

# Hanford Analytical Services Quality Assurance Requirements Document

## Volume 3: Field Analytical Technical Requirements

Prepared for the U.S. Department of Energy  
Assistant Secretary for Environmental Management



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**Richland, Washington 99352**

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## LIST OF TERMS

ASTM	American Society for Testing and Materials
CCV	Continuing Calibration Verification
DOE	U.S. Department of Energy
DQO	Data Quality Objective
DQR	Data Quality Requirements
FSP	Field Sampling Plan
HASQARD	Hanford Analytical Services Quality Assurance Requirements Document
ICV	Initial Calibration Verification
MDL	Method Detection Limit
N/A	Not Applicable
NIST	National Institute of Standards and Technology
QA	Quality Assurance
QAPjP	Quality Assurance Project Plan
QC	Quality Control
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure

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## 1.0 INTRODUCTION

This volume, used with Volume 1, “Administrative Requirements,” sets forth the quality assurance (QA) and quality control (QC) requirements that govern analytical work performed in the field. Field analytical techniques are often qualitative or semi-quantitative analytical methods that can be used to provide a quick determination of the presence, magnitude, or absence of a contaminant. This minimizes the expense and extended turnaround time required to analyze samples in a laboratory. Because the QC and analytical sophistication may not need to be controlled to the same extent as for laboratory analyses, a cross-section of additional samples may need to be submitted to a fixed laboratory for confirmatory quantification. Fixed laboratory methods are further described in Volume 4.

As a matter of convention in this document, the measurement of samples in the field may be performed by field screening techniques, process monitoring techniques, or field testing techniques. The data quality objective (DQO) process should dictate the type of measurement system that will be used. A graded approach is recommended to determine the specific field analytical method and applicable QC requirements based on cost considerations and the decision risk associated with use of the data (see Section 5.1.1).

### 1.1 FIELD SCREENING/PROCESS MONITORING

Field screening/process monitoring procedures are performed directly on the sample or media in the field or in the process facility (e.g., pump and treat facility). A variety of field screening/process monitoring methods are available and the project must clearly define and control the use of any data generated. The chance of false positives and false negatives must be known and adequate QC must be demonstrated to ensure acceptance of the data for use by the decision maker or regulatory authority. Measurements are usually acceptable, as long as the method detection limit (MDL) is below the action levels or regulatory threshold limits. The best results for field screening methods are obtained when the contaminant is known and the measurement technique is acceptable for use under the environmental conditions that exist at the site.

Process monitoring typically involves the sampling of critical points within a treatment system to assess system performance and change out requirements. Process monitoring procedures, similar to field screening procedures, are performed directly on the sample in the facility. Process monitoring methods have the same requirements as field screening methods described above and throughout this volume.

In some cases, hand held portable instruments are used for field screening or process monitoring measurements. This volume only covers the use of these instruments to generate measurements in support of the environmental cleanup mission. It does not cover the use of these instruments in support of the Radiation Control Program or Industrial Hygiene Program.

## **1.2 FIELD TESTING**

Field testing procedures are performed on samples collected in the field and generally analyzed in a field laboratory located at or near the sample collection point. Field analytical measurements may be conducted using the same analytical methods used in a fixed laboratory. Data generated may be used to demonstrate compliance with requirements and must meet similar QC standards as a fixed laboratory and, therefore, require environmental and site conditions to be recorded to ensure that data comparability is based on test conditions similar to those for the fixed laboratory. The level of quality required for the data is determined by the project using the DQO process.

## **2.0 QUALITY ASSURANCE REQUIREMENTS**

This section provides QA criteria to ensure field analytical measurements and process monitoring analytical measurements performed by the field analytical organization supporting the U.S. Department of Energy (DOE), Richland Operations Office and Office of River Protection maintain a consistent standard of performance. For this document, the field analytical organization is defined as any company or group providing radiological, organic, and/or inorganic field screening, process monitoring, or field testing services in support of environmental decision-making.

### **2.1 DATA QUALITY OBJECTIVES**

The primary responsibility for identifying data quality requirements (DQRs) lies with the client or data user. After developing project DQOs/plans, the client or data user discusses basic information about the nature of the sample(s) and the intended use of the data with the field analytical organization prior to sample collection. As a minimum, the field analytical organization and the client shall agree upon the method performance criteria such as precision, accuracy, and sensitivity for all analyses (e.g., instrument detection limit, MDL, and practical quantitation limit). For field organizations performing field screening, process monitoring, or field testing (i.e., analysis of samples in place), the client will identify critical locations where samples or measurements must be obtained. This information is then translated into a sampling and analysis plan (SAP).

The field analytical organization shall have a system to notify and explain any unique project requirements to all staff performing work for the client. Unique requirements are those that differ from the procedures described in this document and in the field analytical organization's standard operating procedures (SOPs).

The field analytical organization shall notify the client when situations occur that were not anticipated in the SAP. These anomalies or non-conformances may result in plan changes by the project. The types of sampling plan changes are discussed in Volume 1, Section 4.4. To the extent necessary, the field organization should make staff and information available to support the team to resolve technical issues in a manner that is acceptable to the client or data user.

