyze samples.

Table G-4 RADIOCHEMICAL PERFORMANCE CRITERIA (cont.)					
CRITERION: 2	ANALYTICAL SUPPORT LEVEL (ASL) C & D				
ANALYTE: U-234, U-235/236, U-238	SAMPLE MATRIX				
PERFORMANCE PARAMETERS	WATER	SOIL/ SEDIMENT	AIR FILTERS[2]	FLY ASH	CONTAMINATED LIQUID[3]
Highest Allowable Minimum Detectable Concentration (HAMDC)[1]	0.2 pCi/L	0.1 pCi/g	4.0 pCi/Filter	0.2 pCi/g	0.5 pCi/L
Percent Overall Tracer/Chemical Recovery[6]	50-110%	45-110%	45-110%	45-110%	45-110%
Percent Matrix Spike Recovery[6]	70-125%	60-130%	60-130%	60-130%	60-130%
Method Blank Concentration	<HAMDC[4]	<HAMDC[4]	<HAMDC[4]	<HAMDC[4]	<HAMDC[4]
Laboratory Control Sample: Percent of Known Value[6]	85-115%	85-115%	85-115%	85-115%	85-115%
Precision Requirements for Duplicate Samples	RER≤2[5]	RER≤2[5]	RER≤2[5]	RER≤2[5]	RER≤2[5]

(1) $$MDC = \frac{3.29 \cdot (S_{BLK})}{K} + \frac{2.71}{T \cdot K}$$

Where S_{BLK} is the standard deviation of the count rate of an appropriate method blank and, K is the correction factor that includes units conversion and typical values for the volume or weight of sample, decay correction factor, detector efficiency and the chemical recovery. T is the counting time of the sample.

(2) 8" X 10" filters.

(3) Two phase system containing about 90% Water + 10% Organic liquid.

(4) When the concentration of a radionuclide in a sample is significantly greater than the applicable HAMDC, the Radiochemical Analysis Performance Specifications for the HAMDC and Method Blank Concentration are waived. Counts may be terminated earlier than usual provided that the one sigma uncertainty in the net count-rate of the sample(s) in question is ten percent (10%) or less. The measured result for the blank must not exceed the HAMDC or five percent (5%) of the activity concentration of the least active sample in the batch.

(5) Relative Error Ratio, RER $= |C_1 - C_2| / [(TPU_1)^2 + (TPU_2)^2]^{1/2}$ where C_1 and C_2 are the measured concentrations for the sample and duplicate and TPU_1 and TPU_2 are the respective one sigma total propagated uncertainties. Measurements are acceptable if RER ≤ 2. If RER is greater than 2 but less than or equal to 3, investigate the cause and take corrective actions if RER is consistently greater than 2. If RER > 3, take corrective actions and reanalyze the batch of the batch of samples.

(6) Recoveries or percentages of known values which are 15% above or below the ranges listed are acceptable on an infrequent basis, e.g., less than 15% of the time. These occurrences must be investigated and explained. If more than 15% of the recoveries are outside the ranges listed, take corrective actions and reanalyze samples.

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Table G-4 RADIOCHEMICAL PERFORMANCE CRITERIA (cont.)					
CRITERION: 3	ANALYTICAL SUPPORT LEVEL (ASL) B				
ANALYTE: Th-227, 228, 230, 232	SAMPLE MATRIX				
PERFORMANCE PARAMETERS	WATER	SOIL/ SEDIMENT	AIR FILTERS(2)	FLY ASH	CONTAMINATED LIQUID(3)
Highest Allowable Minimum Detectable Concentration (HAMDC)(1)	0.4 pCi/L	0.2 pCi/g	9.0 pCi/Filter	0.4 pCi/g	1.0 pCi/L
Percent Overall Tracer/Chemical Recovery(5)	50-110%	45-110%	45-110%	45-110%	45-110%
Method Blank Concentration	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)
Laboratory Control Sample: Percent of Known Value(5)	85-115%	85-115%	85-115%	85-115%	85-115%

(1) $$MDC = \frac{3.29 \cdot (S_{BLK})}{K} + \frac{2.71}{T \cdot K}$$

Where S_{BLK} is the standard deviation of the count rate of an appropriate method blank and, K is the correction factor that includes units conversion and typical values for the volume or weight of sample, decay correction factor, detector efficiency and the chemical recovery.
T is the counting time of the sample.

(2) 8" X 10" filters.

(3) Two phase system containing about 90% Water + 10% Organic liquid.

(4) When the concentration of a radionuclide in a sample is significantly greater than the applicable HAMDC, the Radiochemical Analysis Performance Specifications for the HAMDC and Method Blank Concentration are waived. Counts may be terminated earlier than usual provided that the one sigma uncertainty in the net count-rate of the sample(s) in question is ten percent (10%) or less. The measured result for the blank must not exceed the HAMDC or five percent (5%) of the activity concentration of the least active sample in the batch.

(5) Recoveries or percentages of known values which are 15% above or below the ranges listed are acceptable on an infrequent basis, e.g., less than 15% of the time. These occurrences must be investigated and explained. If more than 15% of the recoveries are outside the ranges listed, take corrective actions and reanalyze samples.

Table G-4 RADIOCHEMICAL PERFORMANCE CRITERIA (cont.)					
CRITERION: 4	ANALYTICAL SUPPORT LEVEL (ASL) C & D				
ANALYTE: Th-227, 228, 230, 232	SAMPLE MATRIX				
PERFORMANCE PARAMETERS	WATER	SOIL/ SEDIMENT	AIR FILTERS(2)	FLY ASH	CONTAMINATED LIQUID(3)
Highest Allowable Minimum Detectable Concentration (HAMDC)(1)	0.2 pCi/L	0.1 pCi/g	4.0 pCi/Filter	0.2 pCi/g	0.5 pCi/L
Percent Overall Tracer/Chemical Recovery(6)	50-110%	45-110%	45-110%	45-110%	45-110%
Percent Matrix Spike Recovery(6)	70-125%	60-130%	60-130%	60-130%	60-130%
Method Blank Concentration	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)
Laboratory Control Sample: Percent of Known Value(6)	85-115%	85-115%	85-115%	85-115%	85-115%
Precision Requirements for Duplicate Samples	RER≤2(5)	RER≤2(5)	RER≤2(5)	RER≤2(5)	RER≤2(5)

(1) $MDC = \frac{3.29 * (S_{BLK})}{K} + \frac{2.71}{T * K}$

Where S_{BLK} is the standard deviation of the count rate of an appropriate method blank and, K is the correction factor that includes units conversion and typical values for the volume or weight of sample, decay correction factor, detector efficiency and the chemical recovery. T is the counting time of the sample.

(2) 8" X 10" filter.

(3) Two phase system containing about 90% Water + 10% Organic liquid.

(4) When the concentration of a radionuclide in a sample is significantly greater than the applicable HAMDC, the Radiochemical Analysis Performance Specifications for the HAMDC and Method Blank Concentration are waived. Counts may be terminated earlier than usual provided that the one sigma uncertainty in the net count-rate of the sample(s) in question is ten percent (10%) or less. The measured result for the blank must not exceed the HAMDC or five percent (5%) of the activity concentration of the least active sample in the batch.

(5) Relative Error Ratio, RER = $|C_1 - C_2| / [(TPU_1)^2 + (TPU_2)^2]^{1/2}$ where C_1 and C_2 are the measured concentrations for the sample and duplicate and TPU_1 and TPU_2 are the respective one sigma total propagated uncertainties. Measurements are acceptable if RER ≤ 2. If RER is greater than 2 but less than or equal to 3, investigate the cause and take corrective actions if RER is consistently greater than 2. If RER > 3, take corrective actions and reanalyze the batch of the batch of samples.

(6) Recoveries or percentages of known values which are 15% above or below the ranges listed are acceptable on an infrequent basis, e.g., less than 15% of the time. These occurrences must be investigated and explained. If more than 15% of the recoveries are outside the ranges listed, take corrective actions and reanalyze samples.

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Table G-4 RADIOCHEMICAL PERFORMANCE CRITERIA (cont.)					
CRITERION: 5	ANALYTICAL SUPPORT LEVEL (ASL) B				
ANALYTE: Pu-238, 239/240	SAMPLE MATRIX				
PERFORMANCE PARAMETERS	WATER	SOIL/ SEDIMENT	AIR FILTERS(2)	FLY ASH	CONTAMINATED LIQUID(3)
Highest Allowable Minimum Detectable Concentration (HAMDC)(1)	1.0 pCi/L	0.4 pCi/g	4.0 pCi/Filter	0.4 pCi/g	1.0 pCi/L
Percent Overall Tracer/Chemical Recovery(5)	50-110%	45-110%	45-110%	45-110%	45-110%
Method Blank Concentration	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)
Laboratory Control Sample: Percent of Known Value(5)	85-115%	85-115%	85-115%	85-115%	85-115%

(1) $$MDC = \frac{3.29 \cdot (S_{BLK})}{K} + \frac{2.71}{T \cdot K}$$

Where S_{BLK} is the standard deviation of the count rate of an appropriate method blank and, K is the correction factor that includes units conversion and typical values for the volume or weight of sample, decay correction factor, detector efficiency and the chemical recovery. T is the counting time of the sample.

(2) 8" X 10" filter.

(3) Two phase system containing about 90% Water + 10% Organic liquid.

(4) When the concentration of a radionuclide in a sample is significantly greater than the applicable HAMDC, the Radiochemical Analysis Performance Specifications for the HAMDC and Method Blank Concentration are waived. Counts may be terminated earlier than usual provided that the one sigma uncertainty in the net count-rate of the sample(s) in question is ten percent (10%) or less. The measured result for the blank must not exceed the HAMDC or five percent (5%) of the activity concentration of the least active sample in the batch.

(5) Recoveries or percentages of known values which are 15% above or below the ranges listed are acceptable on an infrequent basis, e.g., less than 15% of the time. These occurrences must be investigated and explained. If more than 15% of the recoveries are outside the ranges listed, take corrective actions and reanalyze samples.

Table G-4 RADIOCHEMICAL PERFORMANCE CRITERIA (cont.)					
CRITERION: 6	ANALYTICAL SUPPORT LEVEL (ASL) C & D				
ANALYTE: Pu-238, 239/240	SAMPLE MATRIX				
PERFORMANCE PARAMETERS	WATER	SOIL/ SEDIMENT	AIR FILTERS[2]	FLY ASH	CONTAMINATED LIQUID[3]
Highest Allowable Minimum Detectable Concentration (HAMDC)[1]	0.5 pCi/L	0.2 pCi/g	2.0 pCi/Filter	0.2 pCi/g	0.5 pCi/L
Percent Overall Tracer/Chemical Recovery[6]	45-110%	45-110%	45-110%	45-110%	45-110%
Percent Matrix Spike Recovery[6]	70-125%	60-130%	60-130%	60-130%	60-130%
Method Blank Concentration	<HAMDC[4]	<HAMDC[4]	<HAMDC[4]	<HAMDC[4]	<HAMDC[4]
Laboratory Control Sample: Percent of Known Value[6]	85-115%	85-115%	85-115%	85-115%	85-115%
Precision Requirements for Duplicate Samples	RER≤2[5]	RER≤2[5]	RER≤2[5]	RER≤2[5]	RER≤2[5]

(1) $$MDC = \frac{3.29 \cdot (S_{BLK})}{K} + \frac{2.71}{T \cdot K}$$

Where S_{BLK} is the standard deviation of the count rate of an appropriate method blank and, K is the correction factor that includes units conversion and typical values for the volume or weight of sample, decay correction factor, detector efficiency and the chemical recovery.
T is the counting time of the sample.

(2) 8" X 10" filter.

(3) Two phase system containing about 90% Water + 10% Organic liquid.

(4) When the concentration of a radionuclide in a sample is significantly greater than the applicable HAMDC, the Radiochemical Analysis Performance Specifications for the HAMDC and Method Blank Concentration are waived. Counts may be terminated earlier than usual provided that the one sigma uncertainty in the net count-rate of the sample(s) in question is ten percent (10%) or less. The measured result for the blank must not exceed the HAMDC or five percent (5%) of the activity concentration of the least active sample in the batch.

(5) Relative Error Ratio, RER = $|C_1 - C_2| / [(TPU_1)^2 + (TPU_2)^2]^{1/2}$ where C_1 and C_2 are the measured concentrations for the sample and duplicate and TPU_1 and TPU_2 are the respective one sigma total propagated uncertainties. Measurements are acceptable if RER ≤ 2. If RER is greater than 2 but less than or equal to 3, investigate the cause and take corrective actions if RER is consistently greater than 2. If RER > 3, take corrective actions and reanalyze the batch of the batch of samples.

(6) Recoveries or percentages of known values which are 15% above or below the ranges listed are acceptable on an infrequent basis, e.g., less than 15% of the time. These occurrences must be investigated and explained. If more than 15% of the recoveries are outside the ranges listed, take corrective actions and reanalyze samples.

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Table G-4 RADIOCHEMICAL PERFORMANCE CRITERIA (cont.)					
CRITERION: 7	ANALYTICAL SUPPORT LEVEL (ASL) B				
ANALYTE: Np-237	SAMPLE MATRIX				
PERFORMANCE PARAMETERS	WATER	SOIL/ SEDIMENT	AIR FILTERS[2]	FLY ASH	CONTAMINATED LIQUID[3]
Highest Allowable Minimum Detectable Concentration (HAMDC)[1]	1.0 pCi/L	0.4 pCi/g	4.0 pCi/Filter	0.4 pCi/g	1.0 pCi/L
Percent Overall Tracer/Chemical Recovery[5]	50-110%	45-110%	45-110%	45-110%	45-110%
Method Blank Concentration	<HAMDC[4]	<HAMDC[4]	<HAMDC[4]	<HAMDC[4]	<HAMDC[4]
Laboratory Control Sample: Percent of Known Value[5]	85-115%	85-115%	85-115%	85-115%	85-115%

(1) $$MDC = \frac{3.29 * (S_{BLK})}{K} + \frac{2.71}{T * K}$$

Where S_{BLK} is the standard deviation of the count rate of an appropriate method blank and, K is the correction factor that includes units conversion and typical values for the volume or weight of sample, decay correction factor, detector efficiency and the chemical recovery. T is the counting time of the sample.

(2) 8" X 10" filter.

(3) Two phase system containing about 90% Water + 10% Organic liquid.

(4) When the concentration of a radionuclide in a sample is significantly greater than the applicable HAMDC, the Radiochemical Analysis Performance Specifications for the HAMDC and Method Blank Concentration are waived. Counts may be terminated earlier than usual provided that the one sigma uncertainty in the net count-rate of the sample(s) in question is ten percent (10%) or less. The measured result for the blank must not exceed the HAMDC or five percent (5%) of the activity concentration of the least active sample in the batch.

(5) Recoveries or percentages of known values which are 15% above or below the ranges listed are acceptable on an infrequent basis, e.g., less than 15% of the time. These occurrences must be investigated and explained. If more than 15% of the recoveries are outside the ranges listed, take corrective actions and reanalyze samples.

Table G-4 RADIOCHEMICAL PERFORMANCE CRITERIA (cont.)					
CRITERION: 8	ANALYTICAL SUPPORT LEVEL (ASL) C & D				
ANALYTE: Np-237	SAMPLE MATRIX				
PERFORMANCE PARAMETERS	WATER	SOIL/ SEDIMENT	AIR FILTERS(2)	FLY ASH	CONTAMINATED LIQUID(3)
Highest Allowable Minimum Detectable Concentration (HAMDC)(1)	0.5 pCi/L	0.2 pCi/g	2.0 pCi/Filter	0.2 pCi/g	0.5 pCi/L
Percent Overall Tracer/Chemical Recovery(6)	50-110%	45-110%	45-110%	45-110%	45-110%
Percent Matrix Spike Recovery(6)	70-125%	60-130%	60-130%	60-130%	60-130%
Method Blank Concentration	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)
Laboratory Control Sample: Percent of Known Value(6)	85-115%	85-115%	85-115%	85-115%	85-115%
Precision Requirements for Duplicate Samples	RER≤2(5)	RER≤2(5)	RER≤2(5)	RER≤2(5)	RER≤2(5)

(1) $MDC = \frac{3.29 * (S_{BLK})}{K} + \frac{2.71}{T * K}$

Where S_{BLK} is the standard deviation of the count rate of an appropriate method blank and, K is the correction factor that includes units conversion and typical values for the volume or weight of sample, decay correction factor, detector efficiency and the chemical recovery. T is the counting time of the sample.

(2) 8" X 10" filter.

(3) Two phase system containing about 90% Water + 10% Organic liquid.

(4) When the concentration of a radionuclide in a sample is significantly greater than the applicable HAMDC, the Radiochemical Analysis Performance Specifications for the HAMDC and Method Blank Concentration are waived. Counts may be terminated earlier than usual provided that the one sigma uncertainty in the net count-rate of the sample(s) in question is ten percent (10%) or less. The measured result for the blank must not exceed the HAMDC or five percent (5%) of the activity concentration of the least active sample in the batch.

(5) Relative Error Ratio, RER = $|C_1 - C_2| / [(TPU_1)^2 + (TPU_2)^2]^{1/2}$ where C_1 and C_2 are the measured concentrations for the sample and duplicate and TPU_1 and TPU_2 are the respective one sigma total propagated uncertainties. Measurements are acceptable if RER ≤ 2. If RER is greater than 2 but less than or equal to 3, investigate the cause and take corrective actions if RER is consistently greater than 2. If RER > 3, take corrective actions and reanalyze the batch of samples.

(6) Recoveries or percentages of known values which are 15% above or below the ranges listed are acceptable on an infrequent basis, e.g., less than 15% of the time. These occurrences must be investigated and explained. If more than 15% of the recoveries are outside the ranges listed, take corrective actions and reanalyze samples.

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Table G-4 RADIOCHEMICAL PERFORMANCE CRITERIA (cont.)					
CRITERION: 9	ANALYTICAL SUPPORT LEVEL (ASL) B				
ANALYTE: Po-210	SAMPLE MATRIX				
PERFORMANCE PARAMETERS	WATER	SOIL/ SEDIMENT	AIR FILTERS(2)	FLY ASH	CONTAMINATED LIQUID(3)
Highest Allowable Minimum Detectable Concentration (HAMDC)(1)	1.0 pCi/L	0.4 pCi/g	4.0 pCi/Filter	0.4 pCi/g	1.0 pCi/L
Percent Overall Tracer/Chemical Recovery(5)	50-110%	45-110%	45-110%	45-110%	45-110%
Method Blank Concentration	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)
Laboratory Control Sample: Percent of Known Value(5)	85-115%	85-115%	85-115%	85-115%	85-115%

(1) $$MDC = \frac{3.29 \cdot (S_{BLK})}{K} + \frac{2.71}{T \cdot K}$$

Where S_{BLK} is the standard deviation of the count rate of an appropriate method blank and, K is the correction factor that includes units conversion and typical values for the volume or weight of sample, decay correction factor, detector efficiency and the chemical recovery.
T is the counting time of the sample.

(2) 8" X 10" filter.

(3) Two phase system containing about 90% Water + 10% Organic liquid.

(4) When the concentration of a radionuclide in a sample is significantly greater than the applicable HAMDC, the Radiochemical Analysis Performance Specifications for the HAMDC and Method Blank Concentration are waived. Counts may be terminated earlier than usual provided that the one sigma uncertainty in the net count-rate of the sample(s) in question is ten percent (10%) or less. The measured result for the blank must not exceed the HAMDC or five percent (5%) of the activity concentration of the least active sample in the batch.

(5) Recoveries or percentages of known values which are 15% above or below the ranges listed are acceptable on an infrequent basis, e.g., less than 15% of the time. These occurrences must be investigated and explained. If more than 15% of the recoveries are outside the ranges listed, take corrective actions and reanalyze samples.

Table G-4 RADIOCHEMICAL PERFORMANCE CRITERIA (cont.)					
CRITERION: 10	ANALYTICAL SUPPORT LEVEL (ASL) C & D				
ANALYTE: Po-210	SAMPLE MATRIX				
PERFORMANCE PARAMETERS	WATER	SOIL/ SEDIMENT	AIR FILTERS(2)	FLY ASH	CONTAMINATED LIQUID(3)
Highest Allowable Minimum Detectable Concentration (HAMDC)(1)	0.5 pCi/L	0.2 pCi/g	2.0 pCi/Filter	0.2 pCi/g	0.5 pCi/L
Percent Overall Tracer/Chemical Recovery(6)	50-110%	45-110%	45-110%	45-110%	45-110%
Percent Matrix Spike Recovery(6)	70-125%	60-130%	60-130%	60-130%	60-130%
Method Blank Concentration	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)
Laboratory Control Sample: Percent of Known Value(6)	85-115%	85-115%	85-115%	85-115%	85-115%
Precision Requirements for Duplicate Samples	RER≤2(5)	RER≤2(5)	RER≤2(5)	RER≤2(5)	RER≤2(5)

(1) $MDC = \frac{3.29 * (S_{BLK})}{K} + \frac{2.71}{T * K}$

Where S_{BLK} is the standard deviation of the count rate of an appropriate method blank and, K is the correction factor that includes units conversion and typical values for the volume or weight of sample, decay correction factor, detector efficiency and the chemical recovery.
T is the counting time of the sample.

2) 8" X 10" filter.

(3) Two phase system containing about 90% Water + 10% Organic liquid.

(4) When the concentration of a radionuclide in a sample is significantly greater than the applicable HAMDC, the Radiochemical Analysis Performance Specifications for the HAMDC and Method Blank Concentration are waived. Counts may be terminated earlier than usual provided that the one sigma uncertainty in the net count-rate of the sample(s) in question is ten percent (10%) or less. The measured result for the blank must not exceed the HAMDC or five percent (5%) of the activity concentration of the least active sample in the batch.

(5) Relative Error Ratio, RER = $|C_1 - C_2| / [(TPU_1)^2 + (TPU_2)^2]^{1/2}$ where C_1 and C_2 are the measured concentrations for the sample and duplicate and TPU_1 and TPU_2 are the respective one sigma total propagated uncertainties. Measurements are acceptable if RER ≤ 2. If RER is greater than 2 but less than or equal to 3, investigate the cause and take corrective actions if RER is consistently greater than 2. If RER > 3, take corrective actions and reanalyze the batch of samples.

6) Recoveries or percentages of known values which are 15% above or below the ranges listed are acceptable on an infrequent basis, e.g., less than 15% of the time. These occurrences must be investigated and explained. If more than 15% of the recoveries are outside the ranges listed, take corrective actions and reanalyze samples.

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Table G-4 RADIOCHEMICAL PERFORMANCE CRITERIA (cont.)					
CRITERION: 11	ANALYTICAL SUPPORT LEVEL (ASL) B				
ANALYTE: Am-241	SAMPLE MATRIX				
PERFORMANCE PARAMETERS	WATER	SOIL/ SEDIMENT	AIR FILTERS[2]	FLY ASH	CONTAMINATED LIQUID[3]
Highest Allowable Minimum Detectable Concentration (HAMDC)[1]	2.0 pCi/L	0.4 pCi/g	11 pCi/Filter	2.0 pCi/g	11 pCi/L
Percent Overall Tracer/Chemical Recovery[5]	50-110%	45-110%	45-110%	45-110%	45-110%
Method Blank Concentration	<HAMDC[4]	<HAMDC[4]	<HAMDC[4]	<HAMDC[4]	<HAMDC[4]
Laboratory Control Sample: Percent of Known Value[5]	85-115%	85-115%	85-115%	85-115%	85-115%

(1) $$MDC = \frac{3.29 \cdot (S_{BLK})}{K} + \frac{2.71}{T \cdot K}$$

Where S_{BLK} is the standard deviation of the count rate of an appropriate method blank and, K is the correction factor that includes units conversion and typical values for the volume or weight of sample, decay correction factor, detector efficiency and the chemical recovery.
T is the counting time of the sample.

(2) 8" X 10" filter.

(3) Two phase system containing about 90% Water + 10% Organic liquid.

(4) When the concentration of a radionuclide in a sample is significantly greater than the applicable HAMDC, the Radiochemical Analysis Performance Specifications for the HAMDC and Method Blank Concentration are waived. Counts may be terminated earlier than usual provided that the one sigma uncertainty in the net count-rate of the sample(s) in question is ten percent (10%) or less. The measured result for the blank must not exceed the HAMDC or five percent (5%) of the activity concentration of the least active sample in the batch.

(5) Recoveries or percentages of known values which are 15% above or below the ranges listed are acceptable on an infrequent basis, e.g., less than 15% of the time. These occurrences must be investigated and explained. If more than 15% of the recoveries are outside the ranges listed, take corrective actions and reanalyze samples.

Table G-4 RADIOCHEMICAL PERFORMANCE CRITERIA (cont.)					
CRITERION: 12	ANALYTICAL SUPPORT LEVEL (ASL) C & D				
ANALYTE: Am-241	SAMPLE MATRIX				
PERFORMANCE PARAMETERS	WATER	SOIL/ SEDIMENT	AIR FILTERS[2]	FLY ASH	CONTAMINATED LIQUID[3]
Highest Allowable Minimum Detectable Concentration (HAMDC)[1]	1.0 pCi/L	0.2 pCi/g	5.0 pCi/Filter	1.0 pCi/g	5.0 pCi/L
Percent Overall Tracer/Chemical Recovery[6]	50-110%	45-110%	45-110%	45-110%	45-110%
Percent Matrix Spike Recovery[6]	70-125%	60-130%	60-130%	60-130%	60-130%
Method Blank Concentration	<HAMDC[4]	<HAMDC[4]	<HAMDC[4]	<HAMDC[4]	<HAMDC[4]
Laboratory Control Sample: Percent of Known Value[6]	85-115%	85-115%	85-115%	85-115%	85-115%
Precision Requirements for Duplicate Samples	RER≤2[5]	RER≤2[5]	RER≤2[5]	RER≤2[5]	RER≤2[5]

(1) $MDC = \frac{3.29 * (S_{BLK})}{K} + \frac{2.71}{T * K}$

Where S_{BLK} is the standard deviation of the count rate of an appropriate method blank and, K is the correction factor that includes units conversion and typical values for the volume or weight of sample, decay correction factor, detector efficiency and the chemical recovery.
T is the counting time of the sample.

(2) 8" X 10" filter.

(3) Two phase system containing about 90% Water + 10% Organic liquid.

(4) When the concentration of a radionuclide in a sample is significantly greater than the applicable HAMDC, the Radiochemical Analysis Performance Specifications for the HAMDC and Method Blank Concentration are waived. Counts may be terminated earlier than usual provided that the one sigma uncertainty in the net count-rate of the sample(s) in question is ten percent (10%) or less. The measured result for the blank must not exceed the HAMDC or five percent (5%) of the activity concentration of the least active sample in the batch.

(5) Relative Error Ratio, RER = $|C_1 - C_2| / [(TPU_1)^2 + (TPU_2)^2]^{1/2}$ where C_1 and C_2 are the measured concentrations for the sample and duplicate and TPU_1 and TPU_2 are the respective one sigma total propagated uncertainties. Measurements are acceptable if RER ≤ 2. If RER is greater than 2 but less than or equal to 3, investigate the cause and take corrective actions if RER is consistently greater than 2. If RER > 3, take corrective actions and reanalyze the batch of samples.

(6) Recoveries or percentages of known values which are 15% above or below the ranges listed are acceptable on an infrequent basis, e.g., less than 15% of the time. These occurrences must be investigated and explained. If more than 15% of the recoveries are outside the ranges listed, take corrective actions and reanalyze samples.

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Table G-4 RADIOCHEMICAL PERFORMANCE CRITERIA (cont.)					
CRITERION: 13	ANALYTICAL SUPPORT LEVEL (ASL) B				
ANALYTE: Ra-226	SAMPLE MATRIX				
PERFORMANCE PARAMETERS	WATER	SOIL/ SEDIMENT	AIR FILTERS[2]	FLY ASH	CONTAMINATED LIQUID[3]
Highest Allowable Minimum Detectable Concentration (HAMDC)[1]	2.0 pCi/L	0.6 pCi/g	4.0 pCi/Filter	0.4 pCi/g	2.0 pCi/L
Percent Overall Tracer/Chemical Recovery[5]	50-110%	45-110%	45-110%	45-110%	45-110%
Method Blank Concentration	<HAMDC[4]	<HAMDC[4]	<HAMDC[4]	<HAMDC[4]	<HAMDC[4]
Laboratory Control Sample: Percent of Known Value[5]	75-125%	75-125%	75-125%	75-125%	75-125%

(1) $$MDC = \frac{3.29 \cdot (S_{BLK})}{K} + \frac{2.71}{T \cdot K}$$

Where S_{BLK} is the standard deviation of the count rate of an appropriate method blank and, K is the correction factor that includes units conversion and typical values for the volume or weight of sample, decay correction factor, detector efficiency and the chemical recovery.
T is the counting time of the sample.

(2) 8" X 10" filter.

(3) Two phase system containing about 90% Water + 10% Organic liquid.

(4) When the concentration of a radionuclide in a sample is significantly greater than the applicable HAMDC, the Radiochemical Analysis Performance Specifications for the HAMDC and Method Blank Concentration are waived. Counts may be terminated earlier than usual provided that the one sigma uncertainty in the net count-rate of the sample(s) in question is ten percent (10%) or less. The measured result for the blank must not exceed the HAMDC or five percent (5%) of the activity concentration of the least active sample in the batch.

(5) Recoveries or percentages of known values which are 15% above or below the ranges listed are acceptable on an infrequent basis, e.g., less than 15% of the time. These occurrences must be investigated and explained. If more than 15% of the recoveries are outside the ranges listed, take corrective actions and reanalyze samples.

Table G-4 RADIOCHEMICAL PERFORMANCE CRITERIA (cont.)					
CRITERION: 14	ANALYTICAL SUPPORT LEVEL (ASL) C & D				
ANALYTE: Ra-226	SAMPLE MATRIX				
PERFORMANCE PARAMETERS	WATER	SOIL/ SEDIMENT	AIR FILTERS(2)	FLY ASH	CONTAMINATED LIQUID(3)
Highest Allowable Minimum Detectable Concentration (HAMDC)(1)	1.0 pCi/L	0.25 pCi/g	2.0 pCi/Filter	0.2 pCi/g	1.0 pCi/L
Percent Overall Tracer/Chemical Recovery(6)	50-110%	45-110%	45-110%	45-110%	45-110%
Percent Matrix Spike Recovery(6)	70-125%	60-130%	60-130%	60-130%	60-130%
Method Blank Concentration	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)
Laboratory Control Sample: Percent of Known Value(6)	75-125%	75-125%	75-125%	75-125%	75-125%
Precision Requirements for Duplicate Samples	RER≤2(5)	RER≤2(5)	RER≤2(5)	RER≤2(5)	RER≤2(5)

(1) $$MDC = \frac{3.29 * (S_{BLK})}{K} + \frac{2.71}{T * K}$$

Where S_{BLK} is the standard deviation of the count rate of an appropriate method blank and, K is the correction factor that includes units conversion and typical values for the volume or weight of sample, decay correction factor, detector efficiency and the chemical recovery.
T is the counting time of the sample.

(2) 8" X 10" filter.

(3) Two phase system containing about 90% Water + 10% Organic liquid.

(4) When the concentration of a radionuclide in a sample is significantly greater than the applicable HAMDC, the Radiochemical Analysis Performance Specifications for the HAMDC and Method Blank Concentration are waived. Counts may be terminated earlier than usual provided that the one sigma uncertainty in the net count-rate of the sample(s) in question is ten percent (10%) or less. The measured result for the blank must not exceed the HAMDC or five percent (5%) of the activity concentration of the least active sample in the batch.

(5) Relative Error Ratio, RER $= |C_1 - C_2| / [(TPU_1)^2 + (TPU_2)^2]^{1/2}$ where C_1 and C_2 are the measured concentrations for the sample and duplicate and TPU_1 and TPU_2 are the respective one sigma total propagated uncertainties. Measurements are acceptable if RER ≤ 2. If RER is greater than 2 but less than or equal to 3, investigate the cause and take corrective actions if RER is consistently greater than 2. If RER > 3, take corrective actions and reanalyze the batch of samples.

(6) Recoveries or percentages of known values which are 15% above or below the ranges listed are acceptable on an infrequent basis, e.g., less than 15% of the time. These occurrences must be investigated and explained. If more than 15% of the recoveries are outside the ranges listed, take corrective actions and reanalyze samples.

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Table G-4 RADIOCHEMICAL PERFORMANCE CRITERIA (cont.)					
CRITERION: 15	ANALYTICAL SUPPORT LEVEL (ASL) B				
ANALYTE: Ra-228	SAMPLE MATRIX				
PERFORMANCE PARAMETERS	WATER	SOIL/ SEDIMENT	AIR FILTERS(2)	FLY ASH	CONTAMINATED LIQUID(3)
Highest Allowable Minimum Detectable Concentration (HAMDC)(1)	7.0 pCi/L	1.0 pCi/g	11 pCi/Filter	1.0 pCi/g	7.0 pCi/L
Percent Overall Tracer/Chemical Recovery(5)	50-110%	45-110%	45-110%	45-110%	45-110%
Method Blank Concentration	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)
Laboratory Control Sample: Percent of Known Value(5)	75-125%	75-125%	75-125%	75-125%	75-125%

(1) $$MDC = \frac{3.29 \cdot (S_{BLK})}{K} + \frac{2.71}{T \cdot K}$$

Where S_{BLK} is the standard deviation of the count rate of an appropriate method blank and, K is the correction factor that includes units conversion and typical values for the volume or weight of sample, decay correction factor, detector efficiency and the chemical recovery.
T is the counting time of the sample.

(2) 8" X 10" filter.

(3) Two phase system containing about 90% Water + 10% Organic liquid.

(4) When the concentration of a radionuclide in a sample is significantly greater than the applicable HAMDC, the Radiochemical Analysis Performance Specifications for the HAMDC and Method Blank Concentration are waived. Counts may be terminated earlier than usual provided that the one sigma uncertainty in the net count-rate of the sample(s) in question is ten percent (10%) or less. The measured result for the blank must not exceed the HAMDC or five percent (5%) of the activity concentration of the least active sample in the batch.

(5) Recoveries or percentages of known values which are 15% above or below the ranges listed are acceptable on an infrequent basis, e.g., less than 15% of the time. These occurrences must be investigated and explained. If more than 15% of the recoveries are outside the ranges listed, take corrective actions and reanalyze samples.