### **2.2 CLIENT DATA QUALITY REQUIREMENTS**

DQRs are most frequently listed in the SAPs, which include a field sampling plan (FSP), quality assurance project plan (QAPjP), or other planning documents. The quality requirements shall be mutually understood and agreed upon by the field analytical organization and the client prior to start of the field activity.

The client is responsible for ensuring that access is available to the sample locations and, to the extent possible, that adequate sample material is available to meet project requirements. This can be best achieved if the client includes appropriate field screening, process monitoring, and field testing professionals on the planning team. The field analytical organization(s) providing

field screening, process monitoring, and/or field testing is/are responsible for using proper field measurement procedures and protective sample handling protocols. The field analysis organization and the client share responsibility for selecting appropriate field measurement techniques.

Five parameters (i.e., precision, accuracy, completeness, comparability, and representativeness) are most often used to determine field screening and field testing DQRs. These parameters are defined in Volume 1, Appendix A, "Glossary" and in Volume 4 Section 1.2. Typically these five parameters (or a subset of these) determine data quality and usability and should be considered when selecting a field screening or field testing technique.

### 3.0 SYSTEMS QUALITY ASSURANCE

A number of systems must be in place and operational when field screening, process monitoring, and/or field testing are conducted. These systems must function properly to produce and document the level of quality in the analytical measurements: administrative systems, software systems, technical systems, and physical facility systems. The systems shall be described in the field analytical organization's quality management plan or project QAPjP.

#### 3.1 ADMINISTRATIVE SYSTEMS

Volume 1 of the *Hanford Analytical Services Quality Assurance Requirements Document* (HASQARD) provides the quality requirements for administrative systems that support field analytical activities.

The field analytical team shall establish and maintain a quality system appropriate to the type, range, and volume of sampling, calibration, and/or testing activities. The elements of this system shall be documented in a QA plan. Documentation shall include and/or refer to the following:

- Organizational structure and responsibility
- Procedures or instructions for measuring data precision, accuracy, representativeness, comparability, and completeness
- Procedures or instructions for field operations such as sampling, special processes, purchased items and services, equipment maintenance, instrument calibration and use, field analyses, waste verification, geophysical surveys, and other site characterization activities
- Methods to be used in data reduction, validation, and reporting
- Procedures for corrective action, nonconformance control, identification and control of items, and QC reports to management
- A training and qualifications program to ensure that field sampling/analytical personnel in all positions have been trained and qualified in their specific area of work and in the QA procedures associated with their work
- Document control procedures to ensure that appropriate versions of documentation are being used
- Project interfaces and organizational structure
- Corrective actions and a quality improvement program.

### 3.2 SOFTWARE SYSTEMS

General requirements of software systems are discussed in Volume 1, Section 7.0. Due to variances in field portable equipment, the field analytical team shall ensure that data generated from instrumentation using a software system are backed up and/or downloaded on a regular basis. Computer hardware/software configurations integral to measurement and/or testing equipment that are calibrated for a specific purpose requires calibration and appropriate QC prior to use or testing as being adequate for use and do not require further testing unless the scope of the software usage changes or modifications are made to the hardware/software configuration.

### 3.3 TECHNICAL SYSTEMS

Technical systems ensure that the techniques are applicable and properly applied. These systems may include sample exchanges, standards programs, control of standards, reagents, reference materials or other media potentially impacting the quality of reported results, analytical instrumentation and equipment, data reduction and reporting, data verification and validation, and technical audits/assessments. Procedures for documenting these applicable systems, including required associated precision and accuracy criteria as appropriate, shall be established. Volume 1, Section 8.0, "Procurement Controls," describes the requirements for procured items and services. Volume 1, Section 9.0, "Equipment and Maintenance," describes the requirements for preventative maintenance of field screening, process monitoring, and field testing equipment.

### 3.4 ASSESSMENT SYSTEMS

During the actual performance of field or process monitoring activities, in-process self-assessments or surveillances shall be performed according to the requirements established in Volume 1, Section 10. The QA program shall identify each assessment element and the frequency of assessments.

The audit/self-assessment/surveillance of field analytical activities should be selected from the following subjects:

- **Equipment** – Equipment used for collection, measurement, and testing should meet the applicable standards (e.g., American Society for Testing and Materials [ASTM]) or have been evaluated as acceptable and valid in accordance with the procedures, requirements, and specifications.
- **Verification of analysis activities** – Analysis activities that are the elements of the analysis program will be verified for compliance with the applicable technical and quality standards, specifications, and SAP requirements. The elements to be verified include, but are not limited to, the following:
  - Implementation of QA requirements
  - Qualification of personnel

- Identification, control, and storage of samples, standards, project documents, and generated data
- Implementation of methods or procedures conforming to applicable specifications and SAP/work plan requirements.
- **Corrective action documentation** – Documentation and verification of conditions, observations, and corrective actions taken.
- **Completeness of records** – To determine if records are complete, the following will be examined:
  - Measurements required by the project have been collected
  - Adequate records exist for each sample (or measurement) set and the associated QC samples
  - Specified procedures have been used and changes have been noted according to the established procedures
  - Anomalous field data are identified and appropriately qualified.
- **Evaluation of data with respect to control limits** – Corrective action reports will be examined to determine whether samples associated with out-of-control events are identified in a written report of the sampling activities.
- **Review of holding time data** – Sample holding times will be examined in comparison to the holding times required by the project. Any samples associated with deviations from holding time requirements are identified in a written record of the activities.
- **Implementation and effectiveness of corrective actions** – Corrective action reports will be examined to determine whether analysis activities associated with findings from previous audits/self-assessments/surveillances of similar activities were adequately addressed and corrected.