Table G-4 RADIOCHEMICAL PERFORMANCE CRITERIA (cont.)					
CRITERION: 16	ANALYTICAL SUPPORT LEVEL (ASL) C & D				
ANALYTE: Ra-228	SAMPLE MATRIX				
PERFORMANCE PARAMETERS	WATER	SOIL/ SEDIMENT	AIR FILTERS(2)	FLY ASH	CONTAMINATED LIQUID(3)
Highest Allowable Minimum Detectable Concentration (HAMDC)(1)	3.0 pCi/L	0.5 pCi/g	5.0 pCi/Filter	0.5 pCi/g	3.0 pCi/L
Percent Overall Tracer/Chemical Recovery(6)	50-110%	45-110%	45-110%	45-110%	45-110%
Percent Matrix Spike Recovery(6)	70-125%	60-130%	60-130%	60-130%	60-130%
Method Blank Concentration	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)
Laboratory Control Sample: Percent of Known Value(6)	75-125%	75-125%	75-125%	75-125%	75-125%
Precision Requirements for Duplicate Samples	RER≤2(5)	RER≤2(5)	RER≤2(5)	RER≤2(5)	RER≤2(5)

(1) $MDC = \frac{3.29 * (S_{BLK})}{K} + \frac{2.71}{T * K}$

Where S_{BLK} is the standard deviation of the count rate of an appropriate method blank and, K is the correction factor that includes units conversion and typical values for the volume or weight of sample, decay correction factor, detector efficiency and the chemical recovery.
T is the counting time of the sample.

(2) 8" X 10" filter.

(3) Two phase system containing about 90% Water + 10% Organic liquid.

(4) When the concentration of a radionuclide in a sample is significantly greater than the applicable HAMDC, the Radiochemical Analysis Performance Specifications for the HAMDC and Method Blank Concentration are waived. Counts may be terminated earlier than usual provided that the one sigma uncertainty in the net count-rate of the sample(s) in question is ten percent (10%) or less. The measured result for the blank must not exceed the HAMDC or five percent (5%) of the activity concentration of the least active sample in the batch.

(5) Relative Error Ratio, RER = $|C_1 - C_2| / [(TPU_1)^2 + (TPU_2)^2]^{1/2}$ where C_1 and C_2 are the measured concentrations for the sample and duplicate and TPU_1 and TPU_2 are the respective one sigma total propagated uncertainties. Measurements are acceptable if RER ≤ 2. If RER is greater than 2 but less than or equal to 3, investigate the cause and take corrective actions if RER is consistently greater than 2. If RER > 3, take corrective actions and reanalyze the batch of samples.

(6) Recoveries or percentages of known values which are 15% above or below the ranges listed are acceptable on an infrequent basis, e.g., less than 15% of the time. These occurrences must be investigated and explained. If more than 15% of the recoveries are outside the ranges listed, take corrective actions and reanalyze samples.

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Table G-4 RADIOCHEMICAL PERFORMANCE CRITERIA (cont.)					
CRITERION: 17	ANALYTICAL SUPPORT LEVEL (ASL) B				
ANALYTE: Pu-241	SAMPLE MATRIX				
PERFORMANCE PARAMETERS	WATER	SOIL/ SEDIMENT	AIR FILTERS(2)	FLY ASH	CONTAMINATED LIQUID(3)
Highest Allowable Minimum Detectable Concentration (HAMDC)(1)	1.0 pCi/L	0.2 pCi/g	11 pCi/Filter	1.0 pCi/g	2.0 pCi/L
Percent Overall Tracer/Chemical Recovery(5)	50-110%	45-110%	45-110%	45-110%	45-110%
Method Blank Concentration	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)
Laboratory Control Sample: Percent of Known Value(5)	75-125%	75-125%	75-125%	75-125%	75-125%

(1) $$MDC = \frac{3.29 * (S_{BLK})}{K} + \frac{2.71}{T * K}$$

Where S_{BLK} is the standard deviation of the count rate of an appropriate method blank and, K is the correction factor that includes units conversion and typical values for the volume or weight of sample, decay correction factor, detector efficiency and the chemical recovery.
T is the counting time of the sample.

(2) 8" X 10" filter.

(3) Two phase system containing about 90% Water + 10% Organic liquid.

(4) When the concentration of a radionuclide in a sample is significantly greater than the applicable HAMDC, the Radiochemical Analysis Performance Specifications for the HAMDC and Method Blank Concentration are waived. Counts may be terminated earlier than usual provided that the one sigma uncertainty in the net count-rate of the sample(s) in question is ten percent (10%) or less. The measured result for the blank must not exceed the HAMDC or five percent (5%) of the activity concentration of the least active sample in the batch.

(5) Recoveries or percentages of known values which are 15% above or below the ranges listed are acceptable on an infrequent basis, e.g., less than 15% of the time. These occurrences must be investigated and explained. If more than 15% of the recoveries are outside the ranges listed, take corrective actions and reanalyze samples.

Table G-4 RADIOCHEMICAL PERFORMANCE CRITERIA (cont.)					
CRITERION: 18	ANALYTICAL SUPPORT LEVELS (ASL) C & D				
ANALYTE: Pu-241	SAMPLE MATRIX				
PERFORMANCE PARAMETERS	WATER	SOIL/ SEDIMENT	AIR FILTERS[2]	FLY ASH	CONTAMINATED LIQUID[3]
Highest Allowable Minimum Detectable Concentration (HAMDC)[1]	0.5 pCi/L	0.1 pCi/g	5.0 pCi/Filter	0.5 pCi/g	1.0 pCi/L
Percent Overall Tracer/Chemical Recovery[6]	50-110%	45-110%	45-110%	45-110%	45-110%
Percent Matrix Spike Recovery[6]	70-125%	60-130%	60-130%	60-130%	60-130%
Method Blank Concentration	<HAMDC[4]	<HAMDC[4]	<HAMDC[4]	<HAMDC[4]	<HAMDC[4]
Laboratory Control Sample: Percent of Known Value[6]	75-125%	75-125%	75-125%	75-125%	75-125%
Precision Requirements for Duplicate Samples	RER≤2[5]	RER≤2[5]	RER≤2[5]	RER≤2[5]	RER≤2[5]

(1) $MDC = \frac{3.29 * (S_{BLK})}{K} + \frac{2.71}{T * K}$

Where S_{BLK} is the standard deviation of the count rate of an appropriate method blank and, K is the correction factor that includes units conversion and typical values for the volume or weight of sample, decay correction factor, detector efficiency and the chemical recovery.
T is the counting time of the sample.

(2) 8" X 10" filter.

(3) Two phase system containing about 90% Water + 10% Organic liquid.

(4) When the concentration of a radionuclide in a sample is significantly greater than the applicable HAMDC, the Radiochemical Analysis Performance Specifications for the HAMDC and Method Blank Concentration are waived. Counts may be terminated earlier than usual provided that the one sigma uncertainty in the net count-rate of the sample(s) in question is ten percent (10%) or less. The measured result for the blank must not exceed the HAMDC or five percent (5%) of the activity concentration of the least active sample in the batch.

(5) Relative Error Ratio, RER = $|C_1 - C_2| / [(TPU_1)^2 + (TPU_2)^2]^{1/2}$ where C_1 and C_2 are the measured concentrations for the sample and duplicate and TPU_1 and TPU_2 are the respective one sigma total propagated uncertainties. Measurements are acceptable if RER ≤ 2. If RER is greater than 2 but less than or equal to 3, investigate the cause and take corrective actions if RER is consistently greater than 2. If RER > 3, take corrective actions and reanalyze the batch of samples.

(6) Recoveries or percentages of known values which are 15% above or below the ranges listed are acceptable on an infrequent basis, e.g., less than 15% of the time. These occurrences must be investigated and explained. If more than 15% of the recoveries are outside the ranges listed, take corrective actions and reanalyze samples.

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Table G-4 RADIOCHEMICAL PERFORMANCE CRITERIA (cont.)					
CRITERION: 19	ANALYTICAL SUPPORT LEVEL (ASL) B				
ANALYTE: Pb-210	SAMPLE MATRIX				
PERFORMANCE PARAMETERS	WATER	SOIL/ SEDIMENT	AIR FILTERS(2)	FLY ASH	CONTAMINATED LIQUID(3)
Highest Allowable Minimum Detectable Concentration (HAMDC)(1)	7.0 pCi/L	1.0 pCi/g	20 pCi/Filter	2.0 pCi/g	20 pCi/L
Percent Overall Tracer/Chemical Recovery(5)	50-110%	45-110%	45-110%	45-110%	45-110%
Method Blank Concentration	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)
Laboratory Control Sample: Percent of Known Value(5)	75-125%	75-125%	75-125%	75-125%	75-125%

(1) $$MDC = \frac{3.29 * (S_{BLK})}{K} + \frac{2.71}{T * K}$$

Where S_{BLK} is the standard deviation of the count rate of an appropriate method blank and, K is the correction factor that includes units conversion and typical values for the volume or weight of sample, decay correction factor, detector efficiency and the chemical recovery.
T is the counting time of the sample.

(2) 8" X 10" filter.

(3) Two phase system containing about 90% Water + 10% Organic liquid.

(4) When the concentration of a radionuclide in a sample is significantly greater than the applicable HAMDC, the Radiochemical Analysis Performance Specifications for the HAMDC and Method Blank Concentration are waived. Counts may be terminated earlier than usual provided that the one sigma uncertainty in the net count-rate of the sample(s) in question is ten percent (10%) or less. The measured result for the blank must not exceed the HAMDC or five percent (5%) of the activity concentration of the least active sample in the batch.

(5) Recoveries or percentages of known values which are 15% above or below the ranges listed are acceptable on an infrequent basis, e.g., less than 15% of the time. These occurrences must be investigated and explained. If more than 15% of the recoveries are outside the ranges listed, take corrective actions and reanalyze samples.

Table G-4 RADIOCHEMICAL PERFORMANCE CRITERIA (cont.)					
CRITERION: 20	ANALYTICAL SUPPORT LEVEL (ASL) C & D				
ANALYTE: Pb-210	SAMPLE MATRIX				
PERFORMANCE PARAMETERS	WATER	SOIL/ SEDIMENT	AIR FILTERS(2)	FLY ASH	CONTAMINATED LIQUID(3)
Highest Allowable Minimum Detectable Concentration (HAMDC)(1)	3.0 pCi/L	0.5 pCi/g	10 pCi/Filter	1.0 pCi/g	10 pCi/L
Percent Overall Tracer/Chemical Recovery(6)	50-110%	45-110%	45-110%	45-110%	45-110%
Percent Matrix Spike Recovery(6)	70-125%	60-130%	60-130%	60-130%	60-130%
Method Blank Concentration	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)
Laboratory Control Sample: Percent of Known Value(6)	75-125%	75-125%	75-125%	75-125%	75-125%
Precision Requirements for Duplicate Samples	RER≤2(5)	RER≤2(5)	RER≤2(5)	RER≤2(5)	RER≤2(5)

(1) $MDC = \frac{3.29 \cdot (S_{BLK})}{K} \cdot \frac{2.71}{T \cdot K}$

Where S_{BLK} is the standard deviation of the count rate of an appropriate method blank and, K is the correction factor that includes units conversion and typical values for the volume or weight of sample, decay correction factor, detector efficiency and the chemical recovery.
T is the counting time of the sample.

(2) 8" X 10" filter.

(3) Two phase system containing about 90% Water + 10% Organic liquid.

(4) When the concentration of a radionuclide in a sample is significantly greater than the applicable HAMDC, the Radiochemical Analysis Performance Specifications for the HAMDC and Method Blank Concentration are waived. Counts may be terminated earlier than usual provided that the one sigma uncertainty in the net count-rate of the sample(s) in question is ten percent (10%) or less. The measured result for the blank must not exceed the HAMDC or five percent (5%) of the activity concentration of the least active sample in the batch.

(5) Relative Error Ratio, RER = $|C_1 - C_2| / [(TPU_1)^2 + (TPU_2)^2]^{1/2}$ where C_1 and C_2 are the measured concentrations for the sample and duplicate and TPU_1 and TPU_2 are the respective one sigma total propagated uncertainties. Measurements are acceptable if RER ≤ 2. If RER is greater than 2 but less than or equal to 3, investigate the cause and take corrective actions if RER is consistently greater than 2. If RER > 3, take corrective actions and reanalyze the batch of samples.

(6) Recoveries or percentages of known values which are 15% above or below the ranges listed are acceptable on an infrequent basis, e.g., less than 15% of the time. These occurrences must be investigated and explained. If more than 15% of the recoveries are outside the ranges listed, take corrective actions and reanalyze samples.

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Table G-4 RADIOCHEMICAL PERFORMANCE CRITERIA (cont.)					
CRITERION: 21	ANALYTICAL SUPPORT LEVEL (ASL) B				
ANALYTE: Sr-90	SAMPLE MATRIX				
PERFORMANCE PARAMETERS	WATER	SOIL/ SEDIMENT	AIR FILTERS[2]	FLY ASH	CONTAMINATED LIQUID[3]
Highest Allowable Minimum Detectable Concentration (HAMDC)[1]	2.0 pCi/L	1.0 pCi/g	4.0 pCi/Filter	1.0 pCi/g	2.0 pCi/L
Percent Overall Tracer/Chemical Recovery[5]	50-110%	45-110%	45-110%	45-110%	45-110%
Method Blank Concentration	<HAMDC[4]	<HAMDC[4]	<HAMDC[4]	<HAMDC[4]	<HAMDC[4]
Laboratory Control Sample: Percent of Known Value[5]	75-125%	75-125%	75-125%	75-125%	75-125%

(1) $$MDC = \frac{3.29 \cdot (S_{BLK})}{K} + \frac{2.71}{T \cdot K}$$

Where S_{BLK} is the standard deviation of the count rate of an appropriate method blank and, K is the correction factor that includes units conversion and typical values for the volume or weight of sample, decay correction factor, detector efficiency and the chemical recovery.
T is the counting time of the sample.

(2) 8" X 10" filter.

(3) Two phase system containing about 90% Water + 10% Organic liquid.

(4) When the concentration of a radionuclide in a sample is significantly greater than the applicable HAMDC, the Radiochemical Analysis Performance Specifications for the HAMDC and Method Blank Concentration are waived. Counts may be terminated earlier than usual provided that the one sigma uncertainty in the net count-rate of the sample(s) in question is ten percent (10%) or less. The measured result for the blank must not exceed the HAMDC or five percent (5%) of the activity concentration of the least active sample in the batch.

(5) Recoveries or percentages of known values which are 15% above or below the ranges listed are acceptable on an infrequent basis, e.g., less than 15% of the time. These occurrences must be investigated and explained, If more than 15% of the recoveries are outside the ranges listed, take corrective actions and reanalyze samples.

Table G-4 RADIOCHEMICAL PERFORMANCE CRITERIA (cont.)					
CRITERION: 22	ANALYTICAL SUPPORT LEVEL (ASL) C & D				
ANALYTE: Sr-90	Sample Matrix				
PERFORMANCE PARAMETERS	WATER	SOIL/ SEDIMENT	AIR FILTERS(2)	FLY ASH	CONTAMINATED LIQUID(3)
Highest Allowable Minimum Detectable Concentration (HAMDC)(1)	1.0 pCi/L	0.5 pCi/g	2.0 pCi/Filter	0.5 pCi/g	1.0 pCi/L
Percent Overall Tracer/Chemical Recovery(6)	50-110%	45-110%	45-110%	45-110%	45-110%
Percent Matrix Spike Recovery(6)	70-125%	60-130%	60-130%	60-130%	60-130%
Method Blank Concentration	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)
Laboratory Control Sample: Percent of Known Value(6)	75-125%	75-125%	75-125%	75-125%	75-125%
Precision Requirements for Duplicate Samples	RER≤2(5)	RER≤2(5)	RER≤2(5)	RER≤2(5)	RER≤2(5)

(1) $MDC = \frac{3.29 \cdot (S_{BLK})}{K} \cdot \frac{2.71}{T \cdot K}$

Where S_{BLK} is the standard deviation of the count rate of an appropriate method blank and, K is the correction factor that includes units conversion and typical values for the volume or weight of sample, decay correction factor, detector efficiency and the chemical recovery.
T is the counting time of the sample.

(2) 8" X 10" filter.

(3) Two phase system containing about 90% Water + 10% Organic liquid.

(4) When the concentration of a radionuclide in a sample is significantly greater than the applicable HAMDC, the Radiochemical Analysis Performance Specifications for the HAMDC and Method Blank Concentration are waived. Counts may be terminated earlier than usual provided that the one sigma uncertainty in the net count-rate of the sample(s) in question is ten percent (10%) or less. The measured result for the blank must not exceed the HAMDC or five percent (5%) of the activity concentration of the least active sample in the batch.

(5) Relative Error Ratio, RER = $|C_1 - C_2| / [(TPU_1)^2 + (TPU_2)^2]^{1/2}$ where C_1 and C_2 are the measured concentrations for the sample and duplicate and TPU_1 and TPU_2 are the respective one sigma total propagated uncertainties. Measurements are acceptable if RER ≤ 2. If RER is greater than 2 but less than or equal to 3, investigate the cause and take corrective actions if RER is consistently greater than 2. If RER > 3, take corrective actions and reanalyze the batch of samples.

(6) Recoveries or percentages of known values which are 15% above or below the ranges listed are acceptable on an infrequent basis, e.g., less than 15% of the time. These occurrences must be investigated and explained. If more than 15% of the recoveries are outside the ranges listed, take corrective actions and reanalyze samples.

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Table G-4 RADIOCHEMICAL PERFORMANCE CRITERIA (cont.)					
CRITERION: 23	ANALYTICAL SUPPORT LEVEL (ASL) B				
ANALYTE: Tc-99	SAMPLE MATRIX				
PERFORMANCE PARAMETERS	WATER	SOIL/ SEDIMENT	AIR FILTERS[2]	FLY ASH	CONTAMINATED LIQUID[3]
Highest Allowable Minimum Detectable Concentration (HAMDC)[1]	30 pCi/L	2.0 pCi/g	110 pCi/Filter	20 pCi/g	70 pCi/L
Percent Overall Tracer/Chemical Recovery[5]	50-110%[6]	45-110%[6]	45-110%[6]	45-110%[6]	45-110%[6]
Percent Matrix Spike Recovery[5]	65-120%	60-130%	60-130%	60-130%	60-130%
Method Blank Concentration	<HAMDC[4]	<HAMDC[4]	<HAMDC[4]	<HAMDC[4]	<HAMDC[4]
Laboratory Control Sample: Percent of Known Value[5]	70-130%	70-130%	70-130%	70-130%	70-130%

(1) $$MDC = \frac{3.29 * (S_{BLK})}{K} + \frac{2.71}{T * K}$$

Where S_{BLK} is the standard deviation of the count rate of an appropriate method blank and, K is the correction factor that includes units conversion and typical values for the volume or weight of sample, decay correction factor, detector efficiency and the chemical recovery.
T is the counting time of the sample.

(2) 8" X 10" filter.

(3) Two phase system containing about 90% Water + 10% Organic liquid.

(4) When the concentration of a radionuclide in a sample is significantly greater than the applicable HAMDC, the Radiochemical Analysis Performance Specifications for the HAMDC and Method Blank Concentration are waived. Counts may be terminated earlier than usual provided that the one sigma uncertainty in the net count-rate of the sample(s) in question is ten percent (10%) or less. The measured result for the blank must not exceed the HAMDC or five percent (5%) of the activity concentration of the least active sample in the batch.

(5) Recoveries or percentages of known values which are 15% above or below the ranges listed are acceptable on an infrequent basis, e.g., less than 15% of the time. These occurrences must be investigated and explained. If more than 15% of the recoveries are outside the ranges listed, take corrective actions and reanalyze samples.

(6) Sample-specific chemical recovery measurements must be performed for each sample analyzed. Batch efficiency determinations or batch recovery measurements are not permitted.

Table G-4 RADIOCHEMICAL PERFORMANCE CRITERIA (cont.)					
CRITERION: 24	ANALYTICAL SUPPORT LEVEL (ASL) C & D				
ANALYTE: Tc-99	SAMPLE MATRIX				
PERFORMANCE PARAMETERS	WATER	SOIL/ SEDIMENT	AIR FILTERS[2]	FLY ASH	CONTAMINATED LIQUID[3]
Highest Allowable Minimum Detectable Concentration (HAMDC)[1]	15 pCi/L	1.0 pCi/g	50 pCi/Filter	10 pCi/g	30 pCi/L
Percent Overall Tracer/Chemical Recovery[6, 7]	50-110%	45-110%	45-110%	45-110%	45-110%
Percent Matrix Spike Recovery[6]	70-125%	60-130%	60-130%	60-130%	60-130%
Method Blank Concentration	<HAMDC[4]	<HAMDC[4]	<HAMDC[4]	<HAMDC[4]	<HAMDC[4]
Laboratory Control Sample: Percent of Known Value[6]	70-130%	70-130%	70-130%	70-130%	70-130%
Precision Requirements for Duplicate Samples	RER≤2[5]	RER≤2[5]	RER≤2[5]	RER≤2[5]	RER≤2[5]

(1) $MDC = \frac{3.29 \cdot (S_{BLK})}{K} + \frac{2.71}{T \cdot K}$

Where S_{BLK} is the standard deviation of the count rate of an appropriate method blank and, K is the correction factor that includes units conversion and typical values for the volume or weight of sample, decay correction factor, detector efficiency and the chemical recovery.
T is the counting time of the sample.

(2) 8" X 10" filter.

(3) Two phase system containing about 90% Water + 10% Organic liquid.

(4) When the concentration of a radionuclide in a sample is significantly greater than the applicable HAMDC, the Radiochemical Analysis Performance Specifications for the HAMDC and Method Blank Concentration are waived. Counts may be terminated earlier than usual provided that the one sigma uncertainty in the net count-rate of the sample(s) in question is ten percent (10%) or less. The measured result for the blank must not exceed the HAMDC or five percent (5%) of the activity concentration of the least active sample in the batch.

(5) Relative Error Ratio, RER = $|C_1 - C_2| / [(TPU_1)^2 + (TPU_2)^2]^{1/2}$ where C_1 and C_2 are the measured concentrations for the sample and duplicate and TPU_1 and TPU_2 are the respective one sigma total propagated uncertainties. Measurements are acceptable if RER ≤ 2. If RER is greater than 2 but less than or equal to 3, investigate the cause and take corrective actions if RER is consistently greater than 2. If RER > 3, take corrective actions and reanalyze the batch of samples.

(6) Recoveries or percentages of known values which are 15% above or below the ranges listed are acceptable on an infrequent basis, e.g., less than 15% of the time. These occurrences must be investigated and explained. If more than 15% of the recoveries are outside the ranges listed, take corrective actions and reanalyze samples.

(7) Sample-specific chemical recovery measurements must be performed for each sample analyzed. Batch efficiency determinations or batch recovery measurements are not permitted.

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Table G-4 RADIOCHEMICAL PERFORMANCE CRITERIA (cont.)					
CRITERION: 25	ANALYTICAL SUPPORT LEVEL (ASL) B				
ANALYTE: Gamma Emitting Isotopes[6]	SAMPLE MATRIX				
PERFORMANCE PARAMETERS	WATER	SOIL/ SEDIMENT	AIR FILTERS[2]	FLY ASH	CONTAMINATED LIQUID[3]
Highest Allowable Minimum Detectable Concentration (HAMDC)[1]	9.0 pCi/L	0.4 pCi/g	20 pCi/Filter	2.0 pCi/g	20 pCi/L
Percent Overall Tracer/Chemical Recovery	N/A	N/A	N/A	N/A	N/A
Method Blank Concentration	<HAMDC[4]	<HAMDC[4]	<HAMDC[4]	<HAMDC[4]	<HAMDC[4]
Laboratory Control Sample: Percent of Known Value[5]	85-115%	80-120%	80-120%	80-120%	80-120%

(1) $$MDC = \frac{3.29 \cdot (S_{BLK})}{K} + \frac{2.71}{T \cdot K}$$

Where S_{BLK} is the standard deviation of the count rate of an appropriate method blank and, K is the correction factor that includes units conversion and typical values for the volume or weight of sample, decay correction factor, detector efficiency and the chemical recovery. T is the counting time of the sample.

(2) Glass Fiber 8" X 10".

(3) Two phase system containing about 90% Water + 10% Organic liquid.

(4) When the concentration of a radionuclide in a sample is significantly greater than the applicable HAMDC, the Radiochemical Analysis Performance Specifications for the HAMDC and Method Blank Concentration are waived. Counts may be terminated earlier than usual provided that the one sigma uncertainty in the net count-rate of the sample(s) in question is ten percent (10%) or less. The measured result for the blank must not exceed the HAMDC or five percent (5%) of the activity concentration of the least active sample in the batch.

(5) Recoveries or percentages of known values which are 15% above or below the ranges listed are acceptable on an infrequent basis, e.g., less than 15% of the time. These occurrences must be investigated and explained, If more than 15% of the recoveries are outside the ranges listed, take corrective actions and reanalyze samples.

(6) All samples must be counted for a length of time and in a geometry that will achieve the stated HAMDC. For any gamma emitter determined to be above its respective detection limit, report the radionuclide concentration and also the Minimum Detectable Concentration as determined by the equation in footnote (1).

Table G-4 RADIOCHEMICAL PERFORMANCE CRITERIA (cont.)

CRITERION: 26	ANALYTICAL SUPPORT LEVEL (ASL) C & D				
ANALYTE: Gamma Emitting Isotopes[7]	SAMPLE MATRIX				
PERFORMANCE PARAMETERS	WATER	SOIL/ SEDIMENT	AIR FILTERS[2]	FLY ASH	CONTAMINATED LIQUID[3]
Highest Allowable Minimum Detectable Concentration (HAMDC)[1]	4.0 pCi/L	0.2 pCi/g	10 pCi/Filter	1.0 pCi/g	10 pCi/L
Percent Overall Tracer/Chemical Recovery	N/A	N/A	N/A	N/A	N/A
Percent Matrix Spike Recovery	N/A	N/A	N/A	N/A	N/A
Method Blank Concentration	<HAMDC[4]	<HAMDC[4]	<HAMDC[4]	<HAMDC[4]	<HAMDC[4]
Laboratory Control Sample: Percent of Known Value[6]	85-115%	80-120%	80-120%	80-120%	80-120%
Precision Requirements for Duplicate Samples	RER≤2[5]	RER≤2[5]	RER≤2[5]	RER≤2[5]	RER≤2[5]

(1) $$MDC = \frac{3.29 \cdot (S_{BLK})}{K} + \frac{2.71}{T \cdot K}$$

Where S_{BLK} is the standard deviation of the count rate of an appropriate method blank and, K is the correction factor that includes units conversion and typical values for the volume or weight of sample, decay correction factor, detector efficiency and the chemical recovery.
T is the counting time of the sample.

(2) 8" X 10" filter.

(3) Two phase system containing about 90% Water + 10% Organic liquid.

(4) When the concentration of a radionuclide in a sample is significantly greater than the applicable HAMDC, the Radiochemical Analysis Performance Specifications for the HAMDC and Method Blank Concentration are waived. Counts may be terminated earlier than usual provided that the one sigma uncertainty in the net count-rate of the sample(s) in question is ten percent (10%) or less. The measured result for the blank must not exceed the HAMDC or five percent (5%) of the activity concentration of the least active sample in the batch.

(5) Relative Error Ratio, RER = $|C_1 - C_2| / [(TPU_1)^2 + (TPU_2)^2]^{1/2}$ where C_1 and C_2 are the measured concentrations for the sample and duplicate and TPU_1 and TPU_2 are the respective one sigma total propagated uncertainties. Measurements are acceptable if RER ≤ 2. If RER is greater than 2 but less than or equal to 3, investigate the cause and take corrective actions if RER is consistently greater than 2. If RER > 3, take corrective actions and reanalyze the batch of samples.

(6) Recoveries or percentages of known values which are 15% above or below the ranges listed are acceptable on an infrequent basis, e.g., less than 15% of the time. These occurrences must be investigated and explained. If more than 15% of the recoveries are outside the ranges listed, take corrective actions and reanalyze samples.

(7) All samples must be counted for a length of time and in a geometry that will achieve the stated HAMDC. For any gamma emitter determined to be above its respective detection limit, report the radionuclide concentration and also the Minimum Detectable Concentration as determined by the equation in footnote (1).

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Table G-4 RADIOCHEMICAL PERFORMANCE CRITERIA (cont.)					
CRITERION: 27	ANALYTICAL SUPPORT LEVEL (ASL) B				
ANALYTE: U-Total (Kinetic Phosphorescence Analysis)	SAMPLE MATRIX				
PERFORMANCE PARAMETERS	WATER	SOIL/ SEDIMENT	AIR FILTERS(2)	FLY ASH	CONTAMINATED LIQUID(3)
Highest Allowable Minimum Detectable Concentration (HAMDC)(1)	0.5 ug/L	0.5 ug/g	10 ug/Filter	0.5 ug/g	5.0 ug/L
Percent Overall Tracer/Chemical Recovery	N/A	N/A	N/A	N/A	N/A
Percent Matrix Spike Recovery(5)	75-125%	70-130%	70-130%	70-130%	70-130%
Method Blank Concentration	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)
Laboratory Control Sample: Percent of Known Value(5)	75-125%	75-125%	75-125%	75-125%	75-125%

(1) MDC = 3(SD), where SD is the standard deviation of 10 or more standards near the KPA detection limit.
(2) 8" X 10" filter.
(3) Two phase system containing about 90% Water + 10% Organic liquid.
(4) When the uranium concentration in a sample is significantly greater than the applicable HAMDC, the Radiochemical Analysis Performance Specifications for the HAMDC and Method Blank Concentration are waived. In such instances, the sample specific MDC(s) must not exceed fifty percent (50%) of the sample concentration and the measured blank concentration must not exceed the HAMDC or five percent (5%) of the measured concentration of the sample in the batch with the lowest uranium concentration, whichever is greater.
(5) Recoveries or percentages of known values which are 15% above or below the ranges listed are acceptable on an infrequent basis, e.g., less than 15% of the time. These occurrences must be investigated and explained. If more than 15% of the recoveries are outside the ranges listed, take corrective actions and reanalyze samples.

Table G-4 RADIOCHEMICAL PERFORMANCE CRITERIA (cont.)					
CRITERION: 28	ANALYTICAL SUPPORT LEVEL (ASL) C & D				
ANALYTE: U-Total (Kinetic Phospherescence Analysis)	SAMPLE MATRIX				
PERFORMANCE PARAMETERS	WATER	SOIL/ SEDIMENT	AIR FILTERS(2)	FLY ASH	CONTAMINATED LIQUID(3)
Highest Allowable Minimum Detectable Concentration (HAMDC)(1)	0.1 ug/L	0.1 ug/g	2.0 ug/Filter	0.1 ug/g	1.0 ug/L
Percent Overall Tracer/Chemical Recovery	N/A	N/A	N/A	N/A	N/A
Percent Matrix Spike Recovery(6)	75-125%	70-130%	70-130%	70-130%	70-130%
Method Blank Concentration	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)	<HAMDC(4)
Laboratory Control Sample: Percent of Known Value(6)	75-125%	75-125%	75-125%	75-125%	75-125%
Precision Requirements for Duplicate Samples	RER≤2(5)	RER≤2(5)	RER≤2(5)	RER≤2(5)	RER≤2(5)

(1) MDC = 3(SD), where SD is the standard deviation of 10 or more standards near the KPA detection limit.
(2) 8"X10" filter.
(3) Two phase system containing about 90% Water + 10% Organic liquid.
(4) When the uranium concentration in a sample is significantly greater than the applicable HAMDC, the Radiochemical Analysis Performance Specifications for the HAMDC and Method Blank Concentration are waived. In such instances, the sample specific MDC(s) must not exceed fifty percent (50%) of the sample concentration and the measured blank concentration must not exceed the HAMDC or five percent (5%) of the measured concentration of the sample in the batch with the lowest uranium concentration, whichever is greater.
(5) Relative Error Ratio, RER = $|C_1 - C_2| / [(TPU_1)^2 + (TPU_2)^2]^{1/2}$ where C_1 and C_2 are the measured concentrations for the sample and duplicate and TPU_1 and TPU_2 are the respective one sigma total propagated uncertainties. Measurements are acceptable if RER ≤ 2. If RER is greater than 2 but less than or equal to 3, investigate the cause and take corrective actions if RER is consistently greater than 2. If RER > 3, take corrective actions and reanalyze the batch of samples.
(6) Recoveries or percentages of known values which are 15% above or below the ranges listed are acceptable on an infrequent basis, e.g., less than 15% of the time. These occurrences must be investigated and explained. If more than 15% of the recoveries are outside the ranges listed, take corrective actions and reanalyze samples.

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Table G-4 RADIOCHEMICAL PERFORMANCE CRITERIA (cont.)			
CRITERION: 29	**ANALYTICAL SUPPORT LEVEL (ASL) B**		
ANALYTE: Gross Alpha Activity	**SAMPLE MATRIX**		
PERFORMANCE PARAMETERS	**WATER**	**SOIL/ SEDIMENT**	**AIR FILTERS(2)**
Highest Allowable Minimum Detectable Concentration (HAMDC)(1)	2.0 pCi/L	15 pCi/g	4.0 pCi/Filter
Percent Overall Tracer/Chemical Recovery	N/A	N/A	N/A
Method Blank Concentration	<HAMDC(3)	<HAMDC(3)	<HAMDC(3)
Laboratory Control Sample: Percent of Known Value(4)	40-160%	40-160%	40-160%

(1) $MDC = \frac{3.29 * (S_{BLK})}{K} + \frac{2.71}{T * K}$

Where S_{BLK} is the standard deviation of the count rate of an appropriate method blank and, K is the correction factor that includes units conversion and typical values for the volume or weight of sample, decay correction factor, detector efficiency and the chemical recovery.
T is the counting time of the sample.

(2) 8" X 10" filter.

(3) When the concentration of a radionuclide in a sample is significantly greater than the applicable HAMDC, the Radiochemical Analysis Performance Specifications for the HAMDC and Method Blank Concentration are waived. Counts may be terminated earlier than usual provided that the one sigma uncertainty in the net count-rate of the sample(s) in question is ten percent (10%) or less. The measured result for the blank must not exceed the HAMDC or five percent (5%) of the activity concentration of the least active sample in the batch.

(4) Recoveries or percentages of known values which are 15% above or below the ranges listed are acceptable on an infrequent basis, e.g., less than 15% of the time. These occurrences must be investigated and explained. If more than 15% of the recoveries are outside the ranges listed, take corrective actions and reanalyze samples.