### 3.5 FIELD DOCUMENTATION AND RECORD KEEPING SYSTEMS

Volume 1, Section 6.0, “Documents and Records,” describes the general requirements for field documents and records.

Field activity recordkeeping and document control shall be specified, prepared, and maintained and should include the following, as applicable:

- Materials quality documentation (e.g., certifications), which concerns the quality of material used for field activities, shall be retained with project files

- Chain of custody
- Field measurement data, calibrations, and analytical results
- Logbooks, log forms, or equivalent
- Site-specific FSP, QAPjP, or work plan
- Any sampling plan modifications or changes, field analytical procedural modifications, as well as the reason for the change.

All documentation must be completed in indelible ink. Corrections must be marked with a single line, dated, and initialed. Handwritten documents such as logbooks and forms must be legible. All logbooks are individually identified with a control number. The field logbooks are usually considered as the master record that documents the sampling event and the operation and maintenance of all field analytical testing equipment. Requirements for field logbooks are discussed in Volume 2, Sections 4.2.2 and 4.2.2.2. Requirements for records associated with electronic systems and databases used as part of a field screening or field testing measurement system are further discussed in Section 6.0.

As a minimum, the following entries will be made in the field analytical organization's documentation for each field analytical activity:

- Names of personnel involved in the field activity
- Signature of person making an entry (the printed name of the person should be indicated at least once per logbook/electronic record by the person's signature)
- Field observations
- Instrument calibration information or reference, as applicable
- Equipment identification numbers (if applicable)
- Field decontamination of equipment and personnel (if applicable)
- Sample identification, identification numbers, date, time, preservative (if required), and analysis
- Field measurement data, types of method, types of QC samples used, and field screening data
- Field measurement location
- Pertinent weather or environmental conditions that may affect data
- Lot numbers of the sample collection containers used

- Radiological screening information, if appropriate
- Variances and field changes.

Field logbooks and other field information forms will be peer reviewed within a reasonable timeframe to ensure that all applicable and necessary information is present to support sampling and data quality.

### **3.6 PHYSICAL FACILITY SYSTEMS**

#### **3.6.1 Physical Layout**

The physical layout of the site must allow the deployment of a mobile laboratory or mobile sampling vehicles, installation of monitoring equipment and appropriate power source, or adequate bench top or table top space for process monitoring equipment, or access by personnel to deploy hand-held monitoring equipment. The location and installation of monitoring equipment must ensure that the sampling component of the monitor is measuring a representative sample.

#### **3.6.2 Facility Design**

Facilities include mobile analytical laboratories, sampling vans, and treatment facilities. Proper facility design and maintenance can help to alleviate problems associated with data generation. The following, at a minimum, shall be addressed:

- Ventilation with air exchange rates and pressure differential between work area, suitable working environment (e.g., lighting and temperature control), stable power sources, and radio frequency shielding
- Adequate space for field analytical activities so the activities do not adversely affect analyses (including solvent, standard, reagent, and waste storage, in addition to other work areas)
- Specialized equipment, such as a laboratory hood or high-efficiency particulate air filtration system, where required
- Water purification
- Storage of gases.

#### **3.6.3 Field Analytical Laboratory Safety**

The field analytical organization shall maintain operations in a safe manner and shall examine activities to determine potential hazards. All work shall adhere to the applicable corporate safety, industrial hygiene, and radiological control procedures. When field analyses are performed, portable eyewash stations and appropriate spill kits shall be located near the point of analyses. Entry into the mobile laboratories, sampling vans, or treatment facility rooms shall be

limited to approved personnel or individuals escorted by approved personnel. Whenever the field analytical organization is performing measurements on radiologically contaminated samples, appropriate radiological working procedures, personnel monitoring, and air monitoring shall be in place. Entrances to the mobile facility or treatment facility rooms shall have the appropriate signs on the entry door regarding personnel protective clothing and radiological conditions/controls.

#### **3.6.4 Waste Management**

Waste produced from field analysis may include sample media, calibration standards, syringes, empty sample containers, waste glassware, paper towels, gloves, and other expendable items. Consideration must be given to reagents used to clean syringes or glassware to minimize generation of hazardous waste.

The handling and disposal of radioactive waste and hazardous waste generated by field analytical methods shall comply with all federal, state, and local requirements. Procedures shall incorporate controls that minimize the generation of waste and maximize the concentration, recovery, and recycling of waste products to the extent economically practical. Site-specific requirements and responsibilities for waste handling and disposal of field analytical waste shall be specified in the SAP or other project documentation.

## **4.0 CALIBRATION**

In general, the performance of measurement systems is controlled through calibration and monitored by continuing verification of calibration. This section describes the activities associated with calibration requirements for field measurement systems and the specifications for standards that are used for calibration.

Calibration procedures (or references) and calibration results shall be documented. Volume 4, Section 4.0 may also be used in the calibration of instruments for analysis of similar types of chemical constituents (i.e., radionuclide, organic, and inorganic).

### **4.1 CALIBRATION OF FIELD SCREENING, PROCESS MONITORING, AND FIELD TESTING SYSTEMS**

Calibrations must be performed as follows:

- Prior to initial use of a field analytical measurement system
- At the frequency recommended by the manufacturer or procedure, or as required by regulations
- Upon failure to meet specified QC criteria.

#### **4.1.1 Initial Calibration**

The initial calibration verification (ICV) for field analytical measurement systems checks the accuracy of the calibration and the standards used for that purpose. A level of independence shall exist between the materials used for calibration and for ICV when such materials are available. When an independent source is not available, the field analytical organization should attempt to purchase an alternate lot of the same material. Some field analytical measurement systems may be calibrated electronically as specified by the instrument manufacturer.

Initial calibration may be performed by the field analytical organization or by an organization different than the field analytical organization.

#### **4.1.2 Continuing Calibration Verification**

The continuing calibration verification (CCV) confirms that the original calibration is within acceptance criteria over time. This standard shall be from the same source as that used for either calibration or ICV. The field analytical organization shall perform CCV. Continuing calibration may have different names such as field accuracy check, accuracy verification, etc. Procedures shall describe the frequency of CCV.

## **4.2 CALIBRATION RECORDS**

The field analytical organization's documentation shall include a record of calibration data for all methods and instruments. If calibration is performed by an organization different from the field analytical organization, then the organization performing the calibration must maintain calibration records. Calibration records (i.e., initial calibration, ICV, and CCV) shall include the raw calibration data, identification of the standards used, associated reports, date of analysis, and analyst's name or initials, at a minimum. Calibration data shall be traceable to the standards used. All samples analyzed shall be traceable to the calibration under which the results were produced. Sample analysis can only proceed when measurement systems are accurately calibrated. All calibration records shall be maintained in accordance with Volume 1, Section 6.0.

## **4.3 BALANCES, THERMOMETERS, AND PIPETTES**

All balances and any thermometers, pipettes, and automatic sample dispensers used for quality affecting measurements shall be uniquely identified. Calibration records of measurement devices such as analytical balances and thermometers for critical mass and temperature measurements shall be maintained. All analytical balances shall be calibrated annually, at a minimum, by an approved metrology organization. An approved metrology organization is one that has been evaluated and selected on the basis of specified criteria that are consistent with industry standards for the calibration of balances. These records shall contain the date of calibration, the identity of the person performing the calibration, the identity of the device or serial number, and the date that the calibration expires. This information, including balance identification, shall be affixed on or near the balance. The field analytical organization shall review the calibration data for compliance with the specified criteria. Acceptable balance calibration shall be verified and documented daily when the devices are in use.

The accuracy of thermometers and thermocouples used for critical temperature measurements (e.g., refrigerator temperature for sample storage or total dissolved solids analysis) shall be verified annually by comparing readings of such devices with the readings of a National Institute of Standards and Technology (NIST) traceable, factory certified, thermometer. If radiological conditions limit comparison to an NIST traceable thermometer, then an alternate check process (e.g., check at steam point, ice point, or comparison to some other known temperature reference) may be used in lieu of the NIST comparison. The NIST traceable, factory certified, thermometer shall be re-verified at a specified frequency.

Hand-held temperature probes shall be calibrated in accordance with manufacturer instructions.

Pipettes used for critical measurements shall be verified to ensure acceptable performance.

## **4.4 GENERAL REQUIREMENTS FOR CALIBRATION STANDARDS**

The following standard specifications shall be used, unless otherwise specified in Section 5.1.2 of this volume.

Standards used for calibration of measurement systems shall be traceable to a nationally or internationally recognized standard agency source or measurement system, if available.

A program for verifying and documenting the accuracy and traceability of all working standards against appropriate primary grade standards or the highest quality standards available shall be routinely followed. Complete documentation of the standards shall become part of the project's permanent record.

Standards used for calibration shall be accompanied by a certificate or record that includes the vendor, lot number, purity, date of preparation, date of expiration, and concentration or activity of the standard material. At a minimum, the following information shall be maintained for standard preparations and, if possible, placed on the label:

- Name of preparer
- Date prepared
- Standard identification number
- Parent standard identification number
- Dilution performed
- Dilution solvent
- Final concentration or activity
- Reference to the method of preparation (e.g., procedure ID)
- Expiration date or shelf life (if applicable).

Standards used as radiation check sources shall be traceable and of known quality. When recognized standard material is unavailable or its purchase is impractical, the field analytical organization should attempt to purchase standard material from a reliable source. The field analytical organization shall have procedures in place to determine the acceptability of such materials.

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## **5.0 QUALITY CONTROL**

The purpose of this section is to provide QC requirements for field screening, process monitoring and field testing methods to ensure that the results are accurate and that the sources of uncertainty are identified and controlled. Both QC and QA are initiated at the start of a project and are integrated into all field analysis activities as the DQOs are developed. The stringency of QC requirements shall be dictated by the intended use of the data. Accordingly, QC requirements may range from those comparable to a fixed analytical laboratory to those which involve simply following manufacturers' instruction for operating the measuring device.