Table G-4 RADIOCHEMICAL PERFORMANCE CRITERIA (cont.)			
CRITERION: 30	ANALYTICAL SUPPORT LEVEL (ASL) B		
ANALYTE: Gross Beta Activity	SAMPLE MATRIX		
PERFORMANCE PARAMETERS	WATER	SOIL/ SEDIMENT	AIR FILTERS(2)
Highest Allowable Minimum Detectable Concentration (HAMDC)(1)	4.0 pCi/L	30 pCi/g	30 pCi/Filter
Percent Overall Tracer/Chemical Recovery	N/A	N/A	N/A
Method Blank Concentration	<HAMDC(3)	<HAMDC(3)	<HAMDC(3)
Laboratory Control Sample: Percent of Known Value(4)	50-150%	50-150%	50-150%

(1) $$MDC = \frac{3.29 \cdot (S_{BLK})}{K} + \frac{2.71}{T \cdot K}$$

Where S_{BLK} is the standard deviation of the count rate of an appropriate method blank and, K is the correction factor that includes units conversion and typical values for the volume or weight of sample, decay correction factor, detector efficiency and the chemical recovery.
T is the counting time of the sample.

(2) 8" X 10" filter.

(3) When the concentration of a radionuclide in a sample is significantly greater than the applicable HAMDC, the Radiochemical Analysis Performance Specifications for the HAMDC and Method Blank Concentration are waived. Counts may be terminated earlier than usual provided that the one sigma uncertainty in the net count-rate of the sample(s) in question is ten percent (10%) or less. The measured result for the blank must not exceed the HAMDC or five percent (5%) of the activity concentration of the least active sample in the batch.

(4) Recoveries or percentages of known values which are 15% above or below the ranges listed are acceptable on an infrequent basis, e.g., less than 15% of the time. These occurrences must be investigated and explained. If more than 15% of the recoveries are outside the ranges listed, take corrective actions and reanalyze samples.

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Table G-4 RADIOCHEMICAL PERFORMANCE CRITERIA (cont.)			
CRITERION: 31	ANALYTICAL SUPPORT LEVEL (ASL) A		
ANALYTE: Gross Alpha Activity	SAMPLE MATRIX		
PERFORMANCE PARAMETERS	WATER	SOIL/ SEDIMENT	AIR FILTERS(2)
Highest Allowable Minimum Detectable Concentration (HAMDC)(1)	20 pCi/L	150 pCi/g	40pCi/Filter
Percent Overall Tracer/Chemical Recovery	N/A	N/A	N/A
Method Blank Concentration	<HAMDC(3)	<HAMDC(3)	<HAMDC(3)
Laboratory Control Sample: Percent of Known Value(4)	40-160%	40-160%	40-160%

(1) $$MDC = \frac{3.29 * (S_{BLK})}{K} + \frac{2.71}{T * K}$$

Where S_{BLK} is the standard deviation of the count rate of an appropriate method blank and, K is the correction factor that includes units conversion and typical values for the volume or weight of sample, decay correction factor, detector efficiency and the chemical recovery. T is the counting time of the sample.

(2) 8" X 10" filter.

(3) When the concentration of a radionuclide in a sample is significantly greater than the applicable HAMDC, the Radiochemical Analysis Performance Specifications for the HAMDC and Method Blank Concentration are waived. Counts may be terminated earlier than usual provided that the one sigma uncertainty in the net count-rate of the sample(s) in question is ten percent (10%) or less. The measured result for the blank must not exceed the HAMDC or five percent (5%) of the activity concentration of the least active sample in the batch.

(4) Recoveries or percentages of known values which are 15% above or below the ranges listed are acceptable on an infrequent basis, e.g., less than 15% of the time. These occurrences must be investigated and explained. If more than 15% of the recoveries are outside the ranges listed, take corrective actions and reanalyze samples.

Table G-4 RADIOCHEMICAL PERFORMANCE CRITERIA (cont.)			
CRITERION: 32	**ANALYTICAL SUPPORT LEVEL (ASL) A**		
ANALYTE: Gross Beta Activity	**SAMPLE MATRIX**		
PERFORMANCE PARAMETERS	**WATER**	**SOIL/ SEDIMENT**	**AIR FILTERS(2)**
Highest Allowable Minimum Detectable Concentration (HAMDC)(1)	100 pCi/L	150 pCi/g	150 pCi/Filter
Percent Overall Tracer/Chemical Recovery	N/A	N/A	N/A
Method Blank Concentration	<HAMDC(3)	<HAMDC(3)	<HAMDC(3)
Laboratory Control Sample: Percent of Known Value(4)	50-150%	50-150%	50-150%

(1) $$MDC = \frac{3.29 * (S_{BLK})}{K} + \frac{2.71}{T * K}$$

Where S_{BLK} is the standard deviation of the count rate of an appropriate method blank and, K is the correction factor that includes units conversion and typical values for the volume or weight of sample, decay correction factor, detector efficiency and the chemical recovery. T is the counting time of the sample.

(2) 8" X 10" filter.

(3) When the concentration of a radionuclide in a sample is significantly greater than the applicable HAMDC, the Radiochemical Analysis Performance Specifications for the HAMDC and Method Blank Concentration are waived. Counts may be terminated earlier than usual provided that the one sigma uncertainty in the net count-rate of the sample(s) in question is ten percent (10%) or less. The measured result for the blank must not exceed the HAMDC or five percent (5%) of the activity concentration of the least active sample in the batch.

(4) Recoveries or percentages of known values which are 15% above or below the ranges listed are acceptable on an infrequent basis, e.g., less than 15% of the time. These occurrences must be investigated and explained. If more than 15% of the recoveries are outside the ranges listed, take corrective actions and reanalyze samples.

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Table G-4 RADIOCHEMICAL PERFORMANCE CRITERIA (cont.)	
CRITERION: 33	**ANALYTICAL SUPPORT LEVEL (ASL) B**
ANALYTE: Radon-222	**SAMPLE MATRIX**
PERFORMANCE PARAMETERS	AIR
Highest Allowable Detector Background	1 track per square millimeter
Precision Requirement for Duplicate Samples(1)	< 20% variability
Laboratory Control Sample: Percent of Known Value(2)	80-120%

(1) Ten percent of the samples are counted as duplicates on another count instrument.
(2) For each batch of 200 detectors, three spikes and two blanks are used.

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APPENDIX H

(RESERVED FOR
IN-SITU GAMMA SPECTROMETRY)

Appendix I

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APPENDIX I

FIELD CALIBRATION REQUIREMENTS

APPENDIX I FIELD CALIBRATION REQUIREMENTS

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Appendix I

FIELD CALIBRATION REQUIREMENTS

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I.1 TYPE OF EQUIPMENT

Calibration requirements for the following types of field instrumentation are discussed in this appendix:

A. Water quality instrument and sensors;

B. pH instrument or pH sensor of the water quality instrument;

C. Specific conductance meter or specific conductance sensor of the water quality instrument;

D. Dissolved oxygen meter or dissolved oxygen sensor of the water quality instrument;

E. Redox potential meter or redox potential sensor of the water quality instrument;

F. Turbidity meter or turbidity sensor of the water quality instrument;

G. Water level indicator;

H. Thermometer; or the temperature sensor of the water quality instrument;

I. Photo-ionization detector (HNu, micro TIP, TIP, OVM);

J. Flame-ionization detector (OVA);

K. Pressure transducers;

L. Hand-held radiological survey instruments;

M. Environmental (high volume) air monitoring stations;

N. X-ray fluorescence spectrometer (XRF).

All equipment calibrations shall be fully documented in accordance with the procedure established for each instrument.

I.2 CALIBRATION REFERENCE STANDARDS

Calibration standards shall be traceable to National Institute of Standards and Technology (NIST), EPA-certified standards, or the best quality materials available. Calibration certification verifies that measurement equipment is working properly in accordance to the applicable standard.

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I.2.1 Geophysical Instruments

Instruments for quantitative geophysical measurement shall be calibrated by the manufacturer or by an authorized representative at least annually. Field calibration shall be performed or the response shall be checked, as applicable, in accordance with manufacturer's instructions or an approved standard operating procedure (SOP) each day prior to field use for both quantitative and qualitative instruments.

I.2.2 Flow Meters and Gauges

Instruments that measure flow rate and shall be calibrated in accordance with the manufacturer's instructions or an approved SOP.

I.2.3 Colorimetric Indicator Tube Pumps

Colorimetric indicator tube pumps shall be calibrated prior to purchase. Calibration shall be checked as recommended by manufacturer's instructions or an approved SOP.

I.2.4 Environmental (High Volume) Air Monitoring Stations

Environmental air sampling systems shall be calibrated prior to initial FEMP use, yearly thereafter, and/or after equipment maintenance that would affect calibrations. Calibrations shall be performed in accordance with manufacturer's instructions as documented in approved standard operating procedures. The power source shall be within manufacturer specifications and checked at least annually. Calibration worksheets and records for any one particular unit shall be maintained in the project files.

I.3 CALIBRATION FREQUENCY

Field instruments shall be calibrated at frequencies specified in Section 8.2.

I.4 CALIBRATION PROCEDURES

NOTE

Personnel who perform calibration procedures must first receive appropriate training and must be qualified in the calibration and use of the equipment.

I.4.1 pH

Calibrate pH meters or water quality meter pH sensor in accordance with manufacturer's instructions. Meters shall be direct-reading, temperature-compensating and capable of responding within 0.1 pH unit over a temperature range of 0 to +40 degrees Centigrade. The response time of the instrument shall not be greater than two minutes.

At a minimum, the following shall be performed:

A. Replace or recharge it as necessary.

B. Ensure that electrodes are filled with manufacturer-specified solution (usually potassium chloride).

C. Rinse electrodes with deionized water.

D. Calibrate meter or water quality meter sensor daily, prior to the start of each sampling event, with a standard solution selected according to the expected pH range of sample. Calibration shall be per manufacturer's instructions.

E. Verify calibration with the appropriate calibration standard solution, at each sampling location, in accordance with manufacturer's instructions. Recalibrate as necessary to ensure accurate operation.

I.4.2 Specific Conductance

Specific conductance meters or combination meters with specific conductance sensors shall be direct-reading and temperature-compensating. The calibrated accuracy of the measuring system shall be capable of responding within four percent of full scale over a temperature range of 0 to +40 degrees Centigrade, and instrument response time shall be no greater than two minutes. Two standards that bracket the expected conductivity of the water to be measured (e.g., 100 μmhos per centimeter (μmho/cm) and 1000 μmho/cm for natural waters) shall be used to check instrument response.

Calibrate conductance meters as follows:

A. Switch on instrument for a power check and calibrate as specified in the manufacturer's instructions.

B. Replace battery when redline adjustment cannot be accomplished (see manufacturer's instructions) or when meter indicates a low battery.

I.4.3 Dissolved Oxygen

Dissolved oxygen measuring instruments shall be capable of measuring within 0.1 milligram per liter (mg/L) over a water temperature range of 0 to +40 degrees Centigrade with a response time no greater than two minutes.

Calibrate instruments as specified by manufacturer's instructions.

I.4.4 Redox Potential

Calibration procedures or redox potential instruments vary significantly between manufacturers; therefore, manufacturer's instructions should be followed.

I.4.5 Turbidity

Calibration procedures for turbidity instruments vary significantly between manufacturers; therefore, manufacturer's instructions will be followed.

I.4.6 Water Level Indicator

A. Compare water level indicator tapes (electric or manual) annually or after being subjected to unusual stress (e.g., getting hung on a dedicated pump) to a standard length obtained from NIST. If comparison is impractical, replace the tape.

B. Replace tapes that deviate from the standard more than 0.1 percent or are otherwise unusable (sound no longer audible, numbers worn off, etc.).

I.4.7 Thermometers

NOTE

The following requirements apply to thermometers directly used to collect environmental data. Thermometers used for ancillary purposes shall be calibrated according to SOPs.

A. Check the calibration of working thermometers annually against a NIST-traceable thermometer.

B. Discard thermometers with readings differing by ± 0.5 degree Centigrade.

I.4.8 Photo-Ionization Detector

A. Calibrate Photo-Ionization Detectors (PID) prior to each day of use.

B. Check instrument response after calibration.

I.4.8.1 **PIDs Without Flow Regulators**. Calibrate as follows:

A. Fill a Tedlar sampling bag with calibration gas of known concentration. The concentration should be within the range expected to be measured, if known.

B. Connect PID probe to sampling bag with flexible tubing.

C. Allow sample bag contents to be drawn into the probe and check response in parts per million (ppm).

D. Adjust span potentiometer to produce concentration listed on the span gas cylinder.

E. Allow ion chamber to purge. If instrument reading is zero ± 0.5 ppm, instrument is calibrated.

F. If instrument is not calibrated, reset it at zero and repeat steps A through E.

G. If instrument still is not calibrated, return it for maintenance and recalibration by qualified individual.

H. Document calibration results including the following information:

1. Date calibrated;
2. Name of person who calibrated instrument;
3. Instrument number (serial or other ID number);
4. Results of calibration (ppm, probe eV, span potentiometer setting);
5. Identification of calibration gas (source, type, concentration).

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I.4.8.2 PID Canisters With Flow Regulator. Calibrate as follows:

A. Connect sampling hose to cylinder regulator outlet and other end to PID sampling probe.

B. Open regulator valve.

C. Take reading after 5 to 10 seconds.

D. Perform steps D through H in paragraph I.4.8.1.

E. Check response of PID each time instrument power is turned on by placing a felt tip indelible marking pen (or the cap of such a pen) near the probe and verify that instrument responds positively.

F. Document calibration results including the following information:

1. Date calibrated;

2. Name of person who calibrated instrument;

3. Instrument number (serial or other ID number);

4. Results of calibration (ppm, probe eV, span potentiometer setting);

5. Identification of calibration gas (source, type, concentration).

I.4.9 Flame-Ionization Detector

The following calibration procedure shall be performed by qualified service technicians only annually, at the minimum.

I.4.9.1 Primary Calibration

A. Remove instrument from instrument shell.

B. Turn on **Electronics** and **Zero Instrument** switches on **X10** scale. Turn **gas select** dial to 300.

C. Turn on **Pump** and **Hydrogen** switches, ignite flame, and go to **Survey Mode**.

D. Introduce a methane standard near 100 ppm.

E. Adjust appropriate trimpot on circuit board until meter reads standard.

F. Turn off hydrogen flame and adjust meter needle to read 40 ppm. Calibrate at each X10 mark with **calibration adjust** knob.

G. Switch to **X100** scale. Meter should indicate 0.4 on 1-to-10 meter marks (0.4 X 100 = 40 ppm). If reading is off, adjust with appropriate trimpot.

H. Return to **X10** scale and adjust meter needle to 4 ppm with calibration. Adjust knob if necessary.

I. At the **X10** scale, adjust meter to read 0.4 on 1-to-10 meter marks using **calibration adjust** knob. Switch to **X1** scale. Meter should read 4 ppm. If reading is off, adjust with appropriate trimpot.

J. Mark the calibration date on the outside of the instrument and comply with the requirements of Section I.4.9.3.

I.4.9.2 **Secondary Calibration**. Perform secondary calibration as follows each day instrument is used:

A. Fill air sampling bag with certified methane calibration gas of known concentration.

B. Connect outlet of air sampling bag to Flame Ionization Detector (FID) air sampling line.

C. Record reading on calibration record.

I.4.9.3 **Documentation**. Document calibration providing the following information:

A. Identification of instrument calibrated (serial number or other identification number);

B. Date of calibration;

C. Results of calibration;

D. Name of person who calibrated instrument;

E. Identification of calibration gas (source, type, concentration, lot number).

I.4.10 Pressure Transducer
Recalibrate transducers at least annually according to the manufacturer's instructions.

I.4.11 Hand-Held Radiological Survey Instruments
Hand-held instruments are used to screen material and personnel for gross alpha, beta, or gamma radiation. Instruments shall be calibrated annually at a minimum and source-checked each day of use.

I.4.11.1 **Preliminary Process**.

A. Check instrument to be calibrated with another instrument to ensure there is no residual radioactive contamination.

B. Serialize probe to meter with which it is calibrated.

C. Check reproducibility of instrument with check source.

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NOTE

If instrument does not respond in a similar manner through several trials, electrical malfunction is likely.

I.4.11.2 Calibration.

A. Set the meter at zero.

B. For electronic calibration, pulse with pulse generator at 80 percent and 20 percent of full scale.

C. Set high voltage and run plateau, if necessary.

D. Check efficiency with NIST-traceable radiation source.

E. Record data obtained during calibration.

F. If instrument accuracy is outside the limits of 75 to 150 percent of the source, return instrument to manufacturer for repair.

G. Place a sticker with the next calibration due date on instrument.

I.4.11.3 Miscellaneous Instrumentation. Any radiation/contamination detection instrumentation may be used to obtain Analytical Support Level A and B data, even though it is not specifically listed in this document, provided that the following requirements are met:

A. Instruments are calibrated with manufacturer-recommended procedures;

B. Radioactive sources used in calibration are traceable to NIST;

C. Instruments are source-checked at least daily;

D. Probes are capable of detecting the specified type of radiation at required levels.

I.4.12 X-Ray Fluorescence Spectrometer (XRF) with HgI_2 Detector - Spectrace 9000
This instrument includes a portable multichannel analyzer (MCA) with a mercuric iodide (HgI_2) detector and three sealed radioactive sources (^{55}Fe, ^{109}Cd, and ^{241}Am) (see Section K.6.4.6). The unit is preset at the factory to allow adjustment for the matrices to be surveyed by the user. Instrument calibration shall be verified each day prior to use to confirm that the instrument is functioning within calibration, resolution and intensity specifications.

I.4.12.1 Calibration, Resolution, and Intensity Verification. The following verification procedure shall be performed before each day's use to confirm that the unit is functioning within calibration, resolution, and intensity specifications.

A. Spectral intensity verification.

1. Place the pure iron element provided with the instrument over the window and run a 50 second analysis for each source. This operation should be performed

with the instrument in the lab stand base only and using the probe safety cup to cover the iron standard.

2. Review the raw relative intensities for iron, manganese and cobalt.

3. A relative intensity greater than 0.950 for iron and less than 0.006 for manganese and cobalt indicates that the system is working properly.

B. Spectral resolution verification.

1. Check the ^{109}Cd spectrum of the iron standard and ensure that the counts per second at 6.25 keV and 6.55 are less than one half of the count rate at 6.40 keV.

C. Energy calibration verification.

1. Check the ^{109}Cd spectrum of the iron standard and ensure that the centroid of the iron Kα peak is 6.40 keV $\pm$ 0.02 keV.

D. Maintain each day's verification measurements in a log book or on the daily log form for instrument troubleshooting.

I.4.12.2 **Energy Calibration**. The following energy calibration shall be performed when the calibration verification was out of specification or the unit has not been used for several days. Note that the unit performs one form of energy calibration each time an analysis is performed. The second calibration method is user selected to verify the validity of the first.

1. Place the lead-lined safety cover over the probe unit.

2. Initiate the menu selection of the ENERGY CALIBRATION option. The unit will self-calibrate.

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Appendix J

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APPENDIX J

FIELD ACTIVITY METHODS

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APPENDIX J FIELD ACTIVITY METHODS

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Appendix J

FIELD ACTIVITY METHODS

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J.1 PURPOSE

The purpose of this appendix is to provide the methods and requirements for field activities which produce data that comply with DOE and USEPA requirements and which meet the specified Data Quality Objectives (DQOs) for each project.

J.2 SCOPE

General requirements for field activities are provided in this appendix. Additional requirements may be specified in the project-specific documents (e.g., Project-Specific Plans (PSPs) or Statements of Work (SOWs)) to provide detailed instructions applicable only to the specific project. These activities must be performed in accordance with the Applicable or Relevant and Appropriate Requirements (ARARs) for each Operable Unit (OU).

J.3 RESPONSIBILITIES

J.3.1 FEMP Project Manager

The FEMP project manager shall be responsible for the safe and prompt completion of project activities and for securing all permits required by state, local, or onsite authorities. The project manager shall ensure that underground and aboveground utilities are located and avoided to protect field operations personnel from danger and that copies of permits and other applicable documentation shall be available at the field location. The project manager shall also be responsible for ensuring that all activities are conducted in accordance with the ARARs for the project under his control.

J.3.2 Geologist

A geologist (geologist, hydrogeologist, or geological engineer) is responsible for the oversight and documentation of field activities described in this appendix as outlined below. The project manager shall determine and document in the PSP the need for either a geologist or a field technician with applicable experience, based on the activity being performed, the technical specifications required, and the potential for subsurface cross-contamination. A geologist must be present for oversight responsibility of all activities during the following:

A. Well installation;

B. Well abandonment using the overdrill method;

C. Drilling, when lithologic description is required.

J.3.3 Sampling Team Leader

The sampling team leader is responsible for implementing requirements of the PSP including the following:

A. Ensure that team members follow specified procedures;

B. Ensure that work is completed in a safe and efficient manner;

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C. Ensure that documentation is maintained and completed as specified in this document and in procedures identified in the PSP;

D. Ensure communication with the FEMP project manager or designee concerning progress.

J.3.4 Sampling Team Members

Members of the sampling team are responsible for performing sampling activities under the supervision of the team leader and as specified in PSPs and procedures. They shall ensure that documentation is maintained and completed as specified in this document and in procedures identified in the PSP. They shall observe health and safety requirements, ensure that work is completed in a safe and efficient manner, and communicate information on progress and concerns to the team leader.

J.4 FIELD ACTIVITY METHODS AND REQUIREMENTS

J.4.1 Field Documentation

Daily logs are written records of activities and measurements conducted in the field on a given date. The logs shall be completed in the field and compiled as a package following the completion of the days activities. The logs shall have printed, sequentially numbered pages or shall be uniquely numbered by field personnel.

J.4.1.1 **Daily Log Entries**. The geologist and/or team member supervising the activities shall be responsible for entries in the daily log. The daily log shall be a record of events occurring during the field activity and shall be written in such a manner that the event can be reconstructed without reliance on memory. The daily log shall include, but not be limited to, the following information as applicable:

A. Subject of field activity;

B. General work activity;

C. Unusual events;

D. Visitors at the site;

E. Calibration checks;

F. Subcontractor progress and specifications;

G. Communication with regulatory agencies or others;

H. Weather conditions.

J.4.1.2 **Lithologic Logs**. The geologist is responsible for preparing lithologic logs in the field. At a minimum, the lithologic log shall provide the following information:

A. Location identifier;

B. Date started and date completed;

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C. Geologist (logging);

D. Drilling rig make/model;

E. Drilling contractor;

F. Standard penetration test (if applicable);

G. Footage drilled;

H. Materials penetrated;

I. Depth to significant changes in lithology;

J. Samples collected (identified by depth, time, sample number, and collection method);

K. Amount of sample recovery;

L. Qualitative degree of saturation of each sample;

M. Qualitative degree of plasticity of each sample;

N. Depth to saturated zones and potential confining beds;

O. USCS (Unified Soil Classification System) symbol for each sample;

P. Fluid losses;

Q. Color of sample (using Munsell color chart);

R. Surface casing used and method of installation.

J.4.1.3 **Borehole Abandonment Record**. The geologist or team member is responsible for completing the borehole abandonment record. At a minimum, the borehole abandonment record shall provide the following information:

A. Borehole identifier;

B. Water level;

C. Drilling method;

D. Borehole diameter;

E. Borehole depth;

F. Type, amount, and density of materials used;

G. Depths at which materials were placed.

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J.4.1.4 **Well Completion Log**. The geologist is responsible for completing a well completion log. At a minimum, the well completion log shall provide the following information:

A. Well identifier;

B. Geologist (field);

C. Drilling rig make/model;

D. Drilling contractor;

E. Installation start and completion dates;

F. Drilling method;

G. Temporary casing diameter and penetration (if used);

H. Water level;

I. Volume of water lost during drilling (if used);

J. Borehole depth;

K. Well depth;

L. Well screen material, wall thickness, slot size, type, depth (top and bottom), length, diameter;

M. Well riser material, wall thickness, diameter;

N. Volume, type, thickness, and depth to top of filter pack;

O. Volume, type, thickness and depth to top of bentonite seal;

P. Volume, type, and depth to top of grout;

Q. Dimensions of concrete surface pad and thickness of concrete seal;

R. Height of riser above ground surface;

S. Height of protective casing above ground surface.

J.4.1.5 **Plugging and Abandonment Record**. The geologist or team member is responsible for completing a plugging and abandonment record. At a minimum, the plugging and abandonment record shall provide the following information:

A. Borehole identifier;

B. Drilling subcontractor;

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C. Plugging and abandonment start and completion dates;

D. Water level;

E. Reason for plugging and abandonment of well;

F. Method of plugging and abandonment;

G. Types, amounts, volumes of materials used for plugging;

H. Depths at which materials were placed;

I. Condition of well materials;

J. Differences in well from information recorded on well installation records.

J.4.1.6 **Monitoring Well Development Form**. The geologist or team member is responsible for completing a monitoring well development form. At a minimum, the monitoring well development form shall provide the following information:

A. Well identifier;

B. Development start and completion dates and times;

C. Water level before and after development;

D. Total depth of well before and after development;

E. Total volume of water to be removed;

F. Type of development equipment used;

G. Description of development method;

H. Total volume of water removed and time of removal;

I. Water quality field parameter data taken at regular intervals during development;

J. Description of water/sediment removed;

K. Purge water containment and disposition.

J.4.1.7 **Geophysical Surveys**. The geologist or team member is responsible for completing the form required for geophysical surveys. At a minimum, the form shall provide the following information:

A. Dates and times of survey;

B. Purpose of survey;

C. Method of survey;

D. Tools and equipment used;

E. Specific information pertaining to tools;

F. Variations in methods or processes.

J.4.1.8 **Aquifer Testing**. The geologist or team member is responsible for completing the form required for aquifer tests. At a minimum, the form shall provide the following information:

A. Purpose of test;

B. Type of test;

C. Dates and times of test;

D. Static water level;

E. Rate of water discharge or displacement;

F. Drawdown or pressure vs. time;

G. Water quality field parameter readings;

H. Well construction information;

I. Aquifer conditions/description;

J. Equipment used.

J.4.1.9 **Field Documentation Completion**. The following shall be performed.

A. Record all field measurements and comments (see J.4.1.1 - J.4.1.8) using indelible black or blue ink in the appropriate field logs as specified by the PSP.

B. If the information requested on a form is not applicable or is not known, insert an "NA" (not applicable) or "NK" (not known) as appropriate.

C. Line out any unused portions of the page or form by drawing a line across the empty area, and initial and date the line.

D. As each form is completed, initial and date each page.

E. If requirements cannot be performed as described in the PSP, a variance must be approved (see Section 15.3). Reference the variance number in the appropriate field documentation.

F. Identify photographs with the project number, date and time taken (using 24-hour time), and a brief description on the back of each photograph.

G. Ensure that field documentation is subjected to peer review.

J.4.1.10 **Filing Requirements**. The following documentation of field activities shall be filed as indicated. These copies will provide adequate documentation of work activities if originals are destroyed, lost, or stolen.

A. Send photocopies of daily log entries to the FEMP project manager or representative and others as required at least weekly.

B. Maintain originals of field records in the project central file. Keep photocopies of bound books in the central file until the book is complete and entered in the file system.

C. During performance of the field program, maintain copies of field records in the FEMP project manager file.

J.4.2 General Drilling Practices

NOTE

For clarity, the term "well" shall include groundwater monitoring points such as monitoring wells, lysimeters, recovery wells, injection wells, and production wells.

NOTE

For clarity, the term "grout" shall include slurries of bentonite, cement, and expansive cement.

The number, location, depth of boring, and the type of sampling and testing required are dependent on intended use of the data and shall be specified in the PSP. The drilling method selected for a particular project at the FEMP depends on the intended use of the borehole and samples collected, and also shall be presented in the PSP. The FEMP project manager is responsible for determining that the drilling technique used is appropriate for site conditions and project objectives. The chosen drilling method shall reflect the FEMP policy of waste minimization.

A. Drilling methods that may be selected include, but are not limited to, the following:

1. Hand augering (to 8 ft. or less below the ground surface);
2. Rotasonic;
3. Cable-tool;
4. Hollow-stem auger;
5. Drive casing;
6. Spin casing;
7. Direct mud rotary;
8. Air rotary with casing driver;

9. Air rotary with swing-out, under-reaming bit and casing advancer;

10. Reverse-air or mud rotary;

11. Direct push;

12. Cone penetrometer.

B. Drilling operations shall be conducted as follows:

1. Decontaminate drilling equipment before each use as specified in Appendix K.11 and the PSP to prevent contamination of the borehole and after each use to prevent the offsite transport of contaminants.

2. Minimize the introduction of contaminants into the environment and the spreading of contaminants between zones.

3. When a potentially contaminated zone will be penetrated, set a surface casing prior to reaching the target zone.

4. When drilling to install any type of well through areas where historical information or sample screening indicates the presence of near-surface soil contamination or contaminated perched water zones, grout surface casings in place and make them part of the permanent installation. The borehole diameter shall be at least 4 inches larger than the diameter of the surface casing to allow for an adequate grout seal.

5. In outlying areas not suspected of being contaminated, advance large diameter temporary casings as necessary for borehole control.

6. Contain fluids, cuttings, and other waste as specified in the PSP. All waste materials will be handled and disposed of according to applicable FEMP site procedures.

7. Use only potable water from a public water system for drilling operations.

NOTE

The use of additives in drilling fluids is discouraged except in unusual circumstances.

8. If an additive is to be used, obtain approval from the FEMP project manager prior to use.

9. Prior to field activities, analyze a sample of the additive for parameters of interest and review the analysis results for potential impact on objectives of the data collection program.

10. Collect cuttings or soil samples at the frequency specified in the PSP in accordance with the requirements for subsurface soil sampling in Appendix K.5.3.

J.4.2.1 **Borehole Abandonment**. Boreholes that are not converted into monitoring wells must be properly sealed following completion of sampling activities.

Borehole abandonment shall be completed as soon as possible following the completion of sampling objectives. Prior to permanent abandonment, precautions will be taken to mechanically secure the borehole during work stoppages of more than 2 hours.

J.4.2.1.1 **Hand Augered Boreholes**. Hand augered boreholes will generally be limited to 4 inches or less in diameter and 8 feet or less below the ground surface, depending on physical location and lithologic materials present in the subsurface. The following requirements shall apply when abandoning a hand augered boring:

A. For borings no greater than 1 foot deep, backfill the borehole with the excavated soil and regrade the surface.

B. For consolidated materials, attempt to remove all loose or caved-in materials using a hand auger/bucket. For unconsolidated materials, allow collapsing and caving to occur and attempt to tamp loose material toward the bottom of the hole with the auger/bucket assembly.

C. Hydrated bentonite pellets, volclay grout, cement, or other material as specified in the PSP, or a combination of these materials, will be used to plug and abandon the hole to within 30 inches of the ground surface. The materials will be placed into the boring in increments of approximately 2 feet. For bentonite pellets, a sufficient volume of potable water will be poured over each increment of bentonite, allowing several minutes between increments for adequate hydration of the pellets to occur. The top 30 inches will then be backfilled, compacted and graded with surrounding top soil or excess cuttings.

J.4.2.1.2 **Drilled Boreholes**.

NOTE

Drill augers and casings may include probe rod used with direct-push technology.

A. Grout shall be used for plugging unless otherwise specified in the PSP.

B. For boreholes completed in dry, stable materials, drill augers and casings may be removed and grout inserted from the bottom of the hole using a side-discharge tremie line.

C. For boreholes completed in unstable materials, use the drill augers or casing to prevent the collapse of the boring as the grout is inserted. Maintain a grout level above the bottom of the drill augers or casing as the grout is inserted and the drill augers or casing is/are removed.

D. Allow boreholes completed in the Great Miami Aquifer (GMA) to collapse to 5 feet beneath the top of the GMA or to 5 feet beneath the clay interbed, if present, prior to installation of plugging material.

E. If borehole will not collapse, use sand as a plugging material to a depth of 5 feet beneath the top of the GMA or the clay interbed, if present.

F. Place 5 feet of bentonite pellets on top of the sand and hydrate the pellets, if necessary.

G. When bentonite pellets are used for abandonment, the following requirements apply:

1. Measure the depth to the top of the seal periodically throughout the process to ensure bridging has not occurred.

2. Pour pellets into borehole in 2-foot increments and pour a sufficient volume of potable water over each increment of bentonite, allowing a minimum of 5 minutes between increments for adequate hydration of the pellets to occur.

H. Place grout to 30 inches below the surface using a side-discharge tremie hose.

I. Inspect the borehole after 24 hours to ensure that the grout level has not settled. If the grout has settled below 30 inches from the ground surface, add additional grout as needed.

J. The top 30 inches will then be backfilled, compacted and graded with surrounding top soil or excess cuttings.

K. Complete the field documentation as described in J.4.1.3.

J.4.3 Well Design, Construction, and Abandonment

NOTE

For clarity, the term "well" shall include groundwater monitoring points such as monitoring wells, lysimeters, recovery wells, injection wells, and production wells.

NOTE

For clarity, the term "grout" shall include slurries of bentonite, cement, and expansive cement.

The FEMP project manager is responsible for locating and designing wells so that project objectives defined in the PSP are met. The geologist is responsible for overseeing well installation in the field and for properly documenting construction details.

J.4.3.1 **<u>Well Construction Materials</u>.** Use the following materials for construction of wells.

NOTE

Use of glues or solvents is prohibited.

A. Use schedule-40 polyvinyl chloride (PVC) or 316 stainless-steel casing with flush-thread joints. The casing type selected depends on the presence of known or suspected contaminants, the proposed depth, and purpose of the well. If high concentrations of organic compounds are suspected (i.e., parts per thousand), a stainless steel well should be installed. If conditions are highly corrosive, then PVC should be used in place of stainless steel.

B. Use commercial wire-wound stainless steel or PVC screens with flush-thread joints compatible with the well casing. Determine size of screen openings based on effective grain size of monitored zone and filter pack size, or by using data obtained from previous wells that are screened in similar geologic formations and located adjacent to the well being placed.

NOTE

Screen openings shall be capable of catching between 85 and 100 percent of filter pack materials to allow accurate measurement of hydraulic properties, minimize turbulence during sample collection, and optimize capacity to develop the well completely and efficiently. Slotted or wound PVC screens with flush-thread joints compatible with the well casing may be used in wells. However, hydraulic data collected from wells shall be carefully evaluated to determine whether measurements are representative of the aquifer or of well materials.

C. Use well-sorted quartz sand for filter pack material.

NOTE

Selection of filter pack grain size is a function of grain size distribution in the natural formation and should be based upon sieve analysis (Driscoll 1986) unless historical data is used.

D. Prior to the use of any filter pack material, the materials used must be inspected to ensure that they have not been compromised and that PSP requirements are met.

NOTE

Typically, graded sand meeting requirements of American Society for Testing and Materials C-33 for fine aggregate (concrete sand) is sufficient.