Field screening, process monitoring, and field testing shall be performed by trained individuals in accordance with approved written procedures and with properly calibrated instruments that are sensitive to the analyte of interest. In addition, the field analytical methods must also incorporate QC samples throughout the sampling and analysis processes to provide data for evaluating the effectiveness of analytical processes. The QC samples permit assessment of the quality of field generated environmental data and/or on the representativeness of the environmental media being measured. The information gained from the QC assessment can then be used, where necessary, to implement corrective actions during the field sampling and analytical process or to improve processes for future application.

The field analytical group responsible for field screening, process monitoring, and field testing must ensure that the QC applied to a given scope of work is capable of meeting client objectives for precision and accuracy, or the field analytical group must negotiate alternative requirements.

### **5.1 OVERVIEW OF QUALITY CONTROL PROCEDURES**

The HASQARD QA/QC program is based on a variety of QC samples. The results are used to measure method performance, guide real-time corrective action, and document the reliability of analytical data. These QC procedures apply to field screening, process monitoring, and field testing; however, the requirement for specific QC procedures may be modified by the individual project. All measurement systems must be responsive to the target analyte in known manner (frequently referred to as "calibration") and this response must be confirmed at intervals during the analytical process (i.e., CCV). All other QC procedures are applied as often as needed to ensure that variables known to effect method performance are in control during the analysis. The QC measurements help to assess method performance in terms of selectivity, precision, accuracy, representativeness, and sensitivity.

The HASQARD QC requirements establish controls to ensure a documented degree of precision, accuracy, and reproducibility. Based on the field screening, process monitoring, and field testing design, QC samples allow the data user (working in cooperation with the field analytical organization) to control and document analytical performance based on data needs, the characteristics of the site, and the analytical resources available.

### **5.1.1 Field Screening, Process Monitoring, and Field Testing Requirements**

Tables 5.1 and 5.2 establish frequencies and acceptance levels for QC samples for selected field testing and field screening instrumentation. The tables also present a brief definition and description of the purpose of each sample, acceptance criteria, and frequency requirements. The tables are organized according to instrument types. The QC samples that are applicable to a specific class of analytes (i.e., radiological, organic, and inorganic) are also indicated.

The performance of the instrument (measurement system) is considered under ideal conditions and/or with ideal matrices and target analytes. The possible impacts from the method (e.g., sample preparation, reagents, temperature, and execution), impacts of other constituents, or the sample matrix in the field sample are addressed by the required/recommended QC samples. The specific QA/QC criteria that are applied to any set of analyses shall be established during the planning process and communicated to the field analytical organization in work authorization documents. The QA/QC criteria shall be in accordance with the intended use of the data.

### **5.1.2 Standards**

After the stabilization and calibration of the analytical equipment in accordance with the analytical method, the calibration shall be verified with the analysis of an independent verification standard. A qualified person should prepare an acceptable independent standard, or the standard can be purchased as a certified pre-made standard from a vendor. User prepared verification standards are preferably made with chemicals from a different source rather than the chemicals used in the calibration standards. Often the manufacturer will specify the continuing calibration standard to be used for a given measurement on a given instrument or probe. If the independent verification fails to pass the method-specific acceptance criteria, the calibration sequence must be repeated.

The CCV demonstrates instrument performance or stability (e.g., monitors calibration drift) during the analysis. The CCV shall be performed at the beginning and at the end of the analysis, or in accordance with manufacturer instructions. The CCV must meet the method-specific acceptance criteria or recalibration must be performed. At minimum samples bracketed by a noncompliant CCV shall be appropriately qualified. Where sufficient sample volume is available, samples bracketed by a noncompliant CCV shall be reanalyzed.

Performance check standards are analyzed in accordance with the instrument-specific criteria as stated in instrument-specific procedures or manufacturer's criteria. Performance check standards shall meet the QC specified in the instrument-specific procedure before analysis can begin or continue.

**Table 5-1. Field Screening / Process Monitoring Instrumentation Quality Requirements. (4 sheets)**

Instrument	Use	Detection Limits	Calibration	QC Requirements	QC Criteria	Comments
Total organic vapor meters <sup>a</sup>	Sample screening for volatile compounds; soil gas screening.	Varies by Manufacturer	Initial prior to use.	Verification check before and end of use.	±30%	DQO action levels; photoionization detector cannot detect compounds with ionization potential >11.
Indicator kits (colorimetric, such as Hach Kits); immunoassay	Field screening for a variety of analytes; quantification accuracy varies with method.	Varies by kit; follow manufacturer's instructions. MDL study may be required.	Initial by manufacturer; check color response with level of analyte.	Verification check before use for spectrometric methods.	±30%	Check expiration dates and storage requirements; interference from other compounds. DQOs may require additional QC.
Gas chromatograph	Sample analysis of known volatile organic compounds.	Highly dependent upon detector; MDL study required; must be defined prior to use.	Three-point initial.	Continuing checks to bracket the analytical run. Minimum one blank/day.	±50%	MDLs must be supplied and meet DQOs.
pH meter	Field screening (water and soil).	Not applicable (N/A)	Two-point with standards within the expected range.	Verification checks before and after use.	Accuracy to ±0.5 pH units	Check pH calibration based on manufacturer's recommendations.
Conductivity meter	Determine conductivity of water.	N/A	One-point in 0.01N potassium chloride (KCl) solution.	Verification checks before use.	N/A	Follow manufacturer's instructions.
Dissolved oxygen meter	Determine amount of dissolved oxygen in water.	N/A	Follow manufacturer's instructions.	N/A	N/A	Follow manufacturer's instructions.

**Table 5-1. Field Screening / Process Monitoring Instrumentation Quality Requirements. (4 sheets)**

Instrument	Use	Detection Limits	Calibration	QC Requirements	QC Criteria	Comments
Oxidation-Reduction Potential Meter	Determination of oxidation reduction potential	N/A	Follow manufacturer's instructions.	Verification checks before use.	N/A	Follow manufacturer's instructions.
Turbidity meter	Determine turbidity of water.	0.1-1 nephelometric turbidity unit	Follow manufacturer's instructions.	Verification checks before use.	N/A	Follow manufacturer's instructions.
Temperature probe/ thermometer	Measure temperature of samples.	N/A	Calibrate against NIST thermometer, yearly or more frequently depending on stability of device.	N/A	N/A	
Hand-held X-ray fluorescence	Measure metal concentrations in samples	Varies widely among instruments and is highly matrix dependent, lowest are 20 to 100 ppm range; must meet DQOs.				
Geiger-Müller tube <sup>a</sup>	Surveying.	Relatively high detection limit.	Initial and after repair or major maintenance or if system control cannot be established.	Source check daily before and after use. Daily background measurement.	Within $\pm 20\%$ of source activity.	

**Table 5-1. Field Screening / Process Monitoring Instrumentation Quality Requirements. (4 sheets)**

Instrument	Use	Detection Limits	Calibration	QC Requirements	QC Criteria	Comments
Phosphor alpha detector <sup>a</sup>	Survey for alpha contamination.	Project-specific.	Initial and after repair or major maintenance or if system control cannot be established.	Source check daily before and after use. Daily background measurement.	Within $\pm 20\%$ of source activity.	
Plastic scintillator <sup>a</sup>	Survey for beta contamination.	Project-specific.	Initial and after repair or major maintenance or if system control cannot be established.	Source check daily before and after use. Daily background measurement.	Within $\pm 20\%$ of source activity.	
Dual phosphor scintillator <sup>a</sup>	Survey for alpha and beta contamination simultaneously.	Project-specific.	Initial and after repair or major maintenance or if system control cannot be established.	Source check daily before and after use. Daily background measurement.	Within $\pm 20\%$ of source activity.	
Sodium iodide (NaI) scintillator <sup>a</sup>	Surveying for gamma-emitting radiation, some radionuclide identification.	Project-specific.	Calibration for the energy field to be measured or site-specific calibration factors should be developed.	Source check daily before and after use. Daily background measurement.	Within $\pm 20\%$ of source activity.	

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**Table 5-1. Field Screening / Process Monitoring Instrumentation Quality Requirements. (4 sheets)**

Instrument	Use	Detection Limits	Calibration	QC Requirements	QC Criteria	Comments
Intrinsic germanium (high-purity germanium) solid-state detector <sup>a</sup>	Radionuclide identification through gamma analysis.	Project-specific.	Initial and after repair or major maintenance or if system control cannot be established.	Source check daily before and after use. Daily background measurement.	Within $\pm 20\%$ of source activity.	Can identify and quantify concentrations of gamma emitting radionuclides with proper calibration or algorithms. DQOs may require additional QC.

<sup>a</sup>Not applicable for Radiation Control Program or Industrial Hygiene Program measurements

**Table 5-2. Field Testing Instrumentation Quality Requirements. (3 sheets)**

Instrument	Use	Detection Limits	Calibration	QC Requirements	QC Criteria	Comments
Gas chromatograph	Sample analysis of known volatile organic compounds.	Highly dependent upon detector; generally parts per billion; MDL study required; must meet DQOs.	Three-point initial, must be within two standard deviations.	Continuing checks to bracket the analytical run.	±30%	MDLs must be supplied and meet DQOs. Recommend duplicates run at a frequency of 1 per 20 samples. DQOs provide additional QC.
				Minimum of 1 blank/day.	<3 X MDL	
Gas chromatography/ Mass Spectrometry	Sample analysis of known volatile organic compounds.	Generally parts per billion; MDL study required; must meet DQOs.				MDLs must be supplied and meet DQOs. Recommend duplicates run at a frequency of 1 per 20 samples. DQOs provide additional QC.
Bench top X-ray fluorescence	Sample analysis of known inorganic compounds.	Varies widely among instruments, lowest are 20- to 100-ppm range; must meet DQOs.	Initial must bracket routine sample concentrations.	Continuing checks to bracket the analytical run. Minimum of 1 blank/day.	±30%	Calibration standards must be identified and well distributed over the calibration range; selected based on DQO. Recommend duplicates run at a frequency of 1 per 20 samples. DQOs provide additional QC.
				Minimum of 1 blank/day.	<3 X MDL	