E. Bentonite pellets may be used as a seal above the sand filter pack prior to placement of grout slurry.

F. Record the brand name and the lot numbers of bentonite in project files.

G. Annular grout must consist of a slurry of high-solids bentonite (e.g., Volclay) mixed to manufacturer specifications. Volclay grout mixtures used to seal the annular space must conform to the density standard of 9.4 lb/gal. Grout density will be verified by mud balance measurements prior to and during placement of the grout. If grout density in the annulus is less than required, then the grout shall be pumped from the annulus until the 9.4 lb/gal standard is reached. Any grout purged from the annulus of the well shall be managed in accordance with applicable FEMP requirements.

H. The top 30 inches of annular space shall be sealed with concrete. The protective casing will be placed in the concrete seal before the concrete sets up.

J.4.3.2 **Well Construction**. After drilling is complete and the borehole has been cleaned of cuttings, construct well as follows and per the requirements of the PSP.

NOTE

Place well cap on the well casing prior to grout placement to prevent grout from entering the well. Grout purged from the borehole cannot be reused.

A. The FDF Quality Assurance (QA) organization will verify materials to be used for construction of each monitoring well for proper size per specifications (i.e., filter pack material, screen length and slot size, casing length, etc.). This will include verification of volume calculations and actual volumes used.

B. QA personnel will inspect the physical installation of wells by utilizing the following criteria:

1. Borehole depth and diameter are consistent with PSP specifications.

2. Materials used for construction of each monitoring well must meet applicable specifications (i.e., proper size and type).

3. Materials are installed in accordance with SCQ requirements.

4. Grout entering the borehole has been density tested using a mud balance, and is consistent with manufacturer's specifications.

C. Remove temporary casing or hollow stem auger gradually and install backfill materials so that bottom of the temporary casing or augers is kept below the top of the backfill materials.

D. Record depths of filter pack, bentonite seal, and grout.

E. Install wells screened in the glacial overburden and wells screened across the GMA water table (Type 1 and Type 2 wells) as follows:

1. Place required length of screen and riser inside the open borehole, temporary casing, or hollow-stem augers.

NOTE

Make periodic measurements to check uniform placement of filter pack.

2. Install a filter pack to a height of 2 to 5 feet above the screen in Type 1 wells and a minimum of 5 feet above the screen in Type 2 wells.

3. Install a 2 to 5 foot bentonite seal on top of the filter pack for Type 1 wells and a minimum of 5 feet above the filter pack in Type 2 wells.

4. Hydrate the bentonite seal material with sufficient volume of water.

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5. Install grout from the top of the bentonite seal to within 30 inches of the ground surface by side-discharge tremie line method.

F. Install wells screened in the middle of the GMA (Type 3 and Type 6 wells) as follows:

1. Place required length of screen and riser inside the open borehole, temporary casing, or hollow-stem augers.

2. Install a filter pack to a minimum height of 5 feet above the screen.

3. Allow native material to collapse and fill the annulus from the top of the filter pack to the GMA water table.

4. Install a 5-foot bentonite seal on top of the native material.

5. Install grout from the bentonite seal to within 30 inches of the ground surface by side-discharge tremie line method.

G. Install wells screened at the base of the GMA (Type 4 wells) as follows:

1. Place required length of screen and riser inside the open borehole, temporary casing, or hollow-stem augers.

2. Install a filter pack to a minimum height of 5 feet above the screen.

3. Allow native material to collapse and fill the annulus from the top of the filter pack to within 5 feet of the base of the interbedded clay layer. If the interbedded clay layer is absent, allow to collapse to the GMA water table.

4. Install a bentonite seal from 5 feet below the base to 5 feet above the top of the interbedded clay layer. If interbedded clay layer is absent then install a 5-foot bentonite seal at the GMA water table.

5. Install grout from the bentonite seal to within 30 inches of the ground surface by side-discharge tremie line method.

H. Inspect the borehole after 24 hours to ensure that the grout level has not settled. If the grout has settled below 30 inches from the ground surface, add additional grout as needed.

I. For above-ground completions, ensure riser measures 24 to 30 inches above ground surface and a vented well cap is in place.

J. Finish ground-flush completions with an airtight cap.

K. File a notch approximately one-quarter inch deep at top of each well riser as a reference mark for water-level measurements.

L. Install the following minimum protection around wells.

1. Ground-flush installations:

a. Ensure that completions are either water tight or free draining (containing a drainage layer of coarse sand at the bottom of the flush-mount box).

b. Provide a leak-proof well cap with lock.

c. Install manhole-type boxes large enough to accommodate the well riser, well cap, and a lock.

d. Install a protective cover secured with bolts and gaskets that prevents surface water from entering the protective casing.

e. Mark well identifier on well in 2 places as follows:

i. With a metal tag affixed to the well cap inside of the protective cover.

ii. Engraved or marked with indelible marker on outside of protective cover or adjacent to protective cover.

2. Above-ground installations:

a. Use a 5-foot long carbon steel pipe, minimum one-quarter-inch thick, and at least 4 inches greater in diameter than the well riser as a protective casing.

b. Fit protective casing with a hinged cap, hasp and lock.

c. Paint protective casing with primer and high visibility orange paint. The ambient temperature must be within manufacturer's specifications before applying paint.

d. Mark well location on protective casing in 3 places as follows:

i. On inside of cover.

ii. Welded, stamped, engraved, or permanently painted on top of locking cover.

iii. Engraved or marked on outside of well cap.

e. Excavate the surface soil around the well riser to the dimensions of the planned well pad.

f. Place pad form in excavated space around the well riser.

g. The top 30 inches of the annular space shall be sealed with concrete. Place top of protective riser within 4 inches of top of well casing. The concrete pad shall have a minimum height of 2 inches above the ground surface and 2 inches below grade, and shall extend a minimum 12 inches from the

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protective casing. The concrete pad shall be sloped sufficiently to drain water away from the well.

h. Secure protective casing until concrete has set to prevent settling.

i. Ensure height of concrete inside protective casing is higher than the surrounding concrete pad. Add concrete if necessary.

j. Drill 1 or 2 drain holes, minimum of 1/4 inch diameter, in the protective casing just above the inner concrete surface.

k. Guard post installation, if required, shall be structurally independent of any concrete surface seal. The guard posts shall be steel filled with concrete, or I-beams, and shall be located radially around the well at 4-foot intervals. The posts shall be driven into the ground, requiring no excavation. They shall be set 4 feet below the ground surface and approximately 3 feet above the ground surface.

l. Regrade surrounding ground surface with drainage away from well head, and restore disturbed drilling areas to as close to original conditions as possible.

NOTE

Well completion logs shall contain all information specific to the well installation and illustrate a cross section of the screen, filter packs and seals.

m. Prepare a well completion log as described in Appendix J.4.1.4.

J.4.3.2.1 **Cold Weather Concrete Placement**. The following conditions shall apply to the placement of concrete for monitoring well pads when temperatures are below 45° F:

A. The use of salts and chemicals to effect cold weather placement shall not be permitted.

B. All ice, snow, and frost shall be completely removed from surfaces that will be in contact with concrete before the concrete is placed.

C. Concrete shall not be placed on a frozen subgrade or on a subgrade that contains frozen materials. If placements are to be made during freezing weather (32° F or less), the ground upon which the concrete is to be placed shall be heated for 12 hours at a minimum before any concrete is placed.

D. Concrete shall be protected from freezing by adequate covering for 7 days.

J.4.3.3 **Well Abandonment**.

A. The reasons for well abandonment include the following:

1. Elimination of physical hazards;

2. Prevention of groundwater contamination;

3. Conservation of aquifer yield and hydrostatic head;

4. Prevention of intermixing of subsurface waters;

5. Compliance with reasonable requests from property owners;

6. The well is no longer necessary to support FEMP project activities;

7. The well, for whatever reason, does not yield groundwater data representative of conditions in the monitored hydrogeologic zone;

8. Land use changes due to remediation construction activities.

B. No single method of plugging and abandonment is suitable for all wells. When selecting the appropriate method for plugging and abandonment, each well must be evaluated individually, and all aspects of the well's construction, location, and hydrogeologic environment must be considered. Detailed instructions for plugging and abandoning a specific well are provided in the PSP or Scope of Work for each plugging and abandonment project.

The following requirements apply when abandoning a well:

1. Remove concrete pad and protective casing.

NOTE

The protective casing may be removed with the well riser, if pulled, as a single unit.

2. During the grout placement process, measure depths to materials placed in the borehole and record on well abandonment form.

3. Following grouting of the borehole, inspect the borehole after 24 hours to ensure the grout level has not settled. If the grout has settled below 30 inches from the ground surface, add additional grout as needed.

4. For wells that are to be abandoned temporarily in place (i.e., wells will be completely removed during remediation) the following requirements apply:

   a. Add bentonite pellets or grout slurry to fill the well riser.

   b. Ensure bentonite pellets are tamped during installation to prevent bridging.

   c. Replace and secure the well cover.

5. If the well riser and screen are to be completely removed, the following requirements apply to Type 1 PVC wells:

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a. If possible, push the bottom out of the well.

b. Place grout into the borehole through the well riser while pulling well riser and screen, using a side-discharge tremie hose from the bottom to the top. Maintain a grout level approximately 5 feet inside the well screen while removing the well riser and screen from the borehole.

c. Pull well riser and screen slowly from ground.

6. If the well riser and screen are to be completely removed, the following requirements apply to Type 1 stainless steel and all Type 2, 3, 6, and 4 wells:

a. Pull well riser and screen slowly from the ground.

b. Allow the native material to collapse to a depth of 5 feet below the till. If the sands do not collapse, fill the aquifer interval with sand before grouting.

c. After complete removal of the well riser and screen, measure the borehole depth to ensure the borehole walls above the aquifer did not collapse.

d. Place 5 feet of bentonite pellets on top of the sand and hydrate the pellets, if necessary.

e. Place grout in the borehole, using a side-discharge tremie hose from the bentonite seal to the top.

f. If required, install a concrete plug from 30 inches below the surface flush to the surface.

7. If the well is to be overdrilled, the following requirements apply:

NOTE

The well materials may be removed from the ground either before, after, or during the overdrilling of the well.

a. Ensure the outside diameter of the drilling tool is at least as large as the original borehole.

b. Overdrill the boring to a depth of at least one foot below the depth of the original borehole.

c. For Type 2, 3, 6, or 4 wells, allow native material to collapse to a depth of 5 feet below the till. If the native materials do not collapse, fill the borehole with sand to 5 feet below the till.

d. Place 5 feet of bentonite pellets on top of the sand and hydrate the pellets, if necessary.

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e. Place grout in the borehole, using a side-discharge tremie hose from the bentonite seal to the top.

f. If required, install a concrete plug from 30 inches below the surface flush to the surface.

8. If the well is to be partially removed, the following requirements apply:

a. Place sand in the screened interval to 2 feet above the top of the screen.

b. Place 5 feet of bentonite pellets on top of the sand and hydrate the pellets, if necessary.

c. Cut the well riser a minimum of 5 feet below the base of the till.

d. Insert grout, using a side-discharge tremie hose while pulling the well riser.

e. Maintain a grout level approximately 5 feet inside the well riser while removing the well riser from the borehole.

f. If required, install a concrete plug from 30 inches below the surface flush to the surface.

9. Complete Plugging and Abandonment Record as described in J.4.1.5.

J.4.4 Well Development

Wells shall be developed to yield accurate aquifer test results and groundwater samples representative of aquifer conditions. Well development may be conducted using bailers, submersible pumps, bladder pumps, or peristaltic pumps. Surging techniques using surgeblocks are recommended in relatively high-yield aquifers. Excessive drawdown must be avoided; to avoid pumping/bailing a well dry and to prevent damage to the pumps by allowing them to pump air, reduce the purge rate if necessary.

The FEMP project manager shall specify the well development method in the PSP when sufficient historical data exists to make an informed decision. When historical well development data are lacking, the well development method shall be based on observed aquifer response during drilling.

The following requirements apply when developing a well:

A. Decontaminate equipment and materials used for well development as specified in Appendix K.11 and the PSP before each use.

B. Develop the well as soon as possible after well installation, but no sooner than 48 hours after grouting is completed.

C. Continue development until the water is visually clear and temperature, pH, and specific conductance have stabilized.

D. At a minimum, the following requirements apply:

1. Remove 5 times the standing water volume in the well (water in well screen and casing plus saturated filter pack).

2. If recharge is so slow that the required amount of water cannot be removed in a reasonable amount of time, or the water remains discolored, or it contains visible particulates after the 5-volume removal, contact the FEMP project manager for direction to use an alternate procedure.

3. If it appears necessary to add water to the well to assist development, obtain written approval from the FEMP project manager before proceeding.

NOTE

Do not use chemicals (e.g., dispersing agents, disinfectants, or acids) during well development.

4. If the boring was made or enlarged using drilling fluid (water), remove 5 times the measured amount of total fluids lost during drilling in addition to the 5 times the amount of standing water volume. If slow recharge, discoloration, or particulate-laden water is a problem, proceed as in step 2.

E. During development, attempt to remove standing water from over the entire length of the screen and from the entire water column.

F. If construction errors or contamination are suspected during development, promptly notify the FEMP project manager for disposition.

NOTE

If grout degradation or contamination is suspected, evaluate the monitoring data to identify indicators such as elevated pH, sodium, calcium, aluminum and other cations. In addition, FEMP personnel may evaluate and use, where appropriate, methods such as X-ray diffraction and X-ray fluorescence to determine grout degradation or contamination.

G. Record field measurements and comments on the applicable monitoring well development form as described in J.4.1.6. If steps or procedures are not performed as specified, state the reason for the deviation as completely as possible on the form or document the reason for the deviation on an attachment. If a variance (see Section 15.3) was initiated for the deviation, reference the variance number on the field form.

J.4.5 Geophysical Surveys

Geophysical methods shall be chosen based on project objectives. See *A Compendium of Superfund Field Operations Methods* (U.S. Environmental Protection Agency 1987c) for a brief description of commonly used methods.

Specific techniques for conducting geophysical surveys by borehole logging or surface methods shall be provided in the PSP based on the following guidelines.

J.4.5.1 **Borehole Geophysical Logging**. Borehole geophysical methods provide information about subsurface geological characteristics.

A. Information that can be obtained from borehole geophysical surveys include the following:

1. Formation breaks;
2. Thickness of individual beds;
3. Porosity;
4. Nature of borehole and formation fluids;
5. Identification of high-permeability zones;
6. Depth of penetration of drilling fluids;
7. Borehole size.

B. A minimum of one quality control duplicate run shall be made with each tool used on each project where borehole geophysical logging is specified. When performance of the logging operation has met project objectives, the geophysical team leader shall sign and date completed logging forms (see step 4 below).

C. The following procedure applies generally to geophysical surveys and logging of activities:

1. Clean and decontaminate downhole tools and cables prior to downhole logging operation and between each borehole as specified in Appendix K.11.
2. Calibrate logging equipment and provide the FEMP project manager with applicable documentation of before- and after-survey calibrations.
3. Properly clean and decontaminate logging equipment at the conclusion of operation.

NOTE

The FEMP project manager shall ensure that specified originals and copies of logs are placed in project files. The team leader shall record the progress of logging activities.

4. Complete all applicable forms and record unusual occurrences in the daily log as follows:

   a. Include remarks on the log header.

   b. Identify the log run on the log header.

   c. Enter logging speed, length of tool and resolution, borehole identification, and team member names on the log header.

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d. Mark each curve on the log using a unique line format for every curve.

e. Mark the vertical scale in feet and record total depth of the borehole at the bottom of the log.

f. Identify and graduate the horizontal scale for each log run, labeling a minimum of every ten grid spaces horizontally on the log.

5. Transfer copies of data to the FEMP project manager for distribution, analysis, and archiving. Transmit magnetic recordings generated during the course of downhole logging along with results of logging runs immediately. Recordings shall be in a format specified by the FEMP project manager.

J.4.5.2 **Surface Geophysical Surveys.** Surface geophysical methods provide subsurface information without the need for excavation.

A. Information that can be obtained by surface geophysical surveys includes the following:

1. Delineation of contaminant plumes;

2. Identification of high-permeability zones;

3. Location of disposal areas;

4. Location of subsurface anomalies;

5. Identification of subsurface utilities and stratigraphic data.

The PSP shall specify the geophysical method and instruments to be used, grid spacing, time frame for survey, information desired, and the frequency of duplicating lines for quality control purposes.

A minimum of 5 percent of the total linear distance of the survey shall be duplicated. Provisions for verifying interpretations through the use of borings or excavations shall be included in the PSP.

B. The following general procedures are applicable for surface geophysical surveys:

1. Operate instruments as specified in manufacturer instructions or in the PSP.

2. If manufacturer instructions are not used, provide justification in the PSP.

3. Provide the following information on project-specific logging forms:

a. Date of activity;

b. Times survey was begun and finished;

c. Times of breaks in activity;

d. Temperature variations;

e. Descriptions of variation from an established line caused by topography or vegetation; crossing of drainage features; crossing of swampy areas; instrument settings, calibrations, or malfunctions; and operators.

J.4.6 Aquifer Permeability Testing

A decision to conduct an aquifer test for each project shall be made in accordance with guidelines in the PSP. Guidelines for determining test type, location, and objectives for each project shall also be specified in the PSP. Every aquifer test should be considered unique.

The following are requirements for hydraulic tests to characterize certain properties of hydrogeologic units (e.g., hydraulic conductivity, transmissivity, and storability). Data obtained during field hydraulic tests may include the following as described in J.4.1.8:

A. Static water level;

B. Pumping well water discharge rate or volume of water displaced;

C. Drawdown or pressure versus time data for pumping and monitoring wells;

D. Water temperature, pH, specific conductance, and turbidity;

E. Test interval;

F. Weather conditions.

J.4.6.1 <u>**General Test Procedure**</u>**.** The following general requirements pertain to all aquifer permeability testing:

A. Use equipment specified in the PSP based on approximations of the properties of interest from previous drilling and testing data.

B. Record the following information as applicable for each test:

1. Type of test (e.g., slug test, specific capacity test);

2. Type of data recorded (e.g., recovery or drawdown);

3. Test well identification;

4. Identification and relative position of observation wells including a diagram;

5. Depth and length of screened or open interval;

6. Diameter of both well casing and boring;

7. Known or estimated thickness of the aquifer;

8. Static water level;

9. Pump placement;

10. Start and completion times of test;

11. Start and completion times of pumping, if applicable;

12. Drawdown versus time measurements;

13. List of equipment used including pumps, hoses, slugs, transducers, data loggers, and water level measurement devices;

14. Weather conditions, including duration and intensity of precipitation;

15. Testing personnel.

C. Maintain complete original test records in the project files and make copies available to hydrogeologists and field representatives who performed the test.

D. Prepare a diagram of equipment used in each aquifer or permeability test (by the responsible hydrogeologist). Indicate the tubing dimensions, depth of water intake, and location of gauges and packers. Include the diagram in the data records of each test.

E. Calibrate gauges, flowmeters, and other instrumentation used and check for proper operation before use.

F. Obtain copies of calibration documentation from the instrument or testing service company. Maintain calibration records consisting of laboratory measurements, and, if performed, onsite zero adjustment and/or calibration. Include these records in the project file.

G. If a weir or an orifice is used to measure flow volumes or rates, check these devices onsite using a vessel of known volume and a stopwatch. Document accuracy before the testing proceeds.

H. Install equipment and demonstrate to the hydrogeologist that it is in proper working order and performing to specifications before the start of each pumping test.

I. All waste materials, including pumped water, must be handled and disposed according to applicable FEMP procedures and PSP.

J. Decontaminate equipment used in boreholes or wells as specified in Appendix K.11 prior to use and between each test site.

J.4.6.2 **Borehole Hydraulic Testing for Aquifer Characteristics**. The following procedures apply to the use of slug tests and pumping tests to determine the hydraulic parameters of aquifers. Generally, the procedures in Appendix J.4.6.1, steps A through J, apply to both slug tests and aquifer pumping tests. If there are variations to the following procedures, they shall be specified in applicable PSPs.

A. **Slug Tests.** Slug tests are a quick and inexpensive method of estimating the hydraulic conductivity or transmissivity near the screened zone of the well.

1. Use the following equipment to conduct a slug test.

NOTE

A number of water level measuring devices may be used for measuring the depth to water in a well. Accurate readings can be obtained with electronic water level indicators or pressure transducers. Avoid water level measurement by the weighted-tape method except when conducting tests of intervals suspected of having a very low K (hydraulic conductivity) value. It may be difficult to obtain enough readings for analysis of the tests if the water level recovers quickly in a short period of time.

a. Water level measuring device;

b. Known volume of slug (solid cylinder or volume of water added or removed) that will fit into the well, borehole, or container to add or remove a known volume of water;

c. Timer accurate to one second or a pressure transducer and data-logger combination;

d. Semilog graph paper and indelible pen or verified slug-test analysis software.

2. Record the following information before beginning the test:

a. Site identification and well or borehole location;

b. Location and elevation of a reference point from which water depth measurements are made;

c. Elevation of groundwater with respect to the designated reference point;

d. Date and time of test;

e. Well depth, screen length, riser pipe radius, well screen radius, radius of gravel pack plus well screen or borehole depth and radius;

f. Thickness of groundwater zone to be tested (if known);

g. Type and volume of slug added or removed;

h. Type of measuring device used;

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i. Names of personnel conducting test;

j. Changes in barometric pressure.

3. Determine the static water level in the well by periodically measuring depth to water for several minutes and taking average of readings.

NOTE

It is important to remove or add the volumes as quickly as possible because the analysis assumes that an instantaneous change in volume is created in the well.

4. Ensure that the length of the slug is less than the height of the water column.

5. Instantaneously introduce or remove a slug of known volume to displace water level.

NOTE

The number of depth/time measurements necessary to complete the test are variable, but it is critical to make as many measurements as early as possible in the test.

6. Assign time zero to the moment of volume addition/subtraction, measure, and record depth to water and time of each reading. Measure depth to the nearest 0.01 foot.

NOTE

The time required for slug test completion is a function of the volume of the slug, hydraulic conductivity of the formation, and the type of well completion. Slug volume shall be large enough that a sufficient number of water level measurements can be made before the water level returns to equilibrium. Length of test may range from less than a minute to several hours.

7. Continue measuring and recording depth/time until the water level returns to equilibrium or, for slowly recovering wells, until a sufficient number of readings have been made to clearly show a trend on a semilog plot of time versus depth.

8. If the FEMP project manager, USEPA, and Ohio Environmental Protection Agency approve the addition of water to the monitoring well, use water from an uncontaminated, tested source. Transport water in a clean, approved container.

9. Decontaminate bailers and measuring devices prior to the test as specified in Appendix K.11.

10. If tests are performed on more than one monitoring well, avoid cross contamination of the wells by using decontamination procedures specified in Appendix K.11.

B. **Aquifer Pumping Test.** Aquifer pumping tests, commonly referred to as pump tests, are used to determine the hydraulic properties of water-bearing zones. Pump tests influence a larger area and provide results that are often more representative of the overall aquifer characteristics than slug tests. Aquifer characteristics that may be obtained from pumping tests include hydraulic conductivity, transmissivity, specific yield for unconfined aquifers, and storage coefficient for confined aquifers.

Equipment, personnel, and time commitments needed for pumping tests are greater than those for slug tests. Constant-rate discharge, variable-rate, and injection tests are types that may be used. Test method and procedures shall be specified in the PSP.

Equipment needed for pumping tests includes the following items:

NOTE

Pumps are commonly of the submersible or turbine type and are sized consistently with expected aquifer conditions. The well should be developed prior to testing.

1. One or more completed observation well hydraulically connected to the pumped test aquifer and completed to specifications for the particular test;

2. Orifice, weir, flow meter, container, or other type of water measuring device to accurately measure and monitor discharge from the pumped well;

3. Pipe to transport pumped water from the pumping well to a holding tank or effluent location;

4. Valve on a discharge pipe to control pumping rate, or a variable speed pump;

5. Outlet valve near the wellhead for water quality sampling;

6. Depth-to-water measuring devices for each observation and pumping well (may include steel tapes, electric sounding probes, Stevens recorders, or pressure transducers);

7. Thermometer and other necessary water quality equipment;

8. Watches capable of reading to the nearest second, stopwatch, or pressure transducers with data loggers;

9. A 3-by-5-cycle log and 5-cycle semilog graph paper, or appropriate verified computer software and the necessary hardware;

10. Indelible pens and forms for recording times and drawdown measurements at each well;

11. Appropriate references and calculator for field determinations;

12. Barometer or recording barograph for tests conducted in confined aquifers.

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C. The following general procedure applies to pumping tests:

1. Prior to the test, monitor water levels in the observation well to measure diurnal fluctuations (the number of wells and the monitoring period shall be specified in PSPs).

2. Record the following information during the test:

   a. Identification number or location of the pumped well and each observation well;

   b. Location and elevation of each well;

   c. Location and elevation of the reference point from which water depth measurements are made and elevation of the ground surface with respect to the reference point;

   d. Weather condition;

   e. Method of measurement;

   f. Date and time of test;

   g. Well depth, pump depth, screen length, well radius, and radius of filter pack plus well screen for each well.

3. Calibrate measuring equipment used for pumping tests before use.

4. Maintain calibration records that consist of laboratory measurements and onsite zero adjustment and/or calibration performed.

5. File copies of calibration documentation with the test records.

6. When a weir or an orifice is used to measure flow rates, check it onsite with a container of measured volume and a stopwatch. Verify the accuracy of the meters before proceeding with the test. Check meters hourly during the test, and document each check.

7. Record changes in barometric pressure during the test, preferably with an onsite barograph, to correct water levels for fluctuations that may occur as a result of changing atmospheric conditions.

8. Measure water levels to provide the data required to meet test requirements. Early in the test, ensure that sufficient personnel are available to collect at least 10 measurements per log cycle (i.e., 1-to-10 and 10-to-100 minutes) at each selected observation well, or install a pressure transducer and data logger at each well to collect the data at the given frequency.

9. Measure the water level recovery after pumping stops to verify results obtained during drawdown portion of the test. Measure recovering water levels in the pumped well and in the observation wells for a period of time immediately following cessation of pumping.

10. Perform monitoring during recovery period as specified in the PSP.

J.4.7 Well Maintenance

Well maintenance is required to ensure the monitoring well is protective of the environment, to ensure the collection of representative samples, and to extend the life of the monitoring well. The project manager shall be notified of the results of the routine inspections if problems are noted.

A. Routine inspections of monitoring wells include the following at a minimum:

1. Inspection of the ground around the monitoring well for depressions or channels that allow surface water to collect or flow towards the well. The surface must be regraded so that water flows away from the well on all sides.

2. Inspection of the integrity of the locking mechanism and well cap. The locking mechanism and/or well cap must be replaced if they have been tampered with or may compromise the security of the well.

3. Inspection of concrete surface seals for settling and cracking. Concrete surface seals must be completely removed and replaced if settling or cracking has occurred.

4. Ensuring the well is visible in high-traffic areas or areas of active remediation. To protect the well from vehicular damage, it may be necessary to install protective posts. Additional protective measures include installing construction fence around well and ensuring vegetative growth is cut, as appropriate.

B. For wells which are sampled routinely, inspections also include the following:

1. Inspection of the well cap to ensure it is free of debris, fits securely and the vent hole is clear. If the well is flush-mounted, ensure that the cap is water tight to prevent surface water from entering the well. Well caps must be replaced as necessary.

2. Measurement of the bottom of the well to determine if sediment is accumulating in the well. The sediment must be removed by either pumping the accumulated sediment from the well or completely redeveloping the well, as appropriate. If defects or damage to well screens or casing are suspected, downhole camera surveys may be conducted to determine the condition of the monitoring well.

3. Evaluation of the turbidity of the sample. Historical field documentation will be reviewed to determine whether the turbidity is increasing with each sampling event. Increasing turbidity measurements may indicate the need for redevelopment of the monitoring well or, if redevelopment is unsuccessful, the well may require plugging and abandoning. As with accumulation of sediment, downhole camera surveys may be necessary to determine the condition of the monitoring well.

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If well maintenance or inspection activities indicate a problem with the well, then the project manager must determine whether the well should be repaired or abandoned in accordance with Section J.4.3.3. If a monitoring well has been damaged beyond repair so that it is no longer protective of the environment, then the well must be plugged and abandoned. If it is determined that the well does not yield representative samples and rehabilitation efforts are not effective in improving the condition of the monitoring well, the monitoring well must be abandoned. Well abandonment and repair shall be performed and documented in compliance with applicable USEPA and OEPA regulations and the SCQ.

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APPENDIX K

SAMPLING METHODS

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K.1 PURPOSE

The purpose of this appendix is to provide methods for sampling activities that result in data that comply with DOE and USEPA requirements and meet Data Quality Objectives (DQOs) for the FEMP.

K.2 SCOPE

Requirements for various sampling programs and projects at the FEMP are provided in this appendix. Additional requirements may be specified in the Project-Specific Plan (PSP) to provide detailed information for applicable sampling programs. All sampling activities must be performed in accordance with the Applicable or Relevant and Appropriate Requirements (ARARs) for each Operable Unit (OU).

K.3 RESPONSIBILITIES

K.3.1 FEMP Project Manager

The FEMP project or program manager is responsible for scoping the project through a DQO and PSP. The project manager is responsible for coordinating all project activities including those involving OEPA and USEPA split sampling and oversight activities. At the project manager's discretion, this responsibility may be delegated to project team leaders directing the day-to-day activities to ensure the most efficient and effective lines of communication are established. The project manager is also responsible for ensuring that all activities are conducted in accordance with the ARARs for the project under his control.

K.3.2 Sampling Team Leader

The sampling team leader is responsible for implementing requirements of the PSP including the following:

A. Ensure that team members follow specified procedures;

B. Ensure that work is completed in a safe and efficient manner;

C. Ensure that documentation is maintained and completed as specified in this document and procedures specified in the PSP;

D. Ensure communication with the FEMP project manager or designee concerning progress.

K.3.3 Sampling Team Members

Members of the sampling team are responsible for performing sampling activities under the supervision of the team leader and as specified in PSPs. They shall observe health and safety requirements, ensuring that work is completed in a safe and efficient manner, and communicate information on progress and concerns to the team leader.

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K.4 AQUEOUS SAMPLE COLLECTION METHOD

Piezometers at FEMP are often used as monitoring wells; therefore, for the purposes of this document both piezometers and monitoring wells shall be referred to as monitoring wells.

Aqueous samples include natural and waste waters. For the purpose of this document groundwater and surface water are defined as natural waters. Water collected after use or in storm sewers will be treated as wastewater. Relating more specifically to the FEMP, wastewater is any water found in the former production area that has not been previously classified. Therefore, wastewater would include water in pipes, sumps, containers, process equipment, water standing anywhere in buildings or on the ground in the process area, etc.

K.4.1 Field Analytical Method for Natural Water Samples

Temperature, pH, and specific conductance shall be measured in the field and documented on groundwater and surface water sample collection forms. Measurements shall be performed on unpreserved samples. Surface water measurements may be collected directly from the surface water body. Groundwater field measurements may also be taken *in situ* (downhole) to avoid changes that might occur if the sample is removed from the well. Dissolved oxygen, turbidity, and redox potential are also commonly performed field measurements.

K.4.1.1 Temperature. Surface water and groundwater temperature are required to normalize data from other analytical determinations such as pH, specific conductance, alkalinity, and dissolved oxygen. Temperature can also be used as an effective tracer for determining recharge and mixing relationships.

At a minimum, a standard thermometer or combination meter equipped with a temperature sensor, accurate to ±0.5°C, or a metal-cased, direct-reading thermocouple with a normal range of 0-50°C accurate to ±0.5°C is required.

Requirements for measuring temperature of water samples follow:

A. Collect water for field measurement in a sample container (insulated, as required for determining recharge and mixing relationships).

B. Clean the probe end with deionized water and immerse it in the field sample.

C. Suspend the thermometer or probe away from the sides and bottom of the container.

D. Allow the thermometer or probe adequate response time based on the manufacturer's recommendation.

E. Document the readings for each field sample.

K.4.1.2 pH.

A. The following apparatus is required for pH measurements:

1. Standard pH meter or a combination meter that is direct-reading and temperature-compensating with an expanded scale capable of measuring pH to the nearest 0.10 standard unit;

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2. Combination electrode;

3. Standard buffer solutions: pH 7.0, pH 10.0, and pH 4.0.

B. The requirements for measuring the pH of water follow:

1. Calibrate pH meter or combination meter in accordance with manufacturer instructions. Meter shall be accurate to within 0.1 pH unit over a temperature range of 0° to +40°C, and response time of the instrument shall not be greater than two minutes.

2. Ensure that the sensor is filled with manufacturer-specified solution (usually potassium chloride).

3. Rinse sensor with deionized water.

4. If meter does not automatically correct for temperature, make correction in accordance with manufacturer instructions.

5. Record date of buffer expiration.

6. Verify pH meter calibration following arrival at the sampling site with pH 7.0, pH 4.0, or pH 10.0 buffer, depending on expected pH range of the sample (Appendix I). Calibrate combination meters with standard solution following arrival at the sampling site.

7. Recalibrate meters as necessary to ensure accurate operation.

8. Transfer sample into an appropriate container, or use an *in situ* or flow-through sampling system.

9. Ensure that sensor is properly attached to pH meter and that the electrode is exposed to sample solution.

10. Insert sensor into the sample solution and allow it to remain in the sample solution until stabilized. Gently stir sample if a flow-through chamber is not used.

11. Record the pH value to nearest 0.1 unit.

12. Rinse sensors with deionized water between each measurement and do not allow the bulb to dry out between measurements.

13. Store pH meter/sensor according to manufacturer's instructions.

K.4.1.3 **Specific Conductance**. Because specific conductance is sensitive to a number of variables, the measurement shall be made in the field, either *in situ* (e.g., directly in a well or stream) or as soon as possible after sample collection.

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A. The following are required:

1. Conductivity cell or probe;

2. Temperature-compensating conductivity meter or combination meter;

3. Two known standards bracketing the expected conductivity of the sample solution to be measured.

B. Determine the specific conductivity of sample as follows:

1. Calibrate the measuring system (Appendix I). The instrument shall be accurate to within three percent of full scale over a temperature range of 0° to +40°C and a response time less than two minutes.

2. Switch on instrument for a power check. Replace battery when red line adjustment cannot be accomplished or when the meter indicates a low battery.

3. Calibrate to a known standard in accordance with manufacturer instructions. Verify calibration prior to measuring the first sample of a sampling event per manufacturer's instructions. Recalibrate instrument as necessary.

4. Rinse probe twice with deionized water.

5. Insert probe into sample in accordance with manufacturer instructions.

6. Measure temperature of sample with thermometer or thermocouple (Appendix K.4.1.1) if the conductivity cell or probe does not automatically compensate for temperature and record the value.

7. Switch meter to appropriate scale and record readings in millisiemens per centimeter.

8. If necessary, correct specific conductance values for temperature using appropriate temperature correction factors to 25°C.

9. Rinse probe twice with deionized water between each measurement.

10. Store specific conductance probes in accordance with manufacturer instructions between use.

K.4.1.4 **Dissolved Oxygen**. The dissolved oxygen concentration affects redox potential of water and chemical behavior of aqueous constituents. Physical, chemical, and biochemical activities in water may affect dissolved oxygen levels. Measurement of dissolved oxygen is useful in tracking contaminant plumes, determining surface water/groundwater interaction, and locating contaminant source areas.

Dissolved oxygen is normally measured in the field by immersing a membrane electrode in the water. Oxygen gas molecules diffuse through the membrane into a measuring cell at a rate

proportional to concentration of molecular oxygen in the water. Inside the sensor, oxygen reacts with an electrolyte and is reduced spontaneously or by an applied voltage, depending on the instrument. Current that is generated is directly proportional to concentration of molecular oxygen in the water outside the sensor.

A. The following are required to measure dissolved oxygen:

NOTE

In situ measurements or the use of a flow box is recommended for the accurate determination of dissolved oxygen in groundwater.

1. Direct-reading, temperature-compensating, battery operated dissolved oxygen meter or combination meter with a dissolved oxygen probe;

2. Oxygen-sensitive membrane electrode (polarographic or galvanic), which usually includes two solid metal electrodes separated from the test solution by a selective membrane (commonly polyethylene or fluorocarbon);

3. Replacement electrode;

4. Deionized water for calibration and instrument cleaning.

B. Determine the dissolved oxygen concentration of water sample as follows:

1. Calibrate the instrument as specified in the manufacturer's instructions (Appendix I.4.3). The instrument shall be capable of responding within 0.1 milligrams per liter (mg/L) over water temperature range of 0° to +40°C.

2. Measure the temperature when the dissolved oxygen is measured (see Appendix K.4.1.1).

3. Rinse the probe twice with deionized water.

4. Insert the probe into the sample and allow sufficient sample flow across the membrane surface to overcome erratic responses of the instrument.

5. Record readings from the meter.

6. Calibrate the sensor between each sampling location.

7. Rinse the probe twice with deionized water between each measurement.

8. Store the probe in potable water.

K.4.1.5 **Redox Potential**. A chemical reaction in which an element undergoes a loss or a gain of electrons is referred to as oxidation or reduction, respectively. Redox (Eh) is a measure of aqueous electron concentration and is controlled by reactions involving elements present in more than one oxidation state. Chemical behavior and mobility of many aqueous constituents

are influenced by the redox potential of surface and groundwater. Physical, chemical, and biochemical processes in water also affect Eh.

For groundwater, Eh is measured *in-situ* or using a flow box or similar device that prevents atmospheric contamination of the water sample. Reference solutions with known Eh are used to standardize and check accuracy of the electrode system. Preparation of reference solutions shall be documented when prepared.

The procedure for measuring the redox of water follows.

1. Calibrate redox meter or combination meter in accordance with manufacturer instructions. Meter shall be accurate within 20 mV over a temperature range of 0° to 50° C, and response time of the meter shall not be greater than two minutes.

2. Rinse sensor with deionized water.

3. Calibrate redox meter or combination meter in accordance with manufacturer instructions.

4. If meter does not automatically compensate for temperature, make correction in accordance with manufacturer instructions.

5. Ensure sensor and connections are attached.

6. Place probe in sample, allow reading to stabilize approximately five minutes.

7. Read redox value on meter.

8. Rinse sensor with deionized water between each collection of measurements.

K.4.1.6 Turbidity

Because turbidity is sensitive to a number of variables, the measurement shall be made in the field, either *in situ* (e.g., directly in a well or stream) or as soon as possible after sample collection.

A. The following are required:

1. Turbidity cell or probe;

2. Turbidity meter or combination meter;

3. Two known standards bracketing the expected turbidity of the sample solution to be measured.

B. Determine the turbidity of sample as follows:

1. Calibrate the measuring system (see Appendix I.4.5).

2. Switch on instrument for a power check. Replace battery when the meter indicates a low battery.

3. Calibrate to a known standard in accordance with manufacturer instructions. Verify calibration prior to measuring the first sample of a sample event per manufacturer's instructions. Recalibrate instrument as necessary.

4. Rinse probe twice with deionized water.

5. Insert probe into sample in accordance with manufacturer instructions.

6. Record readings in Nephelometric Turbidity Units (NTUs).

7. Rinse probe twice with deionized water between each measurement.

K.4.2 Groundwater Sampling

Groundwater sampling is currently conducted at FEMP for the following:

A. Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA);

B. Resource Conservation and Recovery Act (RCRA);

C. Radiological Environmental Monitoring;

D. Safe Drinking Water Act.

All groundwater sampling must comply with the requirements of the OU5 ARARs.

K.4.2.1 **Water Level Measurements**. Groundwater elevation data are used to monitor aquifer storage, estimate rate and direction of groundwater movement, define recharge/ discharge relationships relative to surrounding features, estimate base flow to streams, and calculate the volume of water in a borehole or well. Groundwater levels are measured at offsite private wells, at onsite and offsite FEMP monitoring wells, and in temporary well points. The following are requirements for collecting water level data from wells including water level measurements prior to sampling.

A. Groundwater level in private wells shall be measured as follows.

1. Obtain permission from owner prior to arrival on site.

2. Obtain well construction information from owner if not previously obtained. Specifically request information on well depth, materials, age, screened interval, method of installation, and installer. If information is not available, document that fact.

3. Upon arrival at the well, check for visible physical damage. Scan area around well for unusual materials or circumstances (e.g., recently discarded trash, old oil cans, animal burrow). Record observations on daily log.

4. Remove the well cap or cover from access hole.

5. Check the water level measuring instrument for proper operation. Lower measurement probe until water is reached.

6. Raise the probe above the water level, shake it slightly, then lower it again and recheck. If measurements do not agree to within 0.02 feet, repeat the measurement until the cause of discrepancy has been determined and agreement of measurements to within ±0.02 feet has been obtained. Document unresolved discrepancies.

7. Record the depth to water to 0.01 feet from the measure point (e.g., top of well casing, top of protective casing, top of sanitary seal). Record measuring point on water level measurement form. Record the time of measurement to the minute using military 2400 hour format.

8. Record the value and time of all measurements.

9. Replace the well cover.

10. Decontaminate the water level measurement probe between each well as specified in Appendix K.11.

B. Water level of FEMP monitoring wells shall be measured as follows.

1. For offsite wells, notify the owner before arrival as required by the agreement established between the FEMP and the landowner.

2. Upon arrival at the site, check the well for physical damage, unusual materials, or circumstances (e.g., recently discarded trash, old oil cans, signs of animal burrowing). Record observations in the daily log.

NOTE

The FEMP has identified certain onsite and offsite wells where preliminary monitoring for volatile gases around the well cap is required. These sites shall be identified in PSPs.

3. Remove the lock from the monitoring well and remove the well cap. Perform the required PID measurements.

4. Check water level measuring instrument for proper operation. Lower measurement probe until water is reached.

5. Raise probe above water level and shake it slightly, then lower it again, and recheck. If measurements do not agree to within 0.02 feet, continue to remeasure until cause of discrepancy has been determined or agreement of measurements has been obtained. Document unresolved discrepancies.

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6. Record depth to water to 0.01 feet from measuring point, (e.g., top of well casing, top of protective casing, top of sanitary seal). Record measuring point on water level measurement form. Record time of measurement to the minute using 2400 hour format.

7. Replace well cover and lock protective lid.

8. Decontaminate water level measurement probe between each well as specified in Appendix K.11.

C. Water levels of temporary well points shall be measured as follows:

1. For offsite temporary well points, notify the owner before arrival as required by the agreement established between the FEMP and the landowner.

2. Upon arrival at the site, check the temporary well for physical damage or unusual materials and circumstances. Record the observations in the daily log.

3. Remove the well cap and perform PID measurements if required.

4. Check the water level measuring instrument for proper operation. Lower the measurement probe until water is reached.

5. Raise probe above water level and shake it slightly then lower it again, and recheck. If measurements do not agree to within 0.08 feet, continue to remeasure until cause of discrepancy has been determined or agreement of measurements has been obtained. Document unresolved discrepancies.

6. Record the depth to water to 0.10 feet (nearest inch) from the ground surface. Record measurement on the Field Activity Log or the water level measurement form. Record time of measurement to the minute using 2400 hour format.

7. Replace the cap on the temporary well point.

8. Decontaminate water level measurement probe between each well as specified in the PSP or Appendix K.11.

K.4.2.2 **General Groundwater Sampling Requirements**. The primary technical consideration in groundwater sampling is to obtain a representative sample of the groundwater body at the well location. Additionally, groundwater sampling at the FEMP shall meet certain requirements in order for subsequent data to be used for the CERCLA program. To ensure that these objectives are achieved, the following minimum requirements must be met during sample collection. Additional requirements may be included in PSPs. Groundwater purging and sampling requirements for temporary well points installed using direct-push technology shall be specified in the PSP and/or reference applicable sections of this SCQ.

A. To ensure that these objectives are achieved, the following minimum guidelines and techniques are required during sample collection:

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1. Upon arrival at well site, determine whether the lock is secure. Inspect well for signs of tampering or forced entry. Check the surrounding area for unusual occurrences such as recently disposed trash or animal burrows. Record observations on daily log.

2. Set up sampling vehicle and equipment to avoid interference with sampling activity.

3. If the potential for surface contamination exists, place plastic sheeting on the ground to avoid contamination of equipment.

4. Ensure sample temperatures do not change rapidly from collection to preservation to avoid affecting chemical reaction rates, reversing cationic and anionic exchanges in solids, and altering microbial growth. Temperature changes should be avoided by preserving analytes immediately following sample collection (i.e., chemical and temperature preservation) and protecting samples from temperature extremes.

5. Ensure volatilization and degassing are minimized during sample collection. Avoidance of volatilization and degassing can be minimized by using dedicated pumps or bladder pumps, and ensuring samples are collected to minimize turbulence.

6. Minimize the effects on organic samples of photo degradation and cross-contamination of airborne organic contaminants by ensuring that samples are collected immediately into amber bottles, as required in Table 6-1 and that all sources of airborne organic contaminants (e.g., vehicle exhaust, etc.) are removed from the area.

7. Eliminate cross-contamination by ensuring all equipment coming into contact with the samples is properly decontaminated, samples are collected from least contaminated areas to most contaminated areas, dedicated equipment is used where feasible, and equipment and materials coming into contact with the sample is minimized.

8. Complete a sample collection form for each sample with information specified in Appendix K.9 plus the following data.

    a. Description of water level measuring point;

    b. Depth to water;

    c. Measured depth of well;

    d. Depth of well from well construction diagram;

    e. Well casing diameter from well installation records;

    f. Calculated well volume;

g. Actual volume removed during purging and maximum rate of purge;

h. Estimated depth (sample depth) to pump intake at start and finish of pumping.

9. If cleaning solvents or internal combustion engines are used at a site when a well is open, place them downwind of the well or far enough away that fumes are diluted beyond the detection limit of a calibrated Photo-Ionization Detector (PID) or Flame-Ionization Detector (FID). Locate the sampling vehicle downwind of the well.

10. Measure depth to groundwater in the well as specified in Appendix K.4.2.1. Measure total depth of monitoring well to the nearest 0.01 foot and compare it to well installation records. If dedicated equipment is present in the monitoring well, then total depth of the monitoring well cannot be measured.

11. Compare total depth measurement to depth indicated by well installation records to determine if silting into the screened portion of the well has occurred. If discrepancies are identified or silting has occurred, immediately refer the matter to the FEMP project manager for resolution. Document the resolution.

12. Two methods for purging monitoring wells exist. The first is a standard purging method which involves the evacuation of multiple well volumes of water from the well casing and screen. Standard purge is used when the well is not equipped with dedicated equipment and when recharge rates are such that drawdown is excessive when pumping at low rates. Standard purge is normally used in Type 1 and Type 2 monitoring wells at the FEMP.

    The second method is micro-purge, which involves the evacuation of stagnant water from the dedicated pump and discharge line. Micro-purge is used in wells where recharge rates allow minimal drawdown when pumping at low rates and where dedicated equipment is installed in the monitoring well.

    a. Standard purge requires the evacuation of at least three times the amount of water in the well casing and screen with a pump or bailer.

    b. Micro-purge requires the evacuation of a precalculated purge volume, which is two times the volume of water contained in the dedicated pump and discharge line. Note that the flow rate must not produce drawdown in the well, since this would produce mixing of the stagnant water column with the water in the screened interval.

13. Upon purge completion:

    a. For Standard Purge (removal of standard three volumes), take sets of pH, temperature, dissolved oxygen, turbidity, and specific conductance measurements until the results between measurements are consistent, then proceed with sample collection. See K.4.2.3 for sample collection requirements.

b. For Micro-purge (removal of a calculated micro-purge volume), take one set of pH, temperature, dissolved oxygen, turbidity, and specific conductance measurements as an indicator of *in situ* conditions prior to sample collection. See K.4.2.3 for sample collection requirements.

14. For Standard Purge, if, after three well volumes have been removed, the chemical parameters have not stabilized according to the above criteria, additional well volumes may be removed. If the parameters have not stabilized within five volumes, it is at the discretion of the project manager whether or not to collect a sample or to continue purging. The conditions of sampling should be noted in the field log.

NOTE

A well in a perched water zone is generally considered dry or having potential well bore damage if it does not recover sufficiently within 24-48 hours after development begins or if it does not yield a complete sample within 24 hours after purging. Due to relatively lower permeability of, or water supply in, perched water intervals of the overlying till, full development may require several days or longer.

15. Do not take samples from wells that do not recover sufficiently. Document well condition on field log. If a well which has previously produced sufficient purge and sample quantities does not recover sufficiently, evaluate the well for potential problems which may affect the integrity of the sample (e.g., well screen blocked by bacteria).

16. Evacuate the monitoring well if it can be pumped or bailed dry and allow it to recover prior to sample collection. The evacuation rate shall be low enough to prevent excessive agitation of recharge water based on hydraulic characteristics of the well. Avoid excessive pumping that can cause samples to be nonrepresentative.

17. If the standard purge method is used on a monitoring well prior to sample collection, lower the pump intake to a depth of five to ten feet below the water level in the casing but above the well screen where possible. Initially, purge well from this depth so that fresh water from the screened interval will move upward through the casing and completely flush the well. Ensure that the pumping rate is low enough to prevent significant agitation and that it is less than the maximum pumping rate used during monitoring well development.

18. If pumping of air (caused by excessive drawdown of the well water level) occurs, reduce the pumping rate. If it continues, lower the pump intake five to ten feet within the well if possible and reduce the pumping rate further to prevent excessive drawdown.

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19. If equipment is removed from the well, then place the equipment on a plastic sheet to avoid equipment contamination.

CAUTION

Do not allow an unauthorized release of any evacuated water to the environment.

20. Collect water produced during evacuation of monitoring wells in appropriate containers.

21. Collect excess water generated during sampling of monitoring wells in appropriate containers.

22. Retain evacuated water (if free of constituents classified as RCRA hazardous waste based on past sampling data) in appropriate containers until disposal into the designated FEMP general sump.

23. Store water that has unknown constituents and is potentially a hazardous waste in a designated area until classification is determined (based on an analysis of the water for Toxicity Characteristic Leaching Procedure (TCLP) parameters) and a disposal method chosen. The disposal method shall be per established FEMP procedures. Observe RCRA requirements for duration of storage.

24. As soon as the well recovers sufficiently to permit sampling (i.e., volume of water contained in the well is equal to or greater than the volume of water required for the analytical suite), collect samples in accordance with the stability and volatility of parameters to be tested in the following order:

    a. Water quality sample for determination of field measurements;

    b. Volatile organic compounds;

    c. Total organic halogens;

    d. Total organic carbon;

    e. Extractable organic compounds (semivolatiles, pesticides, PCBs);

    f. Unfiltered metals;

    g. Filtered metals;

    h. Phenols;

    I. Cyanide;

    j. Sulfide;

    k. pH (laboratory analysis);

l. Specific conductance (laboratory analysis);

m. Alkalinity, bicarbonate, carbonate;

n. Total dissolved solids, total solids, total suspended solids, and/or fluoride;

o. Sulfate and chloride;

p. Nitrogen compounds (ammonia, nitrate-nitrite, total Kjeldahl nitrogen, total organic nitrogen, nitrate, and/or nitrite);

q. Phosphorus (all forms, excluding elemental);

r. Unfiltered radionuclides;

s. Filtered radionuclides.

25. If the well is purged with a submersible pump, collect samples specified in the PSP from pump discharge prior to removing pump from well and before collection of bailed samples. This prevents handling the pump twice and eliminates the need for pump decontamination between well evacuation and sample collection.

26. Use the pump discharge to evacuate and sample wells with limited access and dedicated pumps. Data from such wells may be qualified for certain purposes.

27. Decontaminate pump, lines, and other equipment used in groundwater sampling between wells following requirements in Appendix K.11.

28. Take field measurements at well site on unpreserved samples as described in Appendix K.4.1.

29. Collect samples for specific parameters as specified in Appendix K.4.2.3.

30. Filter samples at well site.

31. Number and label samples as specified in Section 7.

32. Store and preserve samples as specified in Table 6-1 (Appendix A).

33. Complete Chain of Custody/Request For Analysis Record (COC) (Form 7-1, Appendix B) as specified in Section 7.

K.4.2.3 **Parameter-Specific Sampling Procedures.** Perform groundwater sample collection from monitoring wells for volatile organic compounds (VOCs), semivolatile organic compounds, filtered and unfiltered metals, general chemistry, and radiological parameters in accordance with the following requirements:

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NOTE

In cases where grout degradation or contamination is suspected, monitoring data will be evaluated to identify indicators such as elevated pH, sodium, calcium, aluminum and other cations. In addition, FEMP personnel may evaluate and use, where appropriate, methods such as X-ray diffraction and X-ray fluorescence to determine grout degradation or contamination.

K.4.2.3.1 **Volatile Organic Compounds**. Collect VOC samples as follows.

A. Collect samples for VOC analyses using a stainless steel or teflon bailer or stainless steel and/or teflon bladder pump operated at 0.2 liter per minute or less.

B. Perform sample collection in a manner to minimize turbulence and volatilization of VOCs.

C. Collect samples in 40-mL screw cap vials with Teflon-lined septa which have been prepared with preservative as specified in Table 6-1 (Appendix A). Fill sample vials until a meniscus is present above the rim of the vial and seal without air bubbles. Avoid excessive overfilling of prepreserved vials.

D. Visually check each vial for air bubbles by inverting and sharply tapping it against the hand. If air bubbles are present, top off sample bottle and recheck it for air bubbles. When no air bubbles are present, place sample in a cooler to obtain a temperature of 4°C, ±2°C.

E. Complete appropriate field documentation in accordance with Appendix K.9 or as specified in the PSP.

F. Pack samples for shipping as specified in Appendix K.10, ensuring that all chain of custody requirements are met.

K.4.2.3.2 **Semivolatile Compounds and Pesticides/PCBs**. Collect semivolatile compound samples as follows:

A. Collect samples for semivolatile analysis with a stainless steel or teflon bailer or a stainless steel and/or teflon bladder pump or submersible pump.

B. Because some semivolatiles are susceptible to photo degradation, use amber glass sample bottles with teflon-lined caps as specified in Table 6-1 (Appendix A). Fill the bottles to the neck and seal.

C. Complete appropriate field documentation in accordance with Appendix K.9 or as specified in the PSP.

D. Preserve samples in the field in accordance with Table 6-1 (Appendix A). Verify pH using pH paper by dropping drops from sample container or sample container lid onto pH paper. Do not immerse pH paper in the sample. If sample requires pH adjustment, add appropriate preservative drop by drop to achieve desired pH value.

E. Pack samples for shipment as specified in Appendix K.10, ensuring that all chain of custody requirements are met.

K.4.2.3.3 **Unfiltered Metals**. Prepare unfiltered (total) metal samples as follows:

A. Collect samples for unfiltered metals using a peristaltic pump, stainless steel or teflon bailer, and stainless steel and/or teflon bladder pump or submersible pump. If specified in PSP, collect samples through discharge of submersible pump used to purge monitoring well.

B. Fill polyethylene sample bottles to neck and seal.

C. If sample requires pH adjustment (see Appendix A, Table 6-1) and pH is not within specified range, add appropriate preservative drop by drop to achieve desired pH value. Do not immerse pH paper in the sample.

NOTE

Preparation of containers shall be performed in controlled conditions (fume hood) with approximately 1.5 mL concentrated nitric acid per 1000 mL of sample. Do not immerse pH paper in sample container.

D. Tape pH paper to sample container.

E. Complete appropriate field documentation in accordance with Appendix K.9 or as specified in the PSP.

F. Preserve samples in the field by placing them in a cooler to obtain a temperature of 4°C, ±2°C as specified in Table 6-1 (Appendix A).

G. Pack samples as specified in Appendix K.10, ensuring that all chain of custody requirements are met.

K.4.2.3.4 **Filtered Metals**. Prepare filtered metals samples as follows:

A. Collect samples for filtered metals using a peristaltic pump, stainless steel or teflon bailer, stainless steel and/or teflon bladder pump, or submersible pump. If specified in the PSP, collect samples through discharge of a submersible pump used to purge monitoring well.

NOTE

In-line filters that attach directly to pump or bailer discharges are preferred. If not available, use a Millipore filtration apparatus, or equivalent, equipped with a hand or electrical vacuum pump.

B. Use 0.45-micron filters to prepare filtered metals water samples.

C. Conduct filtering at well site, and record on field documentation forms the method used including use of prefilters.

D. Clean or rinse filtering apparatus as specified in Appendix K.11.

E. Discard the first 50 mL of filtrate from each sample to rinse the filter and filtration apparatus of contaminating substances.

NOTE

In-line, multiple stage filters are preferred, but a Millipore or equivalent system may be used. Pore size of prefilters shall be based on lithology of the adjacent formation and amount of sediment in the water. Initial pore size shall be 1.0 micron with a doubling of size for each additional larger filter needed.

F. If water is extremely turbid, use one or more sets of prefilters as necessary. If it is still not possible to filter the sample through a 0.45 micron filter, do not collect the filtered metals sample.

G. Record whether sample is collected and identify prefilters used in sampling log.

H. See K.4.2.3.3 for sample preservation, field documentation, and packaging requirements.

K.4.2.3.5 <u>General Chemistry Parameters</u>. Prepare samples for general chemistry parameters (i.e., major cations and anions and physical parameters) as follows:

A. Collect samples for general chemistry parameters using a peristaltic pump, stainless steel or teflon bailer, stainless steel and/or teflon bladder pump or submersible pump, and, if specified in PSP or procedures, through the discharge of a submersible pump to purge the monitoring well.

B. Fill appropriate sample bottles to the neck and seal.

C. Preserve samples in accordance with Table 6-1 (Appendix A). If sample requires pH adjustment and pH is not within specified range, add appropriate preservative drop by drop to achieve desired pH value. Do not immerse pH paper in the sample.

D. If pH is not within the specified range, add appropriate preservative drop by drop to achieve desired pH value.

E. Complete specified field documentation in accordance with Appendix K.9 or as specified in the PSP.

F. Pack samples for shipping as specified in Appendix K.10, ensuring that all chain of custody requirements are met.

K.4.2.3.6 <u>Radionuclides</u>. Prepare samples for general radionuclides as follows:

A. Collect samples for radionuclides using a peristaltic pump, stainless steel or teflon bailer, stainless steel and/or teflon bladder pump or submersible pump. If specified in the PSP,

collect samples from the discharge of a submersible pump used to purge the monitoring well.

B. Flush sample lines and equipment with sample medium to minimize radionuclide adsorption effects.

C. Use sample containers made of Teflon, polyethylene, or polyvinyl chloride (PVC) as specified in Table 6-1 (Appendix A) to minimize radionuclide losses by adsorption unless tritium is a parameter of interest. If so, use a glass container with a tritium seal cap.

NOTE

Avoid collection of suspended sediments when possible.

D. To collect filtered radionuclides, filter water samples in the field through a 0.45-micron in-line membrane filter as soon as possible after collection (Stolzenburg and Nichols, 1986).

E. If in-line filtration is not available, use containers without preservative to initially collect samples prior to filtration, then transfer samples to containers and preserve them after filtration has been performed.

F. Do not filter samples collected for unfiltered radionuclide analysis.

G. Tightly secure sample container lids.

H. Complete specified field documentation in accordance with Appendix K.9 or a specified in the PSP.

I. Preserve samples in accordance with Table 6-1 (Appendix A). If sample requires pH adjustment and pH is not within specified range, add appropriate preservative drop by drop to achieve desired pH value. Do not immerse pH paper in the sample.

J. Pack samples for shipping as specified in Appendix K.10, ensuring that all chain of custody requirements are met.

K.4.2.4 **Dedicated Equipment**. Use of dedicated groundwater sampling equipment is encouraged. Types of equipment that may be dedicated to a sampling location include, but are not limited to, the following:

A. Bladder-type sampling pumps;

B. Submersible impeller-type purge pumps;

C. Submersible piston-type purge pumps;

D. Packers;

E. Hoses;

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F. Water level measurement equipment.

G. The following procedures apply when installing, maintaining, and using dedicated sampling equipment.

NOTE

Equipment that requires special handling, shall be installed and maintained only by manufacturer-trained personnel.

1. Dedicated sampling equipment is not to be removed from the well except when maintenance is to be performed on either the sampling equipment or the well. Store the designated sampling equipment, such as bailers, in the well casing between uses or pull it from the well and store it in a designated storage structure. If stored outside the well, identify the equipment by the number of its designated well.

2. Decontaminate equipment removed from a well as specified in Appendix K.11 prior to reinstallation.

NOTE

Maintenance may include decontamination to remove mineral precipitation or biological growths.

3. Perform maintenance as specified by the manufacturer or, if specifications are not available, on a set schedule based on past usage or when performance is declining.

K.4.2.5 <u>Sampling Groundwater from Private and Other Production Wells</u>. Private water wells and other production wells near the FEMP may be sampled as part of FEMP programs. Property owner approval shall be obtained and notification made before sampling a private well. Requirements of individual property owner license agreements shall be reviewed prior to each sampling round and complied with during sampling. Sampling shall be conducted only at the time agreed to by the owner. If additional visits to the site are necessary, the property owner shall be notified before each visit or arrangements shall be made for continuing access. Communications with the property owner shall be documented either in a daily log or a telephone conversation log.

Procedures for collecting water samples from private or other production wells shall be identified in PSPs. Minimum elements of these procedures shall be as follows:

A. If the location of the well has not previously been described, record in the field book or daily log form the location of well relative to nearby buildings, drainage features, cultivated areas, equipment storage areas, leach fields and septic tanks, and other pertinent features.

B. Record any unusual conditions in the field book or daily log form.

C. If the following information is not documented, acquire available well construction information from the owner, including driller; date drilled and installed; total depth;

depth to water; casing type, diameter, and length; pump age, type, and size; description of plumbing and electrical equipment; types of treatment systems; and location.

D. Determine whether well is the primary source of water for the household, and document approximate volume of use.

NOTE

Amount of flushing required depends on frequency of well use. One minute of flushing at full capacity is the minimum required.

E. Flush system before collecting sample to remove stagnant water from lines and wellbore.

F. Use sample containers and preservatives specified in Table 6-1 (Appendix A), and collect samples as near to the wellhead as possible upgradient from treatment units.

G. Decontaminate equipment as specified in Appendix K.11.

H. Maintain chain of custody documentation as specified in Section 7.

K.4.3 Surface Water Sampling

Surface water sampling is currently being conducted at FEMP in accordance with National Pollutant Discharge Elimination System (NPDES) requirements and as part of routine monitoring of Paddys Run and the Great Miami River in accordance with the FEMP Integrated Environmental Monitoring Plan required by DOE 5400.1. Samples have also been collected in support of RI/FS and remedial design. Two different techniques are used for collecting surface water samples: grab sampling and composite sampling. The following requirements are applicable to collection of water samples from streams, ponds, lakes, rivers, springs, and seeps.

K.4.3.1 Grab Sampling.

For grab sampling, proceed as follows:

A. Use clean sample containers and appropriate preservatives approved for specific parameters as specified in Table 6-1 (Appendix A).

B. Choose a point of sampling so that a representative sample is obtained.

C. Collect stream samples beginning at the farthest downstream location and work upstream to prevent contamination during sample collection. Avoid surface debris and artificial turbulence during sample collection.

NOTE

Sampling depth shall be approximately 15 centimeters (6 inches) below water surface if possible. When sampling from a bridge, platform, or boat, it may be necessary to use a bailer or a peristaltic pump to collect sample.

D. Use unpreserved containers (grab bottle, ladle, teflon bailer) to collect samples directly from a body of water where water depth is sufficient and access conditions permit. If depth is not sufficient, use a teflon or stainless steel beaker, ladle, scoop, or bailer.

E. Use a peristaltic pump or Kemerer sampler to collect nonvolatile samples.

F. Grasp grab bottle securely at the base with one hand and plunge it mouth down into the water, avoiding surface debris. For rivers and streams, position bottle opening towards the current flow and away from the collector's hand, the shore, or the side of the sampling platform or boat. Tip bottle slightly upwards to allow air to exit and the bottle to fill. Collect a sufficient amount of sample to perform required analyses.

G. Fill sample bottles as specified per parameter in Appendix K.4.3. If a sample bottle is used for collection, cap bottle prior to removal from water. The grab bottle and the sample bottle shall be of the same materials or approved equivalent.

H. After removal of grab bottle from water, transfer sample to the container with preservative or add preservative to the sample container.

I. When more than one grab bottle volume of sample is required to fill necessary sample containers, distribute sample portions equally among individual sample containers to provide homogeneity of collected sample.

J. Perform field measurements as specified in Appendices K.4.1 or filter unpreserved samples immediately after collection. If a peristaltic pump is used to collect samples, use an in-line filter (preferred by Stolzenburg and Nichols, 1986).

K. Complete specified field documentation.

L. Preserve samples as specified in Table 6-1 (Appendix A).

M. Pack samples for shipping as specified in Appendix K.10.

K.4.3.2 **Composite Sampling**. Composite samples may be collected with automatic sampling equipment, or may be collected manually as grab samples (Appendix K.4.3.1) and composited. Procedures for collection of composite samples shall be included in PSPs. Samples for unstable parameters, such as VOCs or TOX shall not be composited.

K.4.3.3 **Parameter-Specific Sampling Procedures**. Perform surface water sample collection for VOCs, SVOCs, filtered and unfiltered metals, general chemistry parameters, and radiological parameters in accordance with the following requirements.

K.4.3.3.1 Volatile Organic Compounds.

A. If possible, collect samples for VOC analysis directly into prepreserved containers as specified in Table 6-1 (Appendix A) or use stainless steel, teflon, or glass scoops, ladles, buckets, or bailers if circumstances require.

B. If conditions do not permit the efficient collection of the surface water sample directly into the prepreserved sample container, collect the sample in a stainless steel, teflon, or glass device and transfer the sample directly to the prepreserved container in a manner to minimize turbulence and volatilization of the VOCs.

C. Fill sample vials with a visually apparent meniscus present above the rim of the vial and seal without air bubbles. Avoid excessive overfilling of prepreserved vials.

D. Visually check each vial for air bubbles by inverting and sharply tapping it against the hand. If air bubbles are present, top off the sample vial and recheck it for air bubbles. When no air bubbles are present, place sample in a cooler to obtain a temperature of 4°C, ±2°C.

E. Complete the appropriate field documentation in accordance with Appendix K.9, or as specified in the PSP.

F. Store and/or pack samples for shipping as specified in Section K.10, ensuring that all chain of custody requirements are met.

K.4.3.3.2 Semivolatile Organic Compounds.

A. Collect samples directly into amber glass containers as specified in Table 6-1 (Appendix A). Cap the bottle while still submerged, remove it from the water body, pour out water in the bottle neck, and recap.

B. If the sample cannot be collected directly into the bottle, use a stainless steel, teflon, or glass scoop, ladle, bucket, or bailer to collect the sample. Fill the sample container as specified in step B for semivolatile organic compounds, Appendix K.2.3.2.

C. Follow steps C through E for semivolatile organic compounds, Appendix K.2.3.2.

K.4.3.3.3 Unfiltered Metals.

A. Collect samples for unfiltered metals into an unpreserved container. Pour the sample into a preserved container as specified in Table 6-1 (Appendix A).

B. If the sample cannot be collected directly into the bottle (i.e., bottle is prepreserved), use a stainless steel, teflon, or glass scoop, ladle, bucket, or bailer or a peristaltic pump with polyethylene or teflon tubing and follow step B for unfiltered metals in Appendix K.4.2.3.3.

C. Follow steps C through G for unfiltered metals in Appendix K.4.2.3.3.

K.4.3.3.4 Filtered Metals.

A. Proceed according to steps A or B (as applicable) for unfiltered metals in Appendix K.4.3.3.3.

B. Proceed as in steps B through H for filtered metals in Appendix K.4.2.3.4.

K.4.3.3.5 General Chemistry Parameters.

A. Collect samples for general chemistry parameters directly into an unpreserved container specified for that parameter in Table 6-1 (Appendix A) when possible. Cap the bottle while it is still submerged, remove it from the water, pour out water in the neck of the bottle, and recap.

B. If the sample cannot be collected directly into the bottle, use a stainless steel, teflon, or glass scoop, ladle, bucket, or bailer or a peristaltic pump with polyethylene or teflon tubing. Follow step B for general chemistry parameters in Appendix K.4.2.3.5.

C. Follow steps C through F for general chemistry parameters in Appendix K.4.2.3.5.

K.4.3.3.6 Radionuclides.

A. Collect samples for radionuclides directly into unpreserved container specified for that radionuclide or group of radionuclides in Table 6-1 (Appendix A) when possible.

B. Proceed as in steps D through J, Appendix K.4.2.3.6, for radionuclides.

C. If the sample cannot be collected directly into the specified container, collect the sample using a teflon, polyethylene, PVC, or stainless steel scoop, ladle, bucket, or bailer or a peristaltic pump with the teflon or polyethylene lines. Proceed as in steps A through J for radionuclides, Appendix K.4.2.3.6.