**Table 5-2. Field Testing Instrumentation Quality Requirements. (3 sheets)**

Instrument	Use	Detection Limits	Calibration	QC Requirements	QC Criteria	Comments
Indicator kits (such as Hach Kits, colorimetric) immunoassay	Field measurement for a variety of analytes.	Very low ppm range; must meet the DQOs. MDL study may be required.	Initial by manufacturer.	Continuing checks to bracket the analytical run.	±30%	Check expiration dates and storage requirements. Recommend duplicates at a frequency of 1 per 20 samples. DQOs may require additional QC.
				Minimum of one blank/day.	<3X MDL	
Alpha spectroscopy <sup>a</sup>	Determines the identity and content of alpha radionuclides.	Project-specific; must meet DQOs.	Initial and after repair, major maintenance or if system control cannot be re-established.	One background/monthly.	Represents background for the time when the sample is counted.	Project-specific calibration may apply. DQOs may require additional QC.
				Daily instrument verification.	±20% of calculated activity.	
Gamma spectrometry <sup>a</sup>	Determines the identity and curie content of gamma-emitting radionuclides.	Project-specific; must meet DQOs.	Initial and after repair or major maintenance or if system control cannot be re-established.	One background/monthly.	Represents background for the time when the sample is counted.	Project-specific calibration may apply. DQOs may require additional QC.
				Daily source verification.	±10% of the source activity.	

**Table 5-2. Field Testing Instrumentation Quality Requirements. (3 sheets)**

Instrument	Use	Detection Limits	Calibration	QC Requirements	QC Criteria	Comments
Liquid scintillation <sup>a</sup>	Analysis of alpha and beta activity, including radionuclides (useful for low-energy radionuclides).	Project-specific; must meet DQOs.	Initial and after repair, major maintenance, or if system control cannot be re-established.	Quench curves for specific cocktail.	±20% of calculated activity.	Project-specific calibration may apply. DQOs may require additional QC.
				One laboratory control sample per 20 samples of the same matrix.	±20% of calculated activity.	
Gross alpha counting <sup>a</sup>	Analysis of total alpha emitters.	Project-specific; must meet DQOs.	Initial and after repair, major maintenance, or if system control cannot be re-established.	One background/ monthly.	Represents background for the time when the sample is counted.	Project-specific calibration may apply. DQOs may require additional QC.
				Daily instrument verification	Three sigma	
				One laboratory control sample per 20 samples of the same matrix.	±20% of calculated activity.	
Beta counting <sup>a</sup>	Analysis of total beta emitters.	Project-specific; must meet DQOs.	Initial and after repair or major maintenance or if system control cannot be re-established.	One background/ monthly.	Represents background for the time when the sample is counted.	Project-specific calibration may apply. DQOs may require additional QC.
				Daily instrument verification	Three sigma	
				One laboratory control sample per 20 samples of the same matrix.	±20% of calculated activity.	

<sup>a</sup>Not applicable for Radiation Control Program or Industrial Hygiene Program measurements.

### **5.1.3 Duplicate Analysis**

#### **5.1.3.1 Analytical Duplicates**

Duplicate analysis consists of performing analyses on two samples of the same population carried through all steps of the analytical method. For field testing methods, a duplicate analysis consists of one sample per batch of 20 or fewer samples, or as otherwise specified in the approved sampling document. Depending on the analytical methods, this may be a sample duplicate or a matrix spike duplicate. Duplicates for some radiological testing methods may consist of recounting samples with the same instrument in the same geometry and comparing the results. Duplicates are used to assess the precision of the preparation and analytical/counting process in a client-specific matrix. Agreement between duplicates indicates the reproducibility (i.e., precision) of the measurement process. Disagreement can occur due to analyte concentration differences within the sample matrix (e.g., non-homogeneity) that are not amenable to analyst control during the analytical process (e.g., isolated particles of analyte in a soil matrix that cannot be reliably sampled using standard laboratory sub-sampling techniques). Disagreement may arise if the method has poor applicability to the analyte/matrix system.

For field screening methods, duplicate analysis consists of replicate measurements of the same property under prescribed similar conditions and is performed if specified in the field screening procedure or required by the client. Replicate measurements evaluate instrument operator precision and instrument precision. Disagreement for radiological measurements can occur when there is radioactive decay of very short-lived nuclides, sample self-absorption, sample thickness variances, and other radiological interferences.

#### **5.1.3.2 Field Duplicates (Replicates)**

Field duplicates provide information regarding the homogeneity of the matrix. The primary purpose for analyzing field duplicates or replicates is to assure representativeness of the sample being measured. This is especially important, for example, in performing field measurements at a well-head where numerous replicates of purge water may be analyzed to assure representativeness. When a representative sample is obtained, field duplicates may also provide an evaluation of the precision of the sampling and analysis process. Unless specified differently in the project-specific SOPs, SAP, or other work control documents, for field duplicates (except for volatile organic compound analysis) the volume needed is collected and homogenized before being divided into two samples in the field. Field duplicates normally will be collected at a frequency of 5 percent to 10 percent of the samples collected per matrix or as specified in the project-specific SOPs, SAP, or other work control documents.

#### **5.1.4 Matrix Spike**

In general, a matrix spike is a client sample that has been spiked with the analyte(s) of interest and is processed in the same manner as the sample. The matrix spike is used to monitor method performance in a specific sample matrix. Matrix spike results are indicators of the effect that the client sample matrix has on the accuracy of measurement of the target analytes. If required by

the method, one spike sample per batch shall be analyzed. Matrix spikes are not commonly performed in field screening measurements or for process monitoring measurements. Matrix spikes are also not commonly performed for radiological field analytical methods in a field environment. If a client or method requires matrix spike samples, then Volume 4, Section 6.0 should be consulted for relevant requirements.