K.4.4 Wastewater Sampling

Wastewater sampling is regulated by the Ohio Environmental Protection Agency (OEPA) under the Clean Water Act (CWA). Test procedures for the analysis of pollutants shall conform to 40 Code of Federal Regulations (CFR), Part 136, "Test Procedures for the Analysis of Pollutants", unless other test procedures have been specified in the permit.

Samples are collected, preserved, and analyzed as specified in PSPs. Data are collected in accordance with permit-specific requirements. Samples are also collected for DOE environmental monitoring and to fulfill requirements of the 1986 Federal Facilities Compliance Agreement.

K.4.4.1 NPDES Permit Sampling.

The NPDES permit requires continuous pH monitoring of the effluent. It also requires the measurement of flow when a discharge occurs at each permitted location. Meters are in place at outfalls 4001 and 4601 to fulfill this requirement. Flow measurement or estimation information for each of the NPDES outfalls that require reporting of flow are taken at the following stations:

- 4001 - Parshall flume. Charts are located in Parshall Flume Building at Manhole 176B.
- 4002 - No meter. Depth of discharge flow is measured. When depth of flow and geometry of the spillway is known, flow can be calculated.

- 4003, 4004, 4005, and 4006: No flow meters. Flows are estimated using published runoff coefficients, based on rainfall and the drainage area for the stormwater outfall.

- 4601 - Flow is measured by a V-notch weir. Charts are located in the building adjacent to the contact basin. Flow is annunciated to sewage treatment plant LCP-2.

Periodic calibration is essential because of the sensitivity of pH monitors. Samples shall be collected six times daily (twice per shift) when a continuous monitor is used to check accuracy of pH monitors. Records documenting results of samples shall be maintained and available for review.

Custody record preparation is initiated in advance of sample collection. Sample bottles are assembled and labeled in advance for intended locations and sample parameters. Preservatives are added and containers are transported to sample locations in coolers.

Samples are collected with automatic samplers at outfalls 4001 and 4601. The automatic sampler collects composite samples by measuring the flow of the sampled media and incrementally drawing a set volume of sample. Each increment is discharged into one large sample container. The automatic sampler collects the total flow-weighted composite volume over a 24-hour time period. At the end of 24 hours, samples are taken from the composited volume. Grab samples are required for specific parameters and at locations without automatic samplers Samples for unstable parameters, such as volatile organic compounds, shall not be composited.

Following is the basic process for NPDES sample collection:

A. Obtain a chain of custody form and sample numbers.

B. Obtain and mark new sample bottles to reflect sample numbers on the custody record.

C. Collect composite samples as follows:

NOTE

Automatic samplers shall be turned off before taking samples and restarted when sampling is finished.

1. Fill bottles for composite samples from the automatic sampler.

2. Mix composited solution by swirling the sampling bottle or using a magnetic stirrer.

3. Pour excess water from sampler back into the wastewater stream.

D. Take grab samples by lowering sample bottle into applicable tank or effluent stream.

NOTE

Be sure that the appropriate sample bottle (with prepared label) is filled.

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E. Affix a computer-generated label to applicable bottles.

NOTE

The label shall contain the analytical sample number, customer sample number, customer name, date of sample, and location from which sample was taken.

F. Preserve samples as specified in Table 6-1 (Appendix A).

G. Complete required field documentation.

H. Deliver the samples to the appropriate sample processing group or analytical laboratory.

Automatic samplers can be programmed for either time-dependent or flow-dependent sampling. The NPDES permit requires that samples be flow-dependent. To activate the sampler, an electric signal is sent from a flow measurement device to the sampler. The program must be reset each time the sampler is reactivated.

The procedure to program the sampler is located at the sampler. Table 6-1 (Appendix A) specifies the type of sample bottle required and preservation instructions.

FEMP standard operating procedures are implemented for wastewater sampling and analysis and are available upon request from the DOE-FEMP.

K.4.4.2 Liquid Matrix Environmental Samples. Samples are collected, preserved and analyzed as specified in PSPs. Grab and composite sampling are the two techniques used for characterization.

A. Collect samples in accordance with the stability and volatility of parameters, to be tested in the following order (US Environmental Protection Agency 1989f):

1. water quality sample for determination of field measurements (temperature, pH, specific conductance and turbidity);
2. volatile organic compounds;
3. total organic halogens;
4. total organic carbon;
5. extractable organic compounds (semivolatiles, pesticides, PCBs);
6. unfiltered metals;
7. filtered metals;
8. phenols;
9. cyanide;

10. sulfate and chloride;

11. nitrate and ammonia;

12. radionuclides.

B. For grab sampling, proceed as follows:

1. Use clean gloves and sample containers for specific parameters as specified in PSPs or Table 6-1 (Appendix A).

2. Choose a sampling point that will yield a representative sample. The sampling point should be chosen with respect to the information desired and local conditions.

3. Avoid surface debris and artificial turbulence during sample collection.

NOTE

The sampling depth should be approximately 15 cm (6 in) below the water surface, if possible.

4. Use unpreserved containers (grab bottle, ladle, teflon bailer) to collect samples directly from a body of water where the water depth is sufficient and access conditions permit. If the depth is not sufficient, use a teflon or stainless steel beaker, ladle, scoop or bailer.

5. Grasp the grab bottle securely at the base with one hand and submerge it with the mouth down into the water, avoiding surface debris. Position the bottle opening away from the collector's hand. Tip the bottle slightly upwards to allow air to exit and the bottle to fill. Collect a sufficient amount of the sample to perform the required analyses.

6. If a sample bottle is used for collection, cap the bottle before removing it from the water. The grab bottle and the sample bottle should be of the same materials or the approved equivalent.

7. After removal of the grab bottle from the water, transfer the sample to the container with the preservative.

8. When more than one grab bottle or sampling container (as previously specified in step 4) of the sample is required to fill necessary sample containers, distribute the sample portions equally among individual sample containers to provide homogeneity of the collected sample.

9. Perform field measurements as specified in the PSPs.

10. Preserve samples as specified in Table 6-1 (Appendix A).

11. Complete required field documentation.

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12. Deliver the samples to the appropriate sample processing group or analytical laboratory.

C. Composite samples may be collected as grab samples and composited. Requirements for the collection of composite samples shall be included in FEMP procedures and referenced in the applicable PSPs. Samples for unstable parameters, such as volatile organic compounds, or TOX shall not be composited.

K.4.5 DOE-Required Effluent Monitoring

The following program elements are to be reflected in FEMP site documentation as guidance/requirements in the development and use of liquid and air monitoring systems for compliance with DOE Order 5400.5.

K.4.5.1 **General Criteria and Monitoring Requirements**. Facility operators shall provide monitoring of liquid waste streams adequate to demonstrate compliance with applicable requirements of DOE 5400.5, Chapter II, Appendices 1a, 1d, 2a and 3; quantify radionuclides released from each discharge point; and alert affected process supervisors of upsets in processes and emission controls.

Provisions for monitoring of liquid effluent during an emergency shall be considered when determining routine liquid effluent monitoring program needs.

K.4.5.2 **Performance Standards for Liquid Effluent Monitoring Systems**. The selection or modification of a liquid effluent monitoring system shall be based on a careful characterization of the source(s), pollutants(s) (characteristic and quantities), sample collection system(s), treatment system(s), and the final release point(s) of the effluents.

A pre-operational assessment shall be made to determine the types and quantities of liquid effluents expected and to establish the associated effluent monitoring needs for new facilities or for facilities modified in a manner that could affect effluent release quantity or quality or the sensitivity of monitoring or surveillance systems.

The performance of the effluent monitoring systems shall be sufficient for determining whether effluent releases of radioactive material are within the Derived Concentration Guidelines specified in DOE 5400.5 and to comply with the reporting requirements of Chapter II, Appendix 7, of that order.

The required detection levels of the analysis and monitoring systems shall be sufficient to demonstrate compliance with all regulatory requirements consistent with the characteristics of the radionuclides that are present or expected to be present in the effluent.

Sampling systems shall be sufficient to collect representative samples that provide for an adequate record of releases from a facility, to predict trends and to satisfy needs to quantify releases.

As specified in Appendix I, monitoring and sampling systems shall be calibrated before use and recalibrated any time they are subject to maintenance, modification, or system changes that may affect equipment calibration. They shall also be recalibrated at least annually and routinely checked with known sources to determine that they are consistently functioning properly.

Environmental conditions (e.g., temperature, humidity, radiation level, dusts, and vapors) shall be considered when locating effluent monitoring systems to avoid conditions that will influence the operation of the system.

Sampling/monitoring lines and components shall be designed to be compatible with the chemical and biological nature of the liquid effluent.

K.4.6 Collection of QC Samples

QC samples, commensurate with the specified ASL and project-specific DQOs, shall be collected and analyzed with aqueous samples.

A. Trip blanks shall be included with each shipping container of aqueous samples to be analyzed for VOCs unless specifically omitted in the DQO. Trip blanks may be specified in DQOs for other parameters. Trip blanks shall be prepared in a controlled environment and accompany the sample containers through collection, shipping, and handling. Certified deionized or certified deionized, organic-free water (see K.11.1) shall be poured into the sample container specified in Table 6-1 (Appendix A).

B. VOC vials shall be filled so that there is no headspace. Fill vials until a meniscus is present above the rim of the vial and seal without air bubbles. Visually check each vial for air bubbles by inverting and sharply tapping it against the hand. If air bubbles are present, top off sample bottle and recheck it for air bubbles. Other containers shall be filled to the neck and sealed.

C. Field blanks are prepared at the sampling site by pouring certified deionized or certified deionized, organic-free water (see K.11.1) into the sample containers specified in Table 6-1 (Appendix A) for the parameters of interest. The field blank containers must remain open to atmospheric conditions during sample collection. Field blank samples shall be collected and handled in the same manner as the actual samples, as specified in Appendices K.4.2.3.1 through K.4.2.3.6.

D. Equipment rinsate samples are collected after decontaminating equipment by pouring or pumping certified deionized or certified deionized, organic-free water (see K.11.1) through the sample collection device(s) (e.g., bailer, pump) and then pouring it into the sample container(s). Rinsate samples shall be collected and handled in the same manner as specified in Appendix K.4.2.3 for the relevant analyte(s) of concern.

E. Duplicate samples are collected by taking a second sample from the same source, immediately following, and in the same type of sample container as the original sample.

F. Split samples are collected by taking a minimum of a double sample volume from the sample source and dividing it into two containers of the same size and type.

G. Preservative blanks are prepared in a controlled environment by filling an appropriate container with certified deionized or certified deionized, organic-free water (see K.11.1), properly preserving it and submitting it to the analytical laboratory. Containers shall be filled as specified in Appendix K.4.2.3 for the type of analysis performed.

H. Container blanks are empty containers submitted to the laboratory to be checked for constituents of concern as specified in Section 4.

I. Additional sample volume may be required for laboratory QC samples. The DQO and/or PSP shall specify the type of laboratory QC samples required and the frequency with which they shall be collected. Matrix spike/matrix spike duplicate samples shall be collected at triple the regular volume for VOCs and at least double the volume for extractable organics. These samples shall be collected and handled in the same manner as the other samples.

J. QC samples are subject to the same documentation, labeling, chain of custody, and shipping and handling requirements as all other samples.

K.5 SOLID MATRIX ENVIRONMENTAL SAMPLES

Solid media include soil, sediment, sludge, and residue. Solid samples are routinely taken at the FEMP for characterization purposes. Generally, grab samples are collected; composite sampling may be performed when specified in PSPs. Composite samples are collected as grab samples and then composited.

Collect samples in accordance with the stability and volatility of parameters to be tested in the following order (US Environmental Protection Agency 1989f):

A. volatile organic compounds;

B. total organic halogens;

C. total organic carbon;

D. extractable organic compounds (semivolatiles, pesticides, PCBs);

E. metals;

F. phenols;

G. cyanide;

H. sulfate and chloride;

I. nitrate and ammonia;

J. radionuclides.

K.5.1 Surface Soil Sampling

Surface soil samples are collected as part of routine monitoring or to characterize soil for the presence of hazardous or radioactive constituents. Surface soil samples are generally collected with manually-operated equipment within 6 inches of the surface.

The following general procedures are applicable to surface soil sampling:

A. Decontaminate sampling equipment prior to use as described in Appendix K.11. Specific equipment to be used shall be based on project objectives and shall be specified in the PSP.

B. Prepare area to be sampled as specified in the PSP. Generally vegetation, large rocks or trash will be collected only if required by the project objectives.

C. Collect samples at the depth and interval specified in the PSP. The size of the sampling tool shall be sufficient to collect the required volume within the depth interval limitation. Collect sufficient sample and rinsate volumes to perform required analyses as defined in PSPs.

D. If possible, collect surface soil samples for VOC analysis using a direct-push coring tube with a teflon or stainless steel liner. Cap and seal each end of the tube and label properly.

E. If conditions do not permit the collection of VOC samples with a direct-push coring tube, collect the surface soil samples with a trowel, scoop, or other appropriate nonreactive device. Immediately transfer the sampled material directly into the appropriate container specified in Table 6-1 (Appendix A) in a manner to minimize volatilization of the VOCs. Fill the sample container as full as possible to minimize headspace.

F. Collect samples for non-VOC samples with a trowel, scoop, coring device, hammer head logger, or other sampling device as specified in the PSP. The sampling device must be constructed of a material that is inert to the materials collected and the analytes to be measured.

G. Transfer the surface soil samples into the appropriate container as specified in Table 6-1 (Appendix A).

H. Label the samples and complete the chain of custody records, field collection reports, and other required field documentation.

I. Place samples requiring refrigeration (see Table 6-1, Appendix A) in a cooler to obtain a temperature of 4°C, ±2°C.

J. Store and/or pack samples for shipping as specified in Section K.10, ensuring that all chain of custody requirements are met.

K.5.1.1 **Soil Compositing**. Mixing or compositing requirements for solid materials are designed to ensure homogeneity within a sample and to ensure that composite samples undergo the same degree of mixing. When compositing is required, adhere to the following procedures unless specifically modified in PSPs. Do not composite samples to be analyzed for volatile parameters.

A. Remove sample from collection device and place it in a decontaminated flat-bottomed container constructed of an inert material relative to the constituents of concern.

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B. When a sufficient volume of sample has been collected, divide the entire volume into relatively even quarters.

C. Mix opposite quarters together, and then mix resulting halves together. All of the material will then be regrouped into a single volume.

D. Repeat steps B and C and then place the sample in appropriate containers.

K.5.2 Sediment Sampling

Sediments are materials that have been transported from their place of origin by fluid action and redeposited. Sediment sampling in Paddys Run, drainages to Paddys Run, and the Great Miami River is conducted for routine monitoring and characterization.

Specific sampling stations shall be documented in PSPs. The following requirements are applicable to sediment sampling.

A. Prior to sampling, decontaminate the sampling device as specified in Appendix K.11. Equipment used shall be selected based on project objectives and specified in PSPs.

B. When traverse sampling of rivers and large streams is necessary, use a clamshell dredge, trowel, or similar device as specified in PSP for sediment collection.

NOTE

Collect sediments from the station farthest downstream first and work upstream.

C. Collect sediment sample to the depth specified in the PSP. In general, large rocks, twigs, or debris should not be collected unless specified in the PSP.

D. Collect a sufficient amount of sample to perform required analyses as specified in the PSP and Table 6-1 (Appendix A).

E. Store samples requiring refrigeration in the field in an ice chest filled with artificial icing material to obtain a temperature of approximately 4°C, ±2°C.

F. Label samples and complete chain of custody records, field collection reports, and laboratory requests for analysis.

K.5.2.1 <u>**Sediment Compositing**</u>. Mixing or compositing requirements are designed to ensure homogeneity within the sample. When mixing is required, adhere to the following procedure unless directed otherwise by the PSP. Do not composite samples collected for analysis of volatile parameters.

A. Remove sample from collection device and place it in a decontaminated flat-bottomed container constructed of inert material relative to the constituents of concern.

B. When a sufficient volume has been collected, divide the sample into approximately even quarters.

C. Mix opposite quarters together, then mix resulting halves together. Regroup all the material into a single volume.

D. Repeat steps B and C and place the sample into appropriate containers.

K.5.3 Subsurface Soil Sampling

Subsurface soils are those materials found at depths greater than 6 inches. Subsurface soil samples are collected in compliance with the following requirements:

A. Decontaminate sampling equipment as specified in Appendix K.11. Do not place sampling equipment directly on the ground or on other potentially contaminated surfaces prior to insertion into the boring. Place it on a clean plastic sheet adjacent to or around the boring. Take care that potentially contaminated excess sample does not contact the ground.

B. Collect subsurface samples using equipment specified in the PSP in compliance with the drilling requirements in Appendix J.

C. Collect undisturbed soil, avoiding caving materials at the base of the borehole.

D. If caving materials are present in the upper part of a sampler, discard this material prior to packaging samples for shipment.

E. Advance borings as specified in the PSP.

F. Collect samples at specified intervals in accordance with the PSP.

NOTE

Shelby tubes or Dennison samplers must be used to collect samples for tests requiring an undisturbed sample (e.g., unconfined compressive strength, permeability test).

G. Lower an appropriate sampling device consisting of a threaded coupling to fit a standard drill or drive rod and a replaceable Shelby tube sampler or other core tube sampler down the borehole and push it into undisturbed material at the bottom of the boring.

H. If using a Shelby tube, leave samples that are to be tested for physical characteristics requiring undisturbed soil in the tube. Screen open ends of the tube for radionuclides or volatiles, if required by the PSP. Cap the tube ends and tape and seal the cap with wax.

I. Send the sample to a FEMP-approved geotechnical laboratory for testing.

NOTE

Split-tube, split-spoon, or direct push samplers may be used for sample collection when undisturbed samples are not required.

J. Collect subsurface split-spoon or core tube samples in accordance with the following requirements:

1. Lower an appropriate decontaminated sampling device consisting of a threaded coupling to fit a standard drill or drive rod and a replaceable split-spoon sampler or core tube sampler down the borehole. Push or drive it into undisturbed material at the bottom of the boring. While driving sampler, record number of blows required to advance it every 6 inches.

2. Remove sampling device from the boring, open it, and screen sample for VOCs and radionuclides, if required, using appropriate field instrumentation.

3. If required, screen for VOCs with a photo-ionization or a flame-ionization detector as follows:

   a. Split sample lengthwise, open it, and place the probe within ½ to 1 inch of the inner surface of the sample.

   b. Screen entire length of sample at a rate no greater than 1 inch per second for a minimum of 15 seconds. Record peak measurement, background reading, range observed while screening, and approximate average.

4. If required, VOC screening of soil sample in container may be performed by placing a portion of the soil sample into a container and sealing the container with aluminum foil and an air-tight screw-on lid. The container is then placed in an area where the temperature is greater than 60°F for 5-10 minutes. The lid is then removed and the aluminum foil punctured with the sample line tip of the PID. The sample measurement is obtained by noting the peak measurement obtained from the void space above the soil.

K. Describe the sample, remove it from the sampler, and transfer it to appropriate containers for shipment to the laboratory. If the samples are to be composited, mix them as specified in Appendix K.5.1.

L. Store samples requiring refrigeration in an ice chest filled with artificial icing material to obtain a temperature of 4°C, ±2°C.

M. Remove subsurface soil samples collected for volatile organic analysis from the interior of the core sample and transfer them as soon as possible to the specified sample container. Fill containers completely to minimize headspace. If samples are to be collected for VOC analysis without field screening, brass, stainless steel, or aluminum split-spoon liners may be used to minimize head space. Cap and seal the filled liners, label properly, and ship liners as the sample.

N. Complete sample label, chain of custody record, and sample collection log in the field.

O. Decontaminate split-spoon sampler and other sampling equipment such as trowels and pans between each use as specified in Appendix K.11.

P. Prepare samples for shipment.

Q. Use the appropriate screening method from Appendix K.5.3.1 to determine which samples are shipped for radiological analysis.

K.5.3.1 **Field Screening of Samples for Radioactive Contamination**. Following are uniform measurement techniques for screening subsurface soil samples for radioactive contamination and instructions for determining which samples shall be analyzed for radiological parameters. The specific sample selection and screening method shall be specified in the PSP. The procedure also describes the technique for screening subsurface soils for intermediate and high energy gamma ray emitters. The screening level is chosen for instrument gross count rates that exceed the background count rate by three standard deviations when the sample is counted in a low-background area.

Screening may be performed with gamma-sensitive instrumentation capable of detecting the desired level of contamination. An example of such instrumentation is a portable multichannel analyzer with associated sodium iodide detector. Screening shall be performed using field instruments specified in PSPs. Perform assay procedure as follows.

A. Calibrate instrument in accordance with applicable procedure.

B. Perform a five minute background count and calculate the time required to obtain the desired minimum detectable activity.

C. Count sample for the predetermined count time and record net counts or count rate.

D. Select samples for radiological analysis based on results of screening at frequency specified in the PSPs.

E. Select samples for laboratory analysis that exhibit the highest relative radiological readings for a given location and horizon.

K.5.4 Collection of QC Samples for Solid Matrices
The following are basic requirements for QC samples for soil and sediment analyses.

A. Trip Blanks

1. Include trip blanks with each shipping container of solid samples analyzed for VOCs at ASL C or D, unless specifically omitted in the DQO and PSP.

2. Prepare and handle trip blanks as specified in Appendix K.4.6.A.

B. Rinsate Samples

1. Obtain equipment decontamination samples by pouring certified deionized or certified deionized, organic-free water (see K.11.1) over the equipment and collecting it in the container specified in Appendix K.4.6.D.

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C. **Duplicate and Split Samples**

1. Collect samples in the same manner as actual samples, except that samples shall be composite and evenly distributed between containers while filling.

2. Do not composite samples for VOC analysis.

D. **Container Blanks**

1. Submit empty containers to the laboratory to check for constituents of concern (Section 4).

E. **Matrix Spike/Matrix Spike Duplicates for laboratory use**

1. When the DQO requires laboratory matrix spike/matrix spike duplicates, collect a sample every twentieth sample or every sampling round, whichever is more frequent. Unless otherwise specified in the PSP, matrix spike/matrix spike duplicate samples require no extra volume for VOCs or extractable organics. These samples shall be collected and handled in the same manner as the other samples.

QC samples are subject to the same documentation, labeling, chain of custody, and shipping and handling requirements as other samples.

K.5.5 Container Sampling

Drums and tanks are commonly used to store wastes at the FEMP. Samples of containerized drummed materials are collected to identify and/or classify the waste (e.g., RCRA hazardous waste, non-RCRA hazardous waste, radioactive waste, mixed waste, or nonhazardous waste). PSPs shall describe objectives for container sampling, representative container selection criteria, analytical testing requirements, statistical analyses for drum sample testing (e.g., confidence levels), and disposal plans.

K.5.5.1 **Sampling and Analysis**. The FEMP Waste Analysis Plan was prepared in accordance with the requirements of Ohio Administrative Code (OAC) 3745; 40 CFR, Parts 264, 268, and 270. The sampling and analysis section of the Waste Analysis Plan describes procedures used at FEMP to characterize waste in order to manage it appropriately.

K.5.5.2 **Analytical Parameters and Rationale**. A waste stream shall be analyzed for those parameters most likely to yield the maximum amount of chemical and physical information. In addition, specific analyses are selected based on historical knowledge, knowledge of the waste generation process, and the constituents suspected to be in the waste. The waste parameters selected shall represent those characteristics necessary to manage the waste in compliance with the FEMP Part B permit application requirements.

K.5.5.3 **Test Methods**. When process knowledge is insufficient to identify a waste stream as hazardous, additional information shall be requested or analytical methods applied to make the determination. Sample preparation and analytical methods are specified in the Part B permit application.

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K.5.5.4 Sampling Procedures. Basic requirements for the drum sampling process follow.

NOTE

Because drum samples are taken from top to bottom, only the sampling location on the top surface needs to be random.

A. Select a sampling position within the drum cross section just prior to taking the sample.

B. Collect sample using one of the following techniques:

NOTE

PSPs will describe use of other sample collection tools, such as sludge judge and Wheaton sampler, not described in this section.

1. Use a **grain sampler** for free-flowing particulate solids that are easy to penetrate and collect sample as follows.

   a. Ensure that the grain sampler is in closed position with slots in the outer tube face up.

   b. Insert the sampler diagonally at a point near the side of the drum, through the center, and to a point opposite the entry point.

   c. Rotate inner tube of the sampler to the open position, collect a sample, and rotate the inner tube to the closed position.

   d. Withdraw the sampler from drum and place it in a horizontal position with the slots in the outer tube facing up.

   e. Rotate inner tube to the open position and place the sample collected in an appropriate container as specified in Table 6-1 (Appendix A).

2. Use a pipe sampler for moist or otherwise cohesive particulate solids that can be pulled out as a core and collect a sample as follows:

NOTE

A pipe sampler shall be long enough to reach the bottom of the sampled drum.

   a. Insert the sampler diagonally through the contents of drum and rotate once or twice to cut a core of material.

   b. Ensure that the slot is face up and slowly withdraw the sampler.

   c. Ensure that the entire length of pipe contains material. If it does not, repeat steps a and b.

d. Use a clean stainless steel spatula and push the material out of sampler into an appropriate container as specified in Table 6-1 (Appendix A).

e. Place a lid on the filled sample container **before** collecting the next sample.

NOTE

Clear plastic composite liquid waste samplers (COLIWASAs) are suitable for liquid wastes at FEMP. Only if plastic is noticeably attacked (softened) by a solvent waste, is it necessary to use a glass COLIWASA (see Appendix K.5.5.5).

3. Use a COLIWASA to collect full depth samples from drums of liquid waste.

a. Adjust the locking mechanism of the sampler, if necessary, to ensure that the neoprene rubber stopper provides a tight closure.

b. Place the stopper rod handle in the T-position and push it down until the handle is against the locking block.

NOTE

If liquid the level in sampler tube is lower than the level outside sampler, it is being lowered too fast and a nonrepresentative sample will be obtained.

c. Slowly lower the COLIWASA vertically into the drum so that the levels of liquid inside and outside the sampler tube remain even.

d. When the stopper hits the bottom of the drum, slowly push the sampler tube downward against the stopper to close the sampler.

e. Turn T-handle upright with one end tight on the locking block to lock the sampler in the closed position.

f. Slowly withdraw the sampler with one hand while wiping the outside of it with a clean, disposable cloth.

g. Dispose the cloth in a manner consistent with suspected drum constituents.

h. Place the end of the COLIWASA into an appropriate sample container (see Appendix A, Table 6-1).

I. Empty the sampler by slowly pulling the lower end of the T-handle away from the locking block.

C. Transport the sample to analytical laboratory under chain of custody protocols specified in Section 7.

D. Upon sampling completion of a drum lot, clean the sampler at a Level III decontamination level as specified in Appendix K.11.

NOTE

It is not necessary to clean the sampler between drums that are from the same lot (i.e., matrix, same waste stream).

E. Document sampling activities by completing the appropriate documentation, including the following:

1. Daily field log book or daily log form;

2. Chain of custody record.

K.5.5.5 **Glass COLIWASA**. If it is necessary to use a glass COLIWASA, proceed as follows.

A. Insert the inner tubing of the glass COLIWASA inside the sheath.

NOTE

If the liquid in the sampler tube is lower than the level outside the sampler, the sampler is being lowered too fast and a nonrepresentative sample will be obtained.

B. Slowly lower the COLIWASA vertically into drum, keeping the ground glass end away from hole in bottom of sheath, so that the levels of liquid inside and outside the sampler tube remain even.

C. When the sheath hits the bottom of the drum, slowly push the inner tube downward so that the ground glass end seals the end of the sheath.

D. Slowly withdraw the COLIWASA with one hand and wipe the outside of the sampler with a clean, disposable cloth. Dispose the cloth in a manner consistent with the suspected drum constituents.

E. Place the end of the COLIWASA into the appropriate sample container (see Appendix A, Table 6-1).

F. Empty the sampler by pulling the inner tube upward, causing the ground glass end to separate from the outer tube bottom.

K.5.5.6 **Liquid Volatile Organic Analysis Sample Collection**. If VOC analysis of a liquid sample is required, collect the sample as follows.

NOTE

For VOC analysis, no air bubbles can be present in the septum bottle.

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A. Carefully fill a septum bottle with sample liquid to the lip of the bottle until a meniscus is present.

B. Slide the teflon spectrum across the lip of the bottle covering the opening, and then screw plastic lid on the bottle.

C. Check the bottle for air bubbles by turning it upside down.

D. If air bubbles are present, empty the bottle and repeat steps A, B, and C until no air bubbles are present.

K.5.6 Sludge Sampling

Sludge is a liquid saturated mass, deposit, sediment or precipitated solid matter produced by water and sewage treatment process. Sludge is found in process equipment, sumps, tanks, drums and similar structures.

A. Before sampling sludge, decontaminate the sampling equipment as specified in Appendix K.11. Equipment shall be selected based on project objectives and shall be specified in the PSP.

B. Using a trowel, scoop, auger, shovel, or tube/check valve sampler, collect the sludge in a stainless steel pan or tray.

C. Transfer samples with a stainless steel scoop from the pan or tray to the sample containers specified in Table 6-1 (Appendix A).

D. Transfer VOC samples directly to the appropriate container specified in Table 6-1 (Appendix A). Fill the containers as full as possible to minimize headspace.

E. Seal containers with custody tape. Label the samples. Complete the chain of custody records and sample collection log.

F. Store the samples as specified in Table 6-1 (Appendix A).

G. Deliver the samples and paperwork to the designated laboratory or the sample receiving group.

K.5.7 Residue Sampling

Residue is material that remains after a part is taken, separated or designated. Residue is found in process equipment, lines, tanks, drums and similar structures.

A. Before sampling residue, decontaminate the sampling equipment as specified in K.11. Equipment used shall be selected based on project objectives and specified in the PSP.

B. Collect samples with a decontaminated trowel, scoop, or coring device or inert material relative to material to be sampled and to analytes of interest specified in the DQO.

C. Transfer samples directly from the sampling tool to the sample containers specified in Table 6-1 (Appendix A).

D. Collect samples for VOC analysis from a depth specified in the PSP. Do not composite samples collected for VOC analysis.

E. Transfer VOC samples directly to the appropriate container specified in Table 6-1 (Appendix A). Fill the containers as full as possible to minimize headspace.

F. Seal containers with custody tape. Label the samples. Complete the chain of custody records and sample collection log.

G. Store samples as specified in Table 6-1 (Appendix A).

H. Deliver the samples and paperwork to the designated laboratory or sample receiving group.

K.6 GASEOUS MATRIX SAMPLES

Air sampling conducted at the FEMP includes stack monitoring for compliance with the Clean Air Act (CAA), radon sampling, general area air sampling for radiological health and safety monitoring, and monitoring for specific organic and inorganic contaminants while conducting field activities. Data may be used for modeling contaminant transport, determining compliance with National Emissions Standards for Hazardous Air Pollutants (NESHAP), determining exposure levels, and determining respiratory protection requirements.

K.6.1 Effluent (Stack) Sampling

Stack monitoring is done at the FEMP to measure radionuclide emissions. Stacks with a potential for delivering a dose of 0.1 millirem (mrem) in one year to any individual shall be monitored and inspected at least weekly as specified in the Clean Air Act, 40 CFR, Part 61, and DOE 5400.5. Total uranium analysis, Th-230 analysis, and air particulate analysis are performed according to current approved methods listed in Appendix G.

K.6.1.1 Performance Standards for Effluent (Stack) Sampling

Performance standards for effluent stack sampling are as follows:

A. Airborne emissions from the FEMP shall be evaluated, and their potential for release of radionuclides assessed. Based on this assessment, decisions shall be made regarding necessary effluent monitoring systems; the rationale shall be documented. The potential for emissions shall include consideration of the loss of emission controls while otherwise operating normally.

B. For new facilities or facilities modified in a manner that could affect effluent release quantity or quality or the sensitivity of monitoring or surveillance systems, a pre-operational assessment shall be made to determine the types and quantities of liquid effluents expected to establish the associated airborne emission monitoring needs of the facility.

C. To the extent practicable, samples shall be extracted from the effluent from a location in a manner that provides a representative sample, using multiport probes if necessary.

D. When continuous monitoring systems are required to signal the need for corrective actions that may be necessary to prevent public or environmental exposures exceeding established limits, the systems shall have alarms set to provide timely warning.

Meteorologic monitoring shall be completed to assess potential offsite impacts for releases of airborne contamination. Assessments may be completed for actual, projected, or accidental releases. Necessary data shall be obtained from onsite instrumentation. Instruments that may be used include wind speed, wind direction, ambient and dewpoint temperature, precipitation, and barometric pressure measuring devices. Sensors and onsite measurement locations shall be determined by applicable PSPs and DQOs.

K.6.1.2 Stack Effluent Sampling.

1. Review the stack log for installed filter number and prescribed flow rate and record it on stack sampling systems inspection/filter collection report form (e.g., Attachment A in Procedure number SMPL-22, "Stack Sampling Systems Inspection and Sample Filter Replacement").

2. Observe control panel of sampling system and record the following available data on stack sampler inspection report form.

NOTE

On sampling systems equipped with multipoint isokinetic samplers, flow rate adjustments to the sampler are not made during filter changeout. An observation shall be made to ensure that the sample rate is between 70% and 100% of the stack flow rate.

   a. Record high and low pressure from differential pressure gauges for the MEPA and HEPA filtration systems.

   b. Record counts per minute (cpm) from the Ludlum stack monitor reading on the stack sampler inspection form.

   c. Record stack alarm set point.

3. Check the Ludlum stack monitor for proper operation and source response as specified in applicable procedures and record results on stack sampling systems inspection/filter collection report form (e.g., Attachment A in Procedure number SMPL-22, "Stack Sampling Systems Inspection and Sample Filter Replacement").

4. At stack sampler, verify that stack sampler, vacuum tubing, and other sampling equipment is operating properly. If defects are found, record them on stack sampler inspection report form and notify Facility Owner.

5. Observe the actual sample rate on the rotameter or electronic readout on the isokinetic panel (whichever is applicable) and record the reading on the stack sampler inspection report form.

6. Adjust sampling rate to prescribed rate if necessary. If the prescribed rate cannot be obtained, record this on the stack sampler inspection report form and notify Facility Owner and so that arrangements can be made with Maintenance to repair the sampling system. If the sampling rate is reading zero, and there is flow through the stack, the system may need to be shut down. Air Programs needs to be notified and a decision will be made on case by case basis depending upon safety considerations and permit requirements.

7. Loosen the retaining clamp around the filter holder and carefully lower the bottom section of filter holder.

8. Visually inspect stack filter. During inspection and handling of stack filter, ensure that there is no loss of filtered material or any contamination from foreign sources. Handling of the filter shall only be done with stainless steel tweezers to avoid the possibility of contaminating the filter.

9. If filter appears to be clean and in good shape, re-install it and record your observations on the stack sampler inspection form. However, if the filter is scheduled for replacement, remove the filter and place it in a plastic petri dish; and install a new numbered and tared filter. When re-assembling the filter holder , ensure the filter is centered in the assembly and tighten the clamp sufficiently to prevent a vacuum leak at sealing surface.

    a. Record the new filter number on stack sampler inspection report form along with the date of installation and sample flow rate.

    b. Prepare a Chain of Custody and Request for Analysis (COC/RFA) form for total uranium, Th-230 and particulates.

    c. Custody tape the petri dish and record the sample number on the petri dish.

    d. Submit the sample and COC/RFA form to the Sample Processing lab (SPL).

K.6.2 Environmental Radon Monitoring

Environmental radon monitoring is conducted employing long-term radon monitoring, continuous radon monitoring, and radon flux sampling to demonstrate compliance with required regulations.

K.6.2.1 **Radon Flux Sampling**. Various federal regulations (40 CFR, Parts 61 and 192) impose limits on the emission of radon gas from a variety of sources owned or operated by DOE. Measurement of radon flux density using a passive charcoal collector is often the method of choice for determining radon emissions from these sources. Details of this measurement method are given in 40 CFR, Part 61, Appendix B, Method 115. Method 115 also references a document written by Hartley and Freeman that describes the Large-Area, Activated-Charcoal Collector (LAACC) in detail and gives general field methods for its use. Radon flux sampling guidelines follow:

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A. Randomly select sampling locations and examine the area to be measured prior to conducting the measurements. Determine the number of locations required and identify problems that may arise during sampling.

NOTE

The required measurement density is determined by the intended use of the measurement results. Method 115 requires a minimum of 100 measurements per source.

B. To obtain radon flux measurements that are representative of long term average radon emissions, observe the following restrictions:

1. Do not initiate measurements within 24 hours after a rainfall. If rainfall occurs during the measurement period, a measurement becomes invalid if the seal around the lip of the collector has washed away or if the collector is surrounded by standing water.

2. Do not perform measurements when the ambient temperature is below 2° C or when the ground is frozen.

C. Prior to use, heat the activated charcoal to be used in the LAACCs to purge it and keep the charcoal in a radon-resistant, sealed container until it is ready to use in the LAACC.

D. Prepare a blank sample by sealing approximately 180 grams of the charcoal to be used to load the LAACCs in a sample can at the same time that the LAACCs are loaded. Label this can with the word "BLANK", the date and time it was sealed, and the initials of the preparer. A minimum of one blank is required for each batch of LAACCs to be exposed in the field.

E. Assemble the LAACCs and place them at the appropriate locations.

F. Expose each LAACC for 24 hours (± 2 hours), then remove it from the measurement surface. Record the date and time of removal in the field log book or daily log form and initial the entry.

G. Remove the collected LAACCs to a staging area away from the measurement area to recover the exposed charcoal. Remove the charcoal from the LAACC and place it in an approved sealed can as soon as possible. Affix a label with sample identification, location, and the dates and times that the samplers were placed and retrieved. Initial the label.

H. Prepare the cans for return to the laboratory for gamma ray analysis as soon as possible to minimize the loss of measurable activity. (Rn-222 has a half life of 3.825 days.)

K.6.2.2 <u>Long-Term Radon Monitoring</u>. The use of alpha track-etch radon monitoring to determine long-term radon-222 (Rn-222) concentrations in air under ambient outdoor conditions has been described by H. W. Alter and R. L. Fleisher (1981).

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A. The following are guidelines for radon monitoring using long-term radon detectors when exposing detectors in the field:

1. To eliminate uncertainty caused by storage and other variables use only recently supplied radon Type M alpha track-etch detectors.

2. Inspect the film detectors upon receipt from distributor.

CAUTION

DO NOT USE damaged or opened mylar bags containing the detectors.

3. Schedule the installation of film detector canisters so that all canisters can be installed soon after a bag is opened. Save the mylar bags for use when film detector canisters are retrieved. Determine which canisters will be exchanged, open appropriate number of bags, and remove enough film detector canisters for exchange. Close any open bags that still contain detector canisters.

4. Visually inspect each cup with a canister to ensure it is satisfactory for field use.

5. Enter the serial number of each film detector canister and its site location on the field data form.

6. Deploy the detectors in the field.

B. The following are guidelines for radon monitoring using long-term radon detectors when retrieving exposed detectors from the field:

1. Enter the date and removal time on field data form next to the correct serial number for each detector.

2. Retrieve the film detector canister. Report any unusual conditions on the field data form.

3. Place a new detector in the housing.

4. Remove detector canister from the plastic cup. Place a seal on the detector canister and place it in a mylar bag. Stack the exposed canisters in a bag until it is full. Seal the open end of the mylar bag with tape when it is full.

5. After retrieving the exposed detectors, review the field data forms to ensure that the detector serial numbers, dates installed, dates removed, and site locations are properly documented.

6. Ensure that the mylar bags containing exposed detectors are sealed with no pinholes or tears. Place custody tape over the seal and initial and date the date.

7. Transcribe data from the field data forms to the COC record and complete the vendor pre-shipping checklist. Specify readout sensitivity and any special handling instructions.

8. Include data forms with the detectors and ship the detectors to the vendor for readout.

K.6.2.3. Continuous Radon Monitoring. Continuous radon monitors provide information about the dynamics of radon distribution and are useful for assessing the effectiveness of remedial actions. The following instructions serve as guidance to determine continuous radon-222 (Rn-222) concentrations in air under ambient outdoor conditions, as specified by the instrument manufacturer:

A. Secure a Pylon AB-5 radon monitor with an attached Continuous Passive Radon Detector and a printer with appropriate cables and proceed to the monitoring location.

B. Perform all electrical connections to the voltage power strip and ensure that the printer is attached to the Pylon AB-5.

C. Record the AB-5 serial number, the AB-5 calibration due date, and the Lucas cell serial number on the data form.

D. Ensure that the printer has an adequate paper supply.

E. Ensure that the AB-5 Pylon is set for continuous counting and that it is set for counting in minutes.

F. Turn the AB-5 Pylon to the ON position and verify that the correct date and time are displayed.

G. Ensure that the count interval length is set to 1 hour.

H. Clear the memory stored in AB-5 Pylon and start the count.

I. Retrieve data at the specified time interval.

K.6.2.4 QA/QC Requirements for Long-term Environmental Radon Monitoring. Radon alpha track-etch detectors allow radon to penetrate a filter canister within a plastic cup. Once the radon decays, an alpha particle is emitted that interacts with the plastic chip within the canister (hence the measurement is based on the "etch" left in the plastic). The radon canisters are received new from the vendor and therefore do not require periodic calibration.

A. The following quality assurance measures are used under the long-term environmental radon monitoring sampling program and are performed with each change-out:

1. All detectors are purchased, analyzed, and spiked by vendor(s) that participate in the USEPA Radon Measurement Proficiency Program.

2. All detectors purchased for a sampling interval must contain plastic taken from the same fabrication batch (sheet of plastic).

3. All detectors received by and sent from the FEMP must be sealed in radon retardant bags.

4. At a minimum, five to ten percent of the purchased detectors (usually 20 total) are retained by the vendor in a background controlled area (where their quality control detectors are stored) and sent to the FEMP toward the end of the sampling period.

5. At a minimum, 75 percent (usually 15) of the retained detectors are sent to a different vendor for spiking and returned to the FEMP.

6. At a minimum, 25 percent (usually five) of the retained detectors remain sealed at a FEMP designated background location as a verification of blank exposure.

7. At the end of the sampling interval, all detectors are packaged in radon retardant bags, segregated by analytical sensitivity level (high or low), and sent for analysis. A chain of custody form accompanies the detectors, denoting serial numbers but not exposure location (the analytical vendor is thus blind to the expected exposure).

8. Hard copy and electronic data received upon analysis must contain the following information:

   a. Detector serial numbers,
   b. Detector lot number,
   c. Analyzing process number,
   d. Total exposure (pCi/L-days),
   e. Gross counts,
   f. Net counts,
   g. Average net tracks per square millimeter.

9. The vendor is also required to perform analyses on their internal control blanks, spikes, and laboratory control samples and provide this and Radon Measurement Proficiency Program mandated data annually, or as applicable.

B. The following process will be used to evaluate replicate data usability by identifying outliers and suspect data points under specific screening conditions. Data will be evaluated using exposure information (pCi/L-days) from data collected in the field, as well as data from detectors exposed to known radon concentrations (spiked samples). This information will be used to assess the variability, precision, and accuracy with known exposures which approximate environmental conditions. The process is five-fold.

1. The precision of the spike data is evaluated for the maximum acceptable variance (this laboratory data represents highest relative error value that will be tolerated for the variability of the field data). This value is found by taking the

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95 percent Confidence Interval value (a value two standard deviations from the mean) of the spiked cup exposure data, dividing this number by the mean exposure of the spiked cups, and expressing the final number as a percent.

2. The above determined value is used for comparison at each detector location to assess acceptable field data precision at that location. If the relative error of the exposure data from a location is greater than what is determined to be acceptable based on spiked data, then data points are excluded according to the screening criteria listed below:

		Field Data		Control Data (95% Relative Error)
(a)	IF	$\frac{\lvert \text{Max. Value} - \text{Avg. Value} \rvert}{\text{Average Value}}$	$\leq$	$\frac{\text{2 Std. Dev. of Spikes}}{\text{Mean Value of Spikes}}$
	AND IF	$\frac{\lvert \text{Min. Value} - \text{Avg. Value} \rvert}{\text{Average Value}}$	$\leq$	$\frac{\text{2 Std. Dev. of Spikes}}{\text{Mean Value of Spikes}}$
	THEN average all data from location.			
(b)	IF	$\frac{\lvert \text{Max. Value} - \text{Avg. Value} \rvert}{\text{Average Value}}$	$\leq$	$\frac{\text{2 Std. Dev. of Spikes}}{\text{Mean Value of Spikes}}$
	AND IF	$\frac{\lvert \text{Min. Value} - \text{Avg. Value} \rvert}{\text{Average Value}}$	$\geq$	$\frac{\text{2 Std. Dev. of Spikes}}{\text{Mean Value of Spikes}}$
	THEN average data from two higher data points.			
(c)	IF	$\frac{\lvert \text{Max. Value} - \text{Avg. Value} \rvert}{\text{Average Value}}$	$\geq$	$\frac{\text{2 Std. Dev. of Spikes}}{\text{Mean Value of Spikes}}$
	AND IF	$\frac{\lvert \text{Min. Value} - \text{Avg. Value} \rvert}{\text{Average Value}}$	$\leq$	$\frac{\text{2 Std. Dev. of Spikes}}{\text{Mean Value of Spikes}}$
	THEN average all data from two lower data points.			
(d)	IF	$\frac{\lvert \text{Max. Value} - \text{Avg. Value} \rvert}{\text{Average Value}}$	$\geq$	$\frac{\text{2 Std. Dev. of Spikes}}{\text{Mean Value of Spikes}}$
	AND IF	$\frac{\lvert \text{Min. Value} - \text{Avg. Value} \rvert}{\text{Average Value}}$	$\geq$	$\frac{\text{2 Std. Dev. of Spikes}}{\text{Mean Value of Spikes}}$

THEN record highest value if within historical range and/or reasonable based on process knowledge.

3. Historically, radon data from property fence line and background locations have been recorded at concentrations of less than one pCi/L. For six months of exposure to this radon concentration, a total radon exposure of approximately 180 pCi/L-days would be observed. To ensure that the measurement technique has the ability to measure these low levels of radon, quality assurance measurements (spikes) at a total radon exposure of approximately 100 pCi/L-days are performed. If the measured exposure varies from the reference value (approximately 100 pCi/L-day), a laboratory exposure bias

correction factor is calculated. This bias correction factor is equal to the expected reference value minus the observed mean value.

4. The bias correction factor is then applied to all location data points that passed the screening criteria for precision, giving a corrected exposure.

5. The corrected concentration is then determined by dividing the corrected exposure by the number of days in the exposure period (sampling time). The resulting concentration data is used to determine a location average corrected radon concentration.

K.6.2.5 **QA/QC Requirements for Continuous Environmental Radon Monitoring**. The continuous environmental radon monitors operate in a passive mode, allowing radon to diffuse through the foam barrier of the alpha-scintillation detector. The units are set to collect measurements of a one-hour duration. Data is reduced to daily (~24 hours) average radon concentration. Summary statistics are performed by month, yielding minimum, maximum, and average daily radon concentrations.

The following quality assurance measures are used under the continuous environmental radon monitoring sampling program.

A. All repairs are performed by the instrument manufacturer.

B. All calibrations are performed in facilities consistent with USEPA's Radon Measurement Proficiency Program for approved radon labs.

C. All calibrations are performed to procedures consistent with USEPA's Radon Measurement Proficiency Program for approved radon labs.

D. All monitoring instruments are calibrated as a contiguous unit (a continuous passive radon detector mated to a specific counting instrument).

E. All monitoring instruments are calibrated with NIST-traceable sources annually or as needed.

F. All monitoring instruments are calibrated in a known radon concentration (usually 10 pCi/L) for a period of 48 hours yielding a sensitivity calibration factor.

G. All calibrated monitoring instruments must be exposed in a radon-free atmosphere for a period of 24 hours in order to determine total instrument background value.

H. All calibrated counting instruments must be counted for a period of 24 hours in order to determine electronic background value of total instrument background value.

I. Routine source checks (i.e., monthly) are performed on the counting instrument. Data will be recorded on process control charts, and only instruments demonstrating the following acceptable performance will remain in the field to collect data:

1. An instrument is acceptable for use if source check data falls within ± two standard deviations of the mean expected count rate.

2. An instrument is unacceptable for use if source check data falls outside of ± two standard deviations of the mean expected count rate. The affected instrument(s) will not be used until examined, repaired, and recalibrated if necessary.

K.6.3 General Area Air Samples

Routine air sampling is performed to measure levels of airborne radioactive material in order to properly characterize areas in accordance with 10 CFR, Part 835 and to establish a basis for determining respiratory protection requirements. Sampling is accomplished as follows using instrumentation that includes a pump with an appropriate filter set at a designated location (e.g., the breathing zone of workers) as well as and counting instruments to determine amount of collected contaminants.

1. Prior to taking a sample, determine amount of activity required for sample.

2. Base sample collection time on pump flow rate and parameters in step 1 so that ten percent of derived air concentration is detected if present.

3. Record start time of sample collection and flow rate.

4. When collection is complete, turn off pump and record the end time.

5. Count filter media on appropriate instrument. Record elapsed time between time of counting and time that filter was removed from pump.

6. If necessary, recount sample and follow applicable procedure for determining long-lived radon or thoron concentrations.

Continuous Air Monitors (CAM) are used to provide real-time air monitoring as required by 10 CFR, Part 835. There are several different types of CAMs in use at the FEMP and each must be operated in accordance with applicable documented procedures. These instruments are generally used as warning devices. However, instruments equipped with strip charts may be used for tracking ambient airborne levels of radioactive contaminants.

K.6.4 Monitoring for Organic and Inorganic Contaminants in the Field

Air monitoring is done to screen samples for organic analysis in the field and to protect workers from organic and inorganic contaminants in accordance with FEMP and OSHA requirements. Types of equipment used and contaminants detected include the following:

A. A PID or FID for organic vapors relative to a standard gas;

B. Colorimetric Indicator Tubes (CIT) for parameter-specific organic and inorganic vapors;

C. Explosimeters for combustible gases;

D. Filter pumps and petrographic microscopes for quantification of asbestos contaminants.

E. Portable gas chromatographs for quantification of specific parameters.

Field monitoring equipment shall be permanently labeled with a unique identification number. Calibration gases and calibration standards shall be in the approximate range of measured contaminants because most monitoring equipment responses are not linear throughout the range of operation. Calibrations shall be checked daily or per use. Instrument response shall be checked at each use. Rechargeable batteries shall be recharged after each day of use and checked prior to the start of each work day. The manufacturer, batch number, type, and response range shall be recorded for disposable materials (e.g., air filters and CITs).

K.6.4.1 **Photo-Ionization Detector**. The PID is the standard field instrument for monitoring the work zone for organic and certain inorganic vapors, screening samples for organic analysis, and performing head space measurements on wells. The instrument may be affected by humidity, electromagnetic fields, high concentrations of many compounds (e.g., methane), and certain instruments may be affected by wind speed into the probe. Common PIDs include the HNu PI-102, the Photovac microtip TIP and TIP II, and the Environmental Instruments OVM.

The PID shall be calibrated to a standard gas of known response (usually isobutylene) and measurements normalized to calibrated units of the gas. Readings shall be qualified to indicate the standard gas (e.g., 10 ppm of isobutylene). Because different gases have different responses to a PID, the concentration of a particular gas cannot be quantified unless it is known that only one ionizable gas is present and the wavelength of the PID bulb, the ionization potential of the gas, and the response factor for that gas at the wavelength of the bulb are known. When a mixture of gases is measured, only the relative response of the mixture to the standard is known. When a PID is used, the following items shall be addressed.

A. Check the calibration with a known standard on a daily basis and record the response on an instrument log (Appendix I.4.8). If a declining trend in instrument response is noted or if the response is not within ten percent of the standard, recalibrate the instrument.

B. Prior to each use, verify the response of the instrument to an organic vapor source such as an indelible marker and allow the instrument to purge itself of the vapor before continuing use.

C. Change the filter, as applicable, on a monthly basis or more often under high-use or harsh conditions. Record the last cleaning or replacement on the instrument log.

D. Clean the lamp and ion chamber on a PID or the burn chamber on a FID (Appendix K.6.4.2) monthly or more often under high-use or harsh conditions. Record cleanings on the instrument log.

E. Set zero either with ultra-pure air or by operating the instrument in a known "clean" area. Measure background readings at the site before start of work.

F. When screening samples for organic contaminants, the background contribution from ambient air or the container in which the sample is placed must be accounted for. Container blanks shall be analyzed at a frequency of at least 1 per 20 measurements when glass or stainless steel containers are used. Container blank measurements shall

be made on every container when plastic or teflon containers are used. Record all background and container blank measurements.

G. When screening samples for organic contaminants, record the maximum reading.

H. Sample preparation and handling when screening for organic contaminants are a function of the sample matrix, expected concentrations of contaminants, field conditions, and the intended data use. These items shall be addressed in PSPs when this type of measurement is specified.

K.6.4.2 **Flame-Ionization Detector**. A FID is used to detect organic compounds using a hydrogen flame-ionization source. Like the PID, a FID measures total concentration of ionizable compounds rather than parameter-specific concentrations. The constituents ionized by an FID are not limited by wavelength. Therefore, a wider range of constituents, including methane (which will not be measured by a PID) will be included in total concentrations relative to a PID. Therefore, total concentrations measured with a FID can not be directly correlated to the concentrations measured by a PID. When a FID is used, items B through H listed in Appendix K.6.4.1 shall be addressed.

K.6.4.3 **Colorimetric Indicator Tubes**. CITs are used to detect a wide variety of organic and inorganic gases and vapors. Individual tubes can be used only once and only for specific elements or compounds. Also, many tubes are useful only in a specified concentration range. Either manual or automatic pumps may be used; however, only tubes manufactured for a specific pump may be used with that pump. Detailed instructions for use accompany each box of tubes.

Prior to using CITs, check the pump for leaks by inserting an unopened tube into the pump and operating it. A sufficient vacuum shall be present to prevent further operation of the pump until the tube is removed. If a sufficient vacuum is not present, recheck the pump with another unopened tube. If test still fails, repair or replace pump.

Care shall be taken when handling broken glass from opened tubes. Used CITs shall be properly disposed.

Different tubes have different response times, so it is important that activities depending on the result of the CIT response be curtailed until the response is complete.

The use of CITs is dependant on the types and concentrations of contaminants expected. If the use of CITs is required, the types of tubes and pumps shall be specified in the PSP. Operating requirements shall be as directed by the manufacturer of the particular tube and pump specified.

K.6.4.4 **Explosimeters**. Explosimeters are used to test an atmosphere for concentration of combustible gases and vapors. When used in confined spaces, an explosimeter shall always be used with an oxygen meter. The explosimeter will only detect presence of explosive gases and vapors, not dusts or mists. Most explosimeters are calibrated relative to methane gas. If there is a potential for encountering a gas or vapor that is more explosive than methane, make adjustments in the alarm settings to increase the sensitivity of the instrument. Never set the initial alarm setting higher than ten percent of the lower explosive limit.

K.6.4.5 Filter Pumps. Filter pumps are used to collect particulates from the air. Size filters to collect the particulates of interest using prefilters if necessary. Check pumps for leaks by blocking the intake to see if a vacuum forms. Filters are quantified for asbestos analysis by point-counting fibers or particles of interest with a petrographic microscope. Other types of measurements rely on weight change of the filters or quantification of chemical changes. Record the filter manufacturer, filter size, installation and removal time, beginning and ending flow rate, and length of pump operation time in the daily field log book or daily log form when use of a filter pump is specified in a PSP.

K.6.4.6 X-Ray Fluorescence Spectrometer (XRF) with HgI_2 Detector - Spectrace 9000. This instrument includes a portable multichannel analyzer (MCA) with a mercuric iodide (HgI_2) detector and three sealed radioactive sources (^{55}Fe, ^{109}Cd, and ^{241}Am). The system performs a qualitative and semi-quantitative analysis of chemical elements by means of energy dispersive x-ray fluorescence spectroscopy. A sample is placed in the sample chamber, where it is irradiated with incidental radiation from a radioactive source contained within the instrument. The sample can be a solid, liquid, slurry or powder and normally requires no special preparation. The analysis is nondestructive and can be repeated with highly reproducible results. After the sample has been irradiated with x-rays and the data collected, the XRF produces a spectral distribution of the characteristic energy lines of all sample elements from sulfur through uranium.

The unit is preset at the factory to allow adjustment for the matrices to be surveyed by the user. Instrument calibration shall be verified each day prior to use to confirm that the instrument is functioning within calibration, resolution, and intensity specifications (see Appendix I.4.12).

The following requirements shall be followed when the instrument is operated:

A. Remove the electronic unit, probe assembly, interface cable, and optional equipment ([mylar film, sample cups and RS-232 (25 to 9 pin) interface cable for a laptop PC]) from the storage case.

B. Prepare the sample for screening and the XRF probe used in the bench-top configuration, or screen the sample *in situ*.

C. Using three sealed radioactive sources (Fe^{55}, Cd^{109}, and Am^{241}), conduct sample screening.

D. Expose the samples to the x-ray energy emitted by the radioactive sources. The XRF performs a qualitative and semi-quantitative screening by measuring x-ray energy and intensity fluoresced by the elements present in the sample.

E. Store data in the electronic memory or (optional) download into a laptop PC.

F. Turn the equipment off and pack it into the protective case. Return the case to the designated storage location.

K.6.5 Radiological Air Particulate Monitoring
The goal of air sampling at a site is to adequately characterize air-related contaminant exposures. At a minimum, sampling results shall be adequate for predictive short-term and

long-term modeling. When long-term inhalation exposures are required, sample results shall be representative of the long-term exposure points. This requires an air sampling program of sufficient temporal scale to encompass the range of meteorological and climatic conditions potentially affecting emissions and of sufficient spatial scale to characterize associated air concentrations at potential exposure points.

The potential exists for exposure to air particulates from past and present releases, both directly from the facility and from resuspension of materials following deposition. Uranium is the primary particulate constituent of concern, making particulate air sampling an important part of the environmental surveillance program conducted to comply with applicable dose limits. Selection of air monitoring methodology depends on emission sources investigated and exposure routes evaluated. For example, if dust inhalation is an exposure pathway of concern, the monitoring equipment shall be able to collect respirable dust samples.

Air sampler locations are based on DOE requirements, public concern, control location, and special studies. Justification of additional monitoring stations or omission of existing stations shall be documented. In general, indicator locations shall not be placed in valleys, near structures that would affect measurements, in areas of different geology, or in areas where altitude differs significantly (150 meters). At least one control air monitoring station shall be maintained and monitored at the same frequency as the indicator stations.

Air samplers shall be mounted in locked, all-weather stations with the sampler discharge located to prevent recirculation of air. The air sampling system shall have a flow rate meter. The air sampling rate shall not vary by more than 20 percent, and total air flow or total running time shall be indicated. Linear flow rate across air particulate filters shall be maintained between 20 to 50 meters per minute (m/min).

Air sampling systems shall be leak-tested, flow-calibrated (Appendix I.2.4), tested, and inspected routinely according to a written procedure (DOE/EH-0173T, Summary 5q). Flow calibration shall be at least as often as suggested by the manufacturer. If the projected dose equivalent from inhalation of particulates exceeds two mrem (20 percent of the regulatory limit), a particle size analysis of the emission shall be conducted at least annually (DOE/EH-0173T, Summary 5f).

Selection of the filter type for collection of air particulates shall be based on site-specific needs. As a minimum, collection efficiency, particle size selectivity, ease of radiochemical analyses, and cost shall be considered when selecting filters.

Performance standards for air sampling are as follows.

A. Airborne emissions from the FEMP shall be evaluated and their potential for release of radionuclides assessed. Based on this assessment, decisions shall be made regarding necessary effluent monitoring systems; the rationale shall be documented. The potential for emissions shall include consideration of the loss of emission controls while otherwise operating normally.

B. For new facilities or facilities modified in a manner that could affect effluent release quantity or quality or the sensitivity of monitoring or surveillance systems, a pre-operational assessment shall be made to determine the types and quantities of liquid

effluents expected to establish the associated airborne emission monitoring needs of the facility.

C. The performance of the airborne emissions monitoring systems shall be sufficient for determining whether the releases of radioactive material are within the limits or requirements specified in DOE 5400.5.

D. Sampling and monitoring systems shall be calibrated before use and recalibrated anytime they are subject to maintenance or modification that may affect equipment calibration.

E. Sampling and monitoring systems shall be recalibrated at least annually and routinely checked with calibration standards to determine that they are consistently functioning properly.

F. Provisions for monitoring of airborne emissions during accidental situations shall be considered when determining routine airborne emission monitoring program needs.

G. Diffuse sources (i.e., area sources or multiple point sources in a limited area) shall be identified and assessed for their potential to contribute to public dose, and shall be considered in designing the site emissions monitoring and environmental surveillance program. Diffuse sources that may contribute a significant fraction (e.g., 10%) of the dose to members of the public resulting from site operations shall be identified, assessed, documented, and verified annually.

H. Airborne emission sampling and monitoring systems shall demonstrate that quantification of airborne emissions is timely, representative, and adequately sensitive.

I. To the extent practicable, samples shall be extracted from the effluent at a location and in a manner that provides a representative sample, using multiport probes if necessary.

J. When continuous monitoring systems are required to signal the need for corrective actions that may be necessary to prevent public or environmental exposures exceeding established limits, the systems shall have alarms set to provide timely warning.

Meteorologic monitoring shall be completed to assess potential offsite impacts for releases of airborne contamination. Assessments may be completed for actual, projected, or accidental releases. Necessary data shall be obtained from onsite instrumentation. Instruments that may be used include wind speed, wind direction, ambient and dewpoint temperature, precipitation, and barometric pressure measuring devices. Sensors and onsite measurement locations shall be determined by applicable PSPs and DQOs.

K.6.5.1 **Radiological Air Particulate Monitoring**. The radiological air particulate monitoring program is designed to provide a continual assessment of the collective emissions accompanying multiple concurrent remediation projects at the FEMP and provide necessary "early warning" feedback regarding the cumulative sitewide effectiveness of project-specific emission controls relative to the health protective NESHAP standard of 10 mrem.

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The program design is based on taking direct measurements of airborne radionuclide concentrations in the environment at or near potential receptor locations. A network of high-volume air monitors has been established based on the location of potential off-site receptors and in consideration of the 16 primary wind rose sectors. The monitoring network encompasses all the current and expected diffuse and point sources at the FEMP. Since the point of compliance under NESHAP Subpart H is the receptor location, monitoring locations are designated at the FEMP property boundary in wind rose sectors where potential receptors are immediately located adjacent to the property boundary. DOE guidance (DOE 1991c) and EPA siting criteria (40 CFR 58, Appendix E) were considered when selecting these locations.

A. Sampling Procedures.

The air filters from the high-volume environmental monitors are collected and analyzed in accordance with the following:

1. DOE Order 5400.5, "Radiation Protection of the Public and Environment";

2. "Environmental Regulatory Guide for Radiological Effluent Monitoring" (DOE 1991c);

3. FEMP SCQ Section 6.0 and Appendix K;

4. Standard Operating Procedure SMPL-08, High Volume Air Monitoring;

5. Data Quality Objective AR-006, "Routine Air Monitoring";

6. Routine analyses are analyzed to ASL B quality level;

7. Quarterly air filter composites are analyzed to ASL D quality level;

8. Standard Operating Procedure EW-0002, Chain of Custody/Request for Analysis Record for Sample Control;

9. Standard Operating Procedure EQT-18, Calibration of Graesby GMW High Volume Air Sampler.

B. Analytical Requirements for Radiological Air Particulate Monitoring.

1. The analytical frequency for this program is designed to meet the following two fundamental criteria:

   a. Provide routine analyses that support a timely evaluation of the effectiveness of sitewide emission controls.

   b. Account for the major contributors to dose as defined in 40 CFR 61.93(b)(5)(ii) for the purposes of demonstrating NESHAP Subpart H compliance.

2. The isotopes selected for analysis represent the major contributors to dose based on the following considerations:

   a. Radionuclides which are stored in large quantities at the FEMP and which will be handled or processed during the remediation effort.

   b. Radionuclides which have been the major contributors to dose based on environmental and stack filter measurements.

   c. Radionuclides which, due to their concentration in waste and contaminated soil, will be the major contributors to dose if the waste or soil is released in the form of fugitive dust.

K.6.5.2 **Direct-Radiation Monitoring**. Direct radiation (TLD) monitoring measures the direct radiation at select locations onsite, at the facility fence line, and in the local community. The data collected under this program are used to assess the collective effect of current remediation activities on the air pathway.

The monitoring design incorporates a network of TLD locations. Three TLDs are deployed quarterly at each location and submitted to the onsite dosimetry laboratory for analysis. External gamma radiation measurements are recorded from each TLD read. All TLDs are analyzed to ASL B.

A. TLD Sampling Procedures.

The TLDs are collected and analyzed in accordance with the following:

1. DOE Order 5400.5 Radiation Protection of the Public and Environment;

2. Environmental Regulatory Guide for Radiological Effluent Monitoring (DOE 1991c);

3. Standard Operating Procedure SMPL-10, Environmental Direct Radiation;

4. Data Quality Objective MS-004 REM Direct Radiation Measurements;

5. Standard Operating Procedure EW-0002, Chain of Custody/Request for Analysis Record for Sample Control.

B. Performance standards for environmental TLDs are as follows:

1. Environmental TLDs shall be mounted at one meter above ground.

2. The frequency of exchange should be based on predicted exposure rates from site operations.

3. The exposure rate should be long enough (typically one calendar quarter) to produce a readily detectable dose (DOE 1991c).

4. Annealing, calibration, readout, storage and exposure periods used should be consistent with the ANSI standard recommendations (ANSI 1975).

All TLDs placed in the field are tracked via a field tracking log which provides information pertaining to when and where dosimeters were deployed as well as scheduled collection date.

K.7 BIOLOGICAL SAMPLING

Biological sampling is conducted at the FEMP to evaluate radiological parameters (e.g., uranium) in selected produce.

K.7.1 Produce Sampling

The following are requirements for collecting samples of farm and garden produce.

A. For offsite properties, obtain permission from property owner and arrange a date and time to collect samples.

B. Complete the sampling prior to fall harvest.

C. Select samples from locations that have not been recently disturbed.

D. Obtain appropriate sample equipment, containers, and preservatives as specified in Table 6-1 (Appendix A) or in PSPs.

E. At a given farm garden, select samples of the same produce type from six locations, if available, and combine them into one sample.

F. Document sample collection activities in a bound field log book or on the daily log form and complete the request for sample analysis and chain of custody records.

G. Handle samples as specified in Section 7 and send samples to designated sample receiving group or laboratory for testing.

K.8 MISCELLANEOUS SAMPLES

A variety of media samples are collected at the FEMP to characterize radiological and chemical contaminants to determine handling and disposal requirements. Media samples shall be collected at sample point locations specified in PSPs. Each sample shall be placed in appropriate sample containers as identified in Table 6-1 (Appendix A) and labeled as specified in Section 7.

The following methodology shall be used to collect solid debris samples from construction, renovation, and demolition (paint chip, wood, concrete, dust, asphalt, masonry, shreddable material, sheet metal, structural steel and transite) for radiological and chemical analyses. Grab sampling is the common sample collection method to be used. Composite samples may be specified in the PSP. Composite samples are collected as grab samples and then composited.

Collect samples in accordance with the stability and volatility of parameters to be tested in the following order:

A. Volatile organic compounds;

B. Total organic halogens;

C. Total organic carbon;

D. Extractable organic compounds (semivolatiles, pesticides, PCBs);

E. Unfiltered metals;

F. Phenols;

G. Cyanide;

H. Sulfate and chloride;

I. Nitrate and ammonia;

J. Radionuclides.

K.8.1 Paint Chip Samples

A. Place clean plastic sheeting on the ground, concrete, or floor surface within the sample area.

B. Use a decontaminated putty knife, paint scraper, or needle scaler to remove loose paint material from host surface.

C. Collect chips in a clean stainless steel pan or tray and transfer them to an appropriate sample container (Table 6-1, Appendix A, or PSPs) with a stainless steel scoop or spoon.

D. Seal the containers with custody tape. Label the samples and complete chain of custody records and sample collection logs.

E. Store samples as specified in Appendix K.10.1.

F. Deliver the samples and chain of custody record to the FEMP laboratory or sample receiving group.

K.8.2 Wood Samples

A. Place clean plastic sheeting on the ground, concrete, or floor surface within the sample area.

B. Use a rotary drill and decontaminated wood bit to extract wood cuttings in a clean stainless steel pan or tray, or a clean plastic liner for nonvolatile analytes.

C. Transfer wood cuttings from the pan or tray with a stainless steel scoop or spoon to an appropriate sample container.

D. Seal the containers with custody tape. Label the samples and complete the chain of custody records and sample collection logs.

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E. Store samples as specified in Appendix K.10.1.

F. Deliver the samples and the chain of custody record to the FEMP laboratory or sample receiving group.

K.8.3 Concrete Samples

A. Place clean plastic sheeting on ground, concrete, or floor surface within sample area.

B. Use a rotary drill and decontaminated coring bit or brushing tool to collect concrete cuttings in a clean stainless steel pan or tray.

C. Transfer cuttings from pan or tray with a stainless steel scoop or spoon to appropriate sample container.

D. Seal the containers with custody tape. Label the samples and complete the chain of custody records and sample collection logs.

E. Store samples as specified in Appendix K.10.1.

F. Deliver the samples and the chain of custody record to the FEMP laboratory or sample receiving group.

K.8.4 Dust Collector Residue Samples

A. Place clean plastic sheeting on ground, concrete, or floor surface within sample area.

B. Use a decontaminated stainless steel scoop to collect samples.

C. Transfer dust residue to appropriate sample container.

D. Seal the containers with custody tape. Label the samples and complete the chain of custody records and sample collection logs.

E. Store samples as specified in Appendix K.10.1.

F. Deliver the samples and the chain of custody record to the FEMP laboratory or sample receiving group.

K.8.5 Asphalt Samples

A. Collect samples for VOC analysis first, so there is less chance for constituents of concern to volatilize or photo degrade.

B. Place a clean, plastic sheet on the concrete or floor surface (or the ground) within the sample area.

C. Use a rotary drill and coring bit, a hammer and chisel, or a direct-push method to collect asphalt cuttings in a clean stainless steel pan or tray, or directly into a core tube liner.

D. Using a hammer and chisel, reduce the cutting sizes to 9.5 mm (1/3 in) or smaller pieces.

E. Transfer the cuttings from the pan or tray with a stainless steel scoop or spoon to an appropriate sample container. Fill the containers as full as possible to minimize headspace.

F. Seal the containers with custody tape. Label the samples and complete the chain of custody records and sample collection logs.

G. Store the samples as specified in Appendix K.10.1.

H. Deliver the samples and chain of custody records to the FEMP laboratory or sample receiving group.

K.8.6 Masonry Samples

A. Collect samples for VOC analysis first, so there is less chance for constituents of concern to volatilize or photo degrade.

B. Place a clean plastic sheet on the ground, concrete, or floor surface within the sample area.

C. Using a hammer and chisel or a rotary drill with a chisel attachment and a dust collector with a HEPA vacuum attachment, chisel the masonry and collect the chips in a clean stainless steel pan or tray.

D. Transfer the chips from the pan or tray to an appropriate sample container, using a stainless steel scoop or spoon. Fill the container as full as possible to minimize headspace.

E. Seal the sample containers with custody tape. Label the samples and complete the chain of custody records and sample collection logs.

F. Store samples as specified in Appendix K.10.1.

G. Deliver the samples and chain of custody record to the FEMP laboratory or sample receiving group.

K.8.7 Shreddable Samples

Shreddable materials such as fabric or plastic shall be sampled as follows.

A. Collect samples for VOC analysis first, so there is less chance for constituents of concern to volatilize or photo degrade.

B. Place a clean plastic sheet on the ground, concrete, or floor surface within the sample area.

C. Use shears to shred the material and collect the shreds in a clean stainless steel pan or tray.

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D. Transfer shreds from the pan or tray with a stainless steel pan or scoop, grippers or forceps to an appropriate sample container. Fill the container as full as possible to minimize headspace.

E. Seal the containers with custody tape. Label the samples and complete the chain of custody records and sample collection logs.

F. Store samples as specified in Appendix K.10.1.

G. Deliver the samples and chain of custody record to the FEMP laboratory or sample receiving group.

K.8.8 Sheet Metal

A. Collect samples for VOC analysis first, so there is less chance for constituents of concern to volatilize or photo degrade.

B. Place a clean plastic sheet on the ground, concrete, or floor surface within the sample area.

C. Using a clean pair of metal shears or tin snips, cut metal slugs from the sample piece, collecting the slugs in a clean stainless steel pan or tray.

D. Transfer the slugs from the pan or tray to an appropriate sample container, using a stainless steel scoop, grippers or forceps. Fill the container as full as possible to minimize headspace.

E. Seal the containers with custody tape. Label the samples and complete the chain of custody records and sample collection logs.

F. Store samples as specified in Appendix K.10.1.

G. Deliver the samples and chain of custody record to the FEMP laboratory or sample receiving group.

K.8.9 Structural Steel

A. Collect samples for VOC analysis first, so there is less chance for constituents of concern to volatilize or photo degrade.

B. Place a clean plastic sheet on the ground, concrete, or floor surface within the sample area.

C. Using a hammer and chisel, a scraper, or a needle scaler, remove coatings and oxides from the structural steel. Collect the scrapings into a clean stainless steel tray or pan until an appropriate amount of media is collected.

D. Transfer the media from the pan or tray to an appropriate sample container using a stainless steel scoop or spoon. Fill the container as full as possible to minimize headspace.

E. Seal the containers with custody tape. Label the samples and complete the chain of custody records and sample collection logs.

F. Store samples as specified in Appendix K.10.1.

G. Deliver the samples and chain of custody record to the FEMP laboratory or sample receiving group.

K.8.10 Transite

A. Collect samples for VOC analysis first, so there is less chance for constituents of concern to volatilize or photo degrade.

B. Place a clean plastic sheet on the ground, concrete, or floor surface within the sample area.

C. Wet the surface to be sampled. Remove the sample using a coring device or a disposable knife.

D. Immediately place the sample in the sample container. Fill the container as full as possible to minimize headspace.

E. Seal the disturbed area with an encapsulant, plastic tape or acceptable alternative.

F. Seal the containers with custody tape. Label the samples and the complete chain of custody records and sample collection logs.

G. Store samples as specified in Appendix K.10.1.

H. Deliver the samples and chain of custody record to the FEMP laboratory or sample receiving group.

K.9 SAMPLE COLLECTION FORMS

NOTE

Information in activity-specific logs (including sample collection forms) shall be written in such a manner that the sampling team may reconstruct that event without reliance upon memory.

Sample collection forms shall be completed for all sampling activities throughout the performance of field activity and are considered part of the daily log (see Sections 5.1 and 6.1). The sample collection form is the beginning of the chain of custody, and it should be carefully completed to ensure a defendable chain of custody. Specific information to be recorded on the sample collection form is listed in Section 6.1.

K.10 FIELD STORAGE AND SHIPMENT OF SAMPLES

Shipment of samples designated as environmental samples is not regulated by the U.S. Department of Transportation (DOT). However, these samples shall be transported in a manner to preserve their integrity. If there is any doubt as to the sample classification, it will be considered a hazardous substance and shipped accordingly.

DOT has regulatory responsibility for the safety of hazardous materials transported offsite by any means. Regulations for packaging, marking, labeling, and shipping of hazardous substances are promulgated by DOT and described in 49 CFR, Parts 171 through 177.

Samples shipped by common carrier or through the United States Mail must comply with DOT Hazardous Materials Regulations (49 CFR, Part 172). The person sending such material is responsible for ensuring compliance as applicable.

Radioactive Materials (RAM) samples are, by definition, hazardous and are subject to specific stringent regulations governing their transportation. RAM transportation is regulated by DOT under the Transportation Safety Act of 1974. Samples collected from areas suspected of being highly contaminated may need to be shipped as hazardous material.

The Nuclear Regulatory Commission (NRC) is responsible for governing the transportation of radioactive source material. Specifically included in NRC responsibilities is approval of certain types of packages (type B and fissile). DOE Orders require the FEMP to ship all RAM in compliance with applicable DOT and NRC rules or to provide equivalent safety to the public.

Applicable chain of custody requirements are discussed in detail in Section 7.

K.10.1 Field Storage

General requirements for the storage of samples in the field are as follows:

A. Keep samples cool and away from direct sunlight.

B. As soon as samples are collected, filtered (when necessary), and preserved, secure the lids and seal each sample container with custody tape.

C. As specified in Table 6-1 (Appendix A), store samples requiring refrigeration in the field in an ice chest cooled with artificial icing material to obtain a temperature of approximately 4°C, ±2°C.

D. Transfer samples promptly to the laboratory or sample receiving group to avoid exceeding holding times. See Appendix K.10.4 for packaging and shipping requirements.

K.10.2 Sample Container Preparation

Sample containers for all analyses shall be purchased precleaned. Suppliers will be required to provide containers which have been cleaned in accordance with "Guidance for Obtaining Contaminant-Free Sample Containers." (U.S. Environmental Protection Agency, 1992). Suppliers will also be required to provide supporting QC summary documentation to demonstrate that the containers are contaminant free.

K.10.3 Sample Preservation

Certain samples must be preserved to minimize the degradation of the constituents of concern prior to analysis. If requested, sample bottles may be prepared in a sample preparation area with premeasured amounts of appropriate chemical preservatives and sent to the field.

Preservation methods are generally limited to pH control, chemical addition, refrigeration, and freezing. Recommended preservatives for various constituents are given in Table 6-1 (Appendix A). These choices are based on the accompanying references and on information supplied by various quality assurance coordinators. As more data become available, recommended holding times may be adjusted to reflect the new information.

The DOT Office of Hazardous Materials, Materials Transportation Bureau, has determined that hazardous materials regulations do not apply to sample preservatives that do not exceed the following concentrations.

A. HCl in water solutions at concentrations of 0.04 percent by weight or less;

B. $HgCl_2$ in water solutions at concentrations of 0.004 percent by weight or less (pH about 1.96 or greater);

C. HNO_3 in water solutions at concentrations of 0.15 percent by weight or less (pH about 1.62 or greater);

D. H_2SO_4 in water solutions at concentrations of 0.35 percent by weight or less (pH about 1.15 or greater);

E. NaOH in water solutions at concentrations of 0.080 percent by weight or less (pH about 12.30 or less);

F. H_3PO_4 in water solutions at concentrations yielding a pH range between 2 and 4.

K.10.4 Environmental Samples

Samples collected and designated environmental samples shall be shipped to maintain sample integrity and chain of custody requirements. However, if an acidic preservative is added to a sample, the amount of preservative must not exceed the reportable quantity listed in 49 CFR. If it does, the sample must be reclassified as a hazardous material in accordance with DOT Hazardous Materials Tables, 49 CFR, and the sample must be shipped accordingly as a corrosive substance. Shipment of certain nitric acid solutions is forbidden on aircraft unless packaged in accordance with 49 CFR, Part 173 (see Appendix K.10.3).

When samples are dispatched to the laboratory for analysis, chain of custody records shall accompany each set of samples. Process sample sets for shipment as follows.

A. Keep lids on original sample containers until they are used for sampling. Do not mix lids. If lids are contaminated, dispose of both lid and container.

C. After a sample is placed in a container, apply a custody seal over the lid and place the container in a plastic bag to minimize potential for contamination by vermiculite or other packing material. Sample containers placed in a box with cardboard separators need

not be placed in plastic bags (e.g., subsurface soil sample jars are returned to their original shipping container, a cardboard box with cardboard inserts).

CAUTION

Do not, under any circumstances, use locally obtained material such as sawdust or sand as a packing material. Do not use ice or earth as packing material.

D. Initially fill metal or plastic picnic-type coolers used for shipping refrigerated/preserved samples with approximately one to two inches of vermiculite or other suitable (noncombustible, absorbent packing) material.

E. Place breakable (e.g., glass) sample containers in a cooler and isolate them from contact with one another using protective material such as bubble wrap or new, unused paint cans. Keep cooler closed except when placing samples in cooler.

F. Pack containers in coolers with artificial icing material.

G. If dry ice is used for coolant, the following procedures apply.

1. Mark each package on at least one side with the designations "Class 9" and "Dry Ice" or "Carbon Dioxide, Solid" and "Frozen Diagnostic Specimens."

2. Package samples in accordance with other requirements of 49 CFR, Part 173.

3. Make advance arrangements between the shipper and each carrier.

H. After packing container with icing material, fill remaining space in the cooler with vermiculite or a suitable substitute.

I. Transport the original chain of custody record and request for analysis to laboratory along with samples. Hand carry records or place them in a plastic bag inside the shipping container and tape it to bottom of cooler lid for shipment with the samples to a laboratory. (See Section 7 for detailed chain of custody and request-for-analysis requirements.)

1. Padlock the containers or seal them for shipment as appropriate. Wrap filament tape or duct tape around container. Then wrap custody tape around the container to prevent access to the contents of the container without breaking the custody seal. Date and initial the custody tape with indelible ink.

2. Address shipping containers to laboratory with indelible pen or ink.

NOTE

Do not mark individual samples within each package with hazard warning labels for environmental samples.

3. If a hazard warning label is applied to container, mark and label the shipping package accordingly.

4. Arrange for transportation of samples, and, when custody is relinquished to the shipper, notify the receiving laboratory custodian by telephone or fax transmission of expected time of arrival and holding time constraints for sample analysis or extraction.

5. Upon receipt by laboratory sample management personnel, examine shipping container contents and record on chain of custody record whether all containers are present and custody seals on all sample containers are intact as specified in Section 7.

J. See PSP for additional requirements.

K.10.5 Packing and Transporting Hazardous Substance Samples
The following are basic steps for handling, packaging, labeling, and shipping hazardous substance samples.

NOTE

The following requirements are based upon DOT regulations in effect at the time this section was revised. Consult with the FEMP transportation group or legal affairs personnel to confirm that these requirements have not been amended.

K.10.5.1 **Hazard Classification**. Select hazard classification of the material from table in 49 CFR, Part 172.101. If more than one class is shown for the shipping name, determine the class by definition.

K.10.5.2 **Proper Shipping Name**. Select proper shipping name and materials from the Hazardous Materials Table (HMT) in 49 CFR, Part 172.101.

K.10.5.3 **Identification Number**. Select the Identification (ID) number that corresponds to the proper shipping name and hazard class from table in 49 CFR, Part 172.101. Enter applicable ID numbers on shipping documents and display them on packaging as required.

K.10.5.4 **Mode of Transportation and Modal Restrictions**. Certain modes of transportation are forbidden for the shipment of some substances (e.g., some concentrations of nitric acid may not be transported on aircraft). The mode of transportation may affect packaging, quantity per package, marking, labeling, shipping papers, or certification.

K.10.5.5 **Proper Packaging**. See table in 49 CFR, Part 172.101 for authorized exceptions and specific packaging authorization. When selecting packaging for transport, the following shall be considered.

A. Type of sample;

B. Sample integrity requirements;

C. Quantity per package;

D. Necessary cushioning material or absorbent materials;

E. Proper pressure;

F. Outage.

Standard general requirements for packages used to ship hazardous materials are contained in 49 CFR, Part 173, Subparts A and B. In general, packages shall be designed and constructed so that under normal transportation conditions there will be no release of the hazardous material, and the effectiveness of the packaging will not be reduced.

K.10.5.6 **Shipping Documentation.** Basic requirements for preparing shipping documentation for hazardous materials include proper shipping name, hazard classification, ID number, total quantity, and the shipper certification. Provide information on shipping papers required by 49 CFR, Part 172, Subpart C.

K.10.5.7 **Certification.** Authorized personnel will certify, by printing on the shipping papers, that the materials being offered for shipment are properly classified, described, packaged, marked, and labeled and are in proper condition for transport as specified in the applicable DOT regulation (49 CFR, Part 172.204).

K.10.5.8 **Marking the Package.** Apply markings specified in 49 CFR, Part 172. Requirements for packaging of 110 gallons or less are identified in 49 CFR, Part 172 and include the following:

A. Shipping name;

B. Identification number;

C. FEMP name and address;

D. Laboratory name and address;

E. Inhalation hazard if required (49 CFR, Part 173);

F. Package orientation markings;

G. Marine pollutant marking, if required per 49 CFR, Part 172.322.

K.10.5.9 **Labeling.** See the table in 49 CFR, Part 172.101 for required labeling, additional labels, location of labels, and packaging of samples.

The Hazardous Materials Tables in 49 CFR, Part 172.101 identify proper labels for hazardous materials. Additional information, including examples of labels, is provided in 49 CFR, Part 172, Subpart E.

K.10.6 Radioactive Samples

In general, most samples collected at FEMP are classified as radioactive for transport purposes; however, certain samples may fall into categories for which special packaging and shipping restrictions are mandated. Guidelines for determining the category to which a particular sample shipment belongs and for selecting a suitable mode of shipment and appropriate packaging follow. Potentially radioactive samples shall be screened as specified by individual laboratory licensing requirements before they can be accepted for analysis.

Regulations impose limits on the total radioactivity (i.e., specific activity times the weight of the package) contained within a package of radioactive material. With respect to type A packages, the limits are expressed as two quantities, A1 and A2, which refer to the maximum permissible activity for radionuclides in special form and normal form radioactive materials, respectively. The samples from FEMP fall into the latter category so the A2 value sets the activity limits for packages of samples. In those cases where contaminated material shipments are designated "low specific activity," "surface contaminated object," or "limited quantity," some fraction of the A2 value will normally apply.

A1 and A2 values are cited in 49 CFR, Part 173.435 for radionuclides of the uranium decay series. Values for radionuclides not listed in the regulations (e.g., lead-214, bismuth-214, polonium-214) have been assigned in accordance with 49 CFR, Part 173.433.

Determination of permissible quantities for samples of contaminated waste from FEMP is more complicated than simple reference to A2 values because such material contains a mixture of radionuclides for which two rules apply. A mixture of radionuclides from a single decay chain is considered to be a single radionuclide if the following criteria apply:

A. Parent and daughters are present in their naturally occurring proportions (e.g., in secular equilibrium);

B. No daughter has a half-life longer than 10 days or a half-life longer than the parent radionuclide.

The A2 quantity applied is that of the parent radionuclide (49 CFR, Part 173.433) for such mixtures.

For those mixtures in which the identity and activity of radionuclides is known, the permissible quantity for each radionuclide shall be such that the following equation is true.

$$F_1 + F_2 + \ldots + F_k \ldots F_n \leq 1$$

Where:

F_k is the ratio of the total activity of the kth radionuclide to its A1 or A2 quantity (49 CFR, Part 173.433).

K.10.7 Low-Specific-Activity Materials

Low-Specific-Activity (LSA) materials include uranium and thorium ores, physical and chemical concentrates of these ores (e.g., yellow cake), unradiated natural or depleted uranium or thorium, surface contaminated objects, nonradioactive material externally contaminated with radioactivity that is not readily dispersible, and material in which the radioactivity is essentially uniformly distributed and does not exceed certain prescribed concentration limits.

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Details for shipping LSA materials are described in 49 CFR, Part 173. The chief advantage of shipping under the LSA category arises when the shipment is consigned "Exclusive Use," that is, under the supervision or direction of a single consignor from point of origin to final destination (49 CFR, Part 173). When packaged shipments of LSA materials are consigned as "Exclusive Use", the shipment is exempt from specification packaging, labeling, and marking. Requirements that shall be met include the following (49 CFR, Part 173).

A. Shipment shall be consigned as "Exclusive Use", unloaded from the conveyance in which it was originally loaded, and accompanied by written instructions for the maintenance of Exclusive-Use shipping controls.

B. Material shall be packaged in strong, tight packages that will not leak under normal transport conditions. Each package shall be marked "Radioactive - LSA."

C. Package shall not exceed limits for removable radioactive contamination and radiation level.

D. The transport vehicle shall be appropriately placarded.

K.10.8 Limited Quantities of Radioactive Material

Limited quantity shipments of radioactive material shall meet the requirements specified in 49 CFR, Part 173. If the activity per package does not exceed 10^{-3} of the A2 quantity of the radionuclide, then it is exempt from specification packaging and from the associated shipping paper, marking, and labeling requirements. Instead, the package need only comply with the following requirements.

A. Material shall be packed in strong, tight packages that will not leak under normal transport conditions. The outside of the inner packaging, or the outside of the packaging itself when there is no inner packaging, shall be marked "Radioactive."

B. The package shall not exceed limits for removable radioactive contamination and radiation level.

C. The package shall be certified acceptable for transport by an enclosed notice in or attached to the package. The notice shall state name of consignor and include the following statement.

> **"This package conforms to conditions and limitations specified in 49 CFR, Part 173.421 for radioactive material, excepted package-limited quantity of material, UN2910."**

K.10.9 General Requirements for Packaging Radioactive Materials

The type of packaging for a radioactive material shipment depends upon general requirements in 49 CFR, Part 173 and specific requirements for the shipping category (type A or B).

A. Unless otherwise specified, shipments of radioactive materials shall comply with requirements of 49 CFR, Part 173 as follows.

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1. Packages shall be tamper-sealed as specified in Section 7 of this document.

2. The smallest outside dimension of a package shall be four inches.

3. Packages shall be designed to maintain shielding efficiency and leak tightness under normal transport conditions. Internal bracing or cushioning shall be adequate.

4. Decay heat generated within the package shall not cause deterioration of the package.

5. Surface temperatures of the package shall not exceed 122°F for mixed loadings or 180°F for vehicles in sole use.

6. Pyrophoric materials shall meet packaging requirements in 49 CFR, Part 173. Pyrophoric radioactive liquids shall not be shipped by air.

7. Each package shall be designed for easy handling and proper security in or on a conveyance during transport.

8. The external surface of each package shall be easily decontaminated as far as practical.

9. Liquid radioactive material shall be packaged in leak-resistant and corrosion-resistant inner containment vessels. In addition, the package shall maintain its integrity if subjected to drop test, contain enough material to absorb twice the volume of liquid from a secondary leak, and provide a corrosion-resistant containment vessel.

10. The package shall not exceed limits for removable radioactive contamination and radiation level.

B. Prior to each use, the following examinations and tests of the packaging are required:

1. Proper labeling for contents;

2. Physical condition;

3. Closure device inspection;

4. Instructions followed;

5. Closure and valves secured;

6. Leak tests;

7. Radiation limits;

8. Contamination limits;

9. Temperatures at equilibrium.

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K.10.9.1 **Type A Package.** FEMP shall maintain on file for at least one year after the latest shipment a complete certification with supporting safety analysis demonstrations that the packaging design, packaging construction methods, and materials were in compliance with specifications. The file shall also relate the contents of the packages shipped to the contents used for testing purposes. The following specifications apply to type A packages:

A. General radioactive materials requirements in 49 CFR, Part 173.410;

B. Type A design requirements in 49 CFR, Part 173.412;

C. Type A performance tests in 49 CFR, Part 173.24.

Marking on the outside of each package shall comply with 49 CFR, Part 178 and shall include the following: "USA DOT Type A and Radioactive Materials." FEMP shall also comply with number size and additional marking requirements of 49 CFR, Part 173.

Type B packaging may be used for type A quantities (49 CFR, Part 173.416). Type A packaging for fissile materials is listed in 49 CFR, Part 173.415.

K.10.9.2 **Type B Package.** It is not anticipated that samples from FEMP will require Type B packaging, but if it is required, the following quality assurance and quality controls will be adhered to as a minimum.

A. Type A criteria shall apply plus adequate provisions for certain serious accident conditions with resultant limited loss of shielding and essentially no loss of containment.

B. Each type B package for fissile materials shall meet the test requirements prescribed in 10 CFR, Part 71 for ability to withstand accident conditions during transportation. Type B packaging requirements for fissile materials are listed in 49 CFR, Part 173.

NOTE

Type B packaging is used for both type B quantity and highway-route-controlled quantity shipments.

C. Type B packaging shall comply with requirements for type A packaging plus test conditions and requirements specified in 49 CFR, Part 173.416.

K.10.9.3 **Industrial Packaging.** Industrial packaging Types IP1 and IP2 shall comply with requirements specified in 49 CFR, Part 173.411. Packaging which meets these criteria may be shipped in "Less Than Load" (LTL) quantities.

K.10.10 Marking and Labeling Radioactive Samples

K.10.10.1 **Marking.** General requirements for marking packages containing radioactive material include the following:

A. Container specification number and name/address (or symbol) of company (specification containers only) (49 CFR, Part 178.3);

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B. Proper shipping name and identification number (UN or NA) for packages with rated capacity of 110 gallons or less (49 CFR, Parts 172.101 and 172.301);

C. Markings in English and printed on or affixed to the surface of a package or on a label tag or sign (49 CFR, Parts 172.301 and 172.310);

D. Gross weight if greater than 110 pounds (49 CFR, Part 172.310);

E. Plain, durable marking on outside of package in letters at least half an inch high with the words "Type A" or Type B" as applicable (49 CFR, Part 172.310);

F. FEMP and FEMP address (49 CFR, Part 172.301);

G. Marked with package orientation markings on two opposite vertical sides of the package with the arrows pointing in the correct upright direction (49 CFR, Part 172.312).

K.10.10.2 Labeling. Label selection shall be based on actual radiation levels at surface and at one meter, the transport index (49 CFR, Parts 173.400, 173.402, 173.403), and, if applicable, the fissile characteristics of the package.

If the sample contains a hazardous substance, a hazardous substance label is required in addition to the radioactive label (e.g., nitric acid solution of radioactive material). Place the labels next to each other on the package, and provide two radioactive labels per package on opposite sides of the package. Each label shall contain the following information:

A. Contents (radionuclides that make up 95% of the activity);

B. Activity in curies or the appropriate international unit;

C. Transport index (on yellow II or III labels only).

K.10.10.3 Shipping Documentation.

A. General requirements for shipping documentation are specified in 49 CFR, Part 172, Subpart C and are as follows:

1. Shipping name;

2. Hazard class;

3. ID number;

4. Quantity.

B. Radioactive requirements for shipping papers are specified in 49 CFR, Part 172.203 and are as follows:

1. Radionuclide (chemical) abbreviation permitted by chemical symbol;

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2. Physical and chemical form if not in special form;

3. Activity of each package in curies, millicuries, or microcuries, or appropriate international units;

4. Package labeling hazard class and category;

5. Transport index for packages labeled radioactive yellow II and yellow IIIa;

6. Fissile data class I, II, or III or "Fissile Exempt";

7. For DOE/NRC approved packages, a notation of the package identification marking.

K.10.11 Radiation and Contamination Control

Measurements of radiation level (dose rate) and of nonfixed (removable) radioactive contamination shall be conducted on radioactive-material shipments to control exposure to radioactivity. The radiation level is the radiation-dose-equivalent rate expressed in mrem/h as specified in 49 CFR, Part 173. Following are the permissible radiation levels for various shipping categories.

A. **Limited Quantity Packages** - Radiation level at any point on the external surface of the package does not exceed 0.5 mrem/h.

B. **LSA Packages** - Radiation level of packages transported as "Exclusive Use" does not, at any time during transport, exceed the following limits.

1. 200 mrem/h on the accessible external surface of the package or 1,000 mrem/h if the following criteria are met:

   a. The shipment is made in a closed transport vehicle;

   b. The package is secured so that its position remains fixed during transport;

   c. No unloading/loading operations occur between the beginning and end of transport.

2. 200 mrem/h at any point on the outer surface of the transport vehicle.

3. 10 mrem/h at any point two meters (6.6 feet) from the outer surfaces of the transport vehicle.

4. 2 mrem/h at any normally occupied position in the transport vehicle (this provision does not apply to private motor carriers when personnel operate under a radiation protection program).

C. **Other Packages** - Radiation level does not exceed 200 mrem/h at any point on the external surface of the package, and the transport index does not exceed ten.

Maximum permissible limits for removable radioactive contamination allowed on a package are specified in 49 CFR, Part 173 and are summarized as follows. The following limits apply to any area of 300 square centimeters.

D. 10^{-5} micro Ci/cm^2 or 22 disintegrations per minute (dpm)/cm^2 for beta/gamma-emitting radionuclides, radionuclides with half-lives less than 10 days, natural uranium, natural thorium, Uranium-235, Uranium-238, Thorium-232, and Thorium-28 and Thorium-230 when contained in ore, and physical concentrates.

E. 10^{-6} micro Ci/cm^2 or 2.2 dpm/cm^2 for other alpha-emitting radionuclides.

Exclusive-use consignments of radioactive material shall not exceed these limits at the beginning of transport and shall not exceed ten times the limits at any time during transport (49 CFR, Part 173.443).

K.10.12 Transportation of Samples on Public Highways

FEMP contractors and subcontractors that transport samples classified as a hazardous substance over public highways shall comply with applicable Federal and state of Ohio regulations pertaining to transportation of hazardous materials.

NOTE

The only exception to this requirement is if a shipment of radioactive materials is made under DOE auspices, is escorted by personnel specially designated by or under the authority of DOE for the purpose of national security, and is exempt from the regulations in 49 CFR, Parts 170 through 189.

K.11 DECONTAMINATION

Sampling equipment, including equipment to be dedicated, shall be decontaminated in order to prevent transfer of contaminants from equipment to sampled media, limit cross-contamination between sampling points, and protect worker health and safety. The following decontamination procedure is designed to accomplish these objectives without affecting the integrity of the collected samples. Generation of hazardous waste and excessive volumes of waste solutions are discouraged. Use of improperly decontaminated equipment is prohibited.

Equipment decontamination shall be performed at a designated decontamination area where a water source and a means of containing decontamination solutions is readily available. Decontamination conducted in the field must be documented in the daily field log. Sampling equipment to be dedicated shall be decontaminated prior to installation or use.

K.11.1 Cleaning Materials

Decontamination requirements are based on those specified in the *Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual*, 1 February 1991, USEPA Region IV Standard Operating Procedure (SOP). Variations from specified materials shall be recorded on the daily field log book or form and potentially affected samples shall be indicated.

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The following materials shall be used during decontamination activities, as applicable:

A. Standard phosphate-free laboratory detergent such as Liquinox or Micro;

B. Pesticide-grade cleaning solvent;

C. Potable water from a public water system;

D. Certified deionized water (may be purchased or produced on site by passing potable water through a standard deionizing resin column) that contains no metals or other inorganic compounds at or above the analytical detection limit of an ICP spectrophotometer scan as defined by the USEPA Contract Laboratory Program (CLP);

E. Certified deionized, organic-free water (may be purchased or produced on site by passing deionized water through an activated carbon filter) that contains no pesticides, extractable organic compounds, and less than 50 μg/L of VOCs as measured by a low-level Gas Chromatography/Mass Spectrometer (GC/MS) scan as defined by the USEPA CLP;

F. A 0.02 normal hydrochloric or sulfuric acid solution (replaces nitric acid specified by the Region IV SOP for safety reasons).

K.11.2 General Equipment Cleaning Procedures

Following are descriptions of the three levels of decontamination identified for this project. The level of decontamination required for a project shall be specified in the PSP.

A. **Level I Decontamination** - Only equipment, tools, and other items that do not come in contact with sampled media shall be cleaned as follows.

1. Steam clean or use high-pressure potable water to wash the designated items.

B. **Level II Decontamination** - Most equipment is designated for Level II decontamination and shall be cleaned as follows.

1. Rinse with potable water.

2. Wash with a phosphate-free laboratory detergent and potable water solution, steam-clean, or wash with high-pressure potable water.

3. Rinse with potable water.

4. Rinse twice with certified deionized organic-free water.

NOTE

Cover equipment used to sample for organic parameters with plastic ONLY if organic parameters released by plastic are not analytical concerns. If aluminum foil is used, wrap equipment with the shiny side out. Do not use

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aluminum foil if aluminum contamination may be an analyte of concern.

5. Air dry and immediately cover with plastic or aluminum foil. Sampling equipment may be wiped dry with clean, lint-free disposable wipes if air drying is not feasible.

6. Label the plastic or aluminum foil with the date of decontamination, the initials of the person performing the decontamination, and the level of decontamination performed. If a plastic bag is used to cover the equipment, then tape the bag tightly.

7. Ensure that decontaminated equipment remains covered and isolated from ambient conditions until use.

C. **Level III Decontamination** - If visibly contaminated by organic chemicals, metals, radionuclides, or other inorganic contaminants of concern to the project or if contamination is detectable by screening with field instruments, Level III cleaning is required as follows.

1. Rinse with potable water.

2. Wash with a phosphate-free laboratory detergent and potable water solution, steam-clean, or wash with high-pressure potable water.

3. Rinse with potable water.

4. Rinse with acid solution.

5. Rinse with potable water.

6. Rinse with an approved solvent such as methanol.

7. Triple rinse with certified deionized, organic-free water.

8. Air dry in a relatively dust-free environment if time permits. Sampling equipment may be wiped dry with clean, lint-free disposable wipes if air drying is not feasible. Cover with plastic or aluminum foil.

9. Label the plastic or aluminum foil with the date of decontamination, the initials of the person performing the decontamination, and the level of decontamination performed. If a plastic bag is used to cover the equipment, then tape the bag tightly.

10. Ensure that decontaminated equipment remains covered and isolated from ambient conditions until use.

K.11.3 Drilling and Direct Push Equipment Decontamination

A. Follow Level I requirements for drilling equipment that contact subsurface material (i.e., augers, drill rods, drill casings, split spoons, auger teeth, or drill bits) when moving between drill sites.

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B. Follow Level II requirements for drilling and sampling equipment that come in contact with chemical or radiological analytical sample media that is suspected to be contaminated.

C. Follow Level I requirements for drilling or sampling equipment that come in contact with analytical sample media that is not contaminated.

D. Use Level III requirements if post-decontamination screening with field instruments indicates gross contamination.

E. Determine decontamination level for drilling rig wheel wells, tires, mast, and other potentially contaminated items based on the next usage. If the rig is to remain in the same work area or contamination area (i.e., the contaminant levels are the same or higher based on existing data), decontamination is not required.

F. Follow Level I requirements if the rig is moved to a cleaner area or to a different work area or contamination area.

K.11.4 Submersible Pumps and Lines

A. Decontaminate the interior and exterior of submersible pumps and lines at Level II.

CAUTION

If a pump becomes grossly contaminated through use at a well, dedicate it to that well.

B. For the final rinse, determine the amount of water required to fill the system and pump at least three times that amount of deionized water through the system.

K.11.5 Filtering Apparatus

A. If in-line filters are not used, remove the used filter and clean sample filtering apparatus at Level II.

B. Do not use filters for more than one sample and do not reuse in-line filters.

K.11.6 Water Level Measurement Probes

Between uses, clean the portion of water level measuring equipment that contacts groundwater at Level II.

K.11.7 Verification of Decontamination Effectiveness

Ensure that decontamination measures are effective as follows.

A. Collect samples of final decontamination rinse at a minimum frequency of 1 per 20 for decontamination of equipment for each type of activity specified in the PSP.

NOTE

More frequent sample collection may be required under some circumstances based on results of

previous rinsate sample analyses, activities performed, or as required by PSPs.

B. Visually inspect equipment for gross contamination (e.g., caked-on mud, grease on threads, organic odor) or screen with field instruments. If evidence of contamination is present, reclean at appropriate level for its intended use.

C. If grossly contaminated equipment is intended for use at a different sampling point, collect rinsate samples after it has been cleaned.

D. Visually inspect equipment before use and clean at appropriate level for its intended use.