Each field analytical organization shall evaluate matrix spike recovery information, if applicable, against client DQRs. The goal is to ensure that limitations on the data caused by the sample matrix and represented by matrix spike performance are adequately portrayed and discussed in the report to the client.

### **5.1.5 Instrument-Specific Quality Control**

Most of the analytical methods used in the field have instrument-specific QC requirements. Tables 5-1 and 5-2 include additional detailed information. In all cases, the analyst shall demonstrate that the method is in control prior to performing sample analysis. If the instrument-specific QC requirements are not met before or during analysis, the analysis shall be terminated and the source of the problem identified and corrected.

## **5.2 GENERAL FIELD ANALYTICAL QUALITY CONTROL**

In this section, QC requirements for collection and analysis of samples using radiological, inorganic, and organic analytical procedures are described. The use of non-certified reagents, standards, materials, and equipment and methods of lesser quality can result in added interferences, smaller precision, and less accuracy. These conditions are likely to be encountered in field applications. Each field analytical group shall have a mechanism in place for demonstrating control over such sources. A list of sources is described in the following subsections.

### **5.2.1 Distilled or Deionized Water**

High-purity water is generally defined as water that has been distilled or deionized (or both) so it will have a conductivity less than 1.0  $\mu\text{S}/\text{cm}$  (greater than 1.0 megaohm-cm resistivity). Each field analytical group shall ensure that water used for data collection activities is of sufficient quality for the operation performed. Water quality shall be regularly monitored through analysis of method blanks when method blanks are required.

### **5.2.2 Compressed Gases**

Each field analytical group shall monitor the quality of gases used in the field instruments to ensure that they are adequate for the operation being performed. At a minimum, this shall consist of monitoring system performance (e.g., for contribution to background and/or blanks from impurities).

### **5.2.3 Reagents**

Each field analytical group shall use reagents for data collection activities that are of sufficient quality for the operation performed. Reagent quality shall be regularly monitored by preparative and analytical QC performance.

### **5.2.4 Lab-ware**

Each field analytical group shall purchase and use lab-ware of sufficient quality to meet client requirements. Lab-ware selected shall be compatible with the testing performed.

### **5.2.5 Glassware Cleaning**

Glassware cleaning shall be performed in a manner that minimizes sample contamination.

### **5.2.6 Good Housekeeping**

Each field analytical group shall maintain operations in a clean and organized manner to maximize available workspace and minimize environmental impact to sample quality. For radiological testing and field screening activities, the workspace must include radiological controls to reduce the potential for increased background activity from other field or laboratory activities, the presence of other samples near the counting equipment, and the potential detector contamination from other samples.

## **6.0 DATA COLLECTION, REDUCTION, REVIEW, AND REPORTING**

Data collection and reporting processes include proper sampling, accurate chain of custody, proper collection of raw data, accurate data reduction and calculation, and the precise transfer of results to a final form. After the data are collected, reduced, and reviewed, the data are reported to the client in an easy to use form. A copy of the report to the client and all supporting analytical information used to generate the report are then assembled and archived as part of the permanent project record. This section discusses how these processes are applied to field screening and field testing methods.

All of the records described in this section shall be maintained in a traceable manner as part of the permanent project file to safeguard the data and meet regulatory requirements as described in Volume 1, Section 6.0. This recordkeeping process will permit the reconstruction of all relevant activities that were used to produce the reported data.

### **6.1 DATA COLLECTION**

Raw data includes all parameters used to calculate a final reportable result. Raw data can be generated by manual and/or electronic means. Manual data-generation records shall be collected and documented according to applicable procedures. Field screening, process monitoring, and field testing frequently involve the use of field logbooks and forms for real-time data collection. Some field screening, process monitoring, and field testing instruments may electronically record field measurement information that is later downloaded or otherwise transferred to more permanent forms of storage. Field analysis performed at a treatment facility or onsite frequently captures manually generated data in logbooks, forms, or equivalent means, or as electronic records that are not interfaced to central data storage devices used in fixed laboratory applications. Procedures shall be in place that detail how these field records are captured and protected as part of the permanent project file.

Many instruments are interfaced with computers and/or integrators and are capable of generating and/or reducing raw data into reportable results. Procedures or written instructions shall be in place to describe the use of automated instruments and will address the processing of data for reporting to the client and the use of instrument-generated reports that are transmitted to the client. To the extent practical, both forms of data (i.e., manually calculated and generated by instruments) should be reported to the client in the same format, with the same number of significant figures when the two sources of data are used to meet the same information requirement as specified in the DQOs, SAPs, or other planning documents.

- Entries into logbooks, forms, or equivalent shall be made in a manner that can be easily read, understood, and reproduced with a standard photocopier. Indelible ink shall be used. Corrections shall be made by drawing a single line through the erroneous entry and then initialing and dating the correction. Hardcopy notebooks and logbooks shall comply with the following:

- Permanent, bound notebooks are required and loose leaf binders or spiral bound shall not be used.
- Entries are made in a permanent fashion and corrections are made without obliterating the original data.
- Entries are dated and signed by the person responsible for performing the activity at the time the activity is performed.
- Entries are in chronological order.

All logbook pages must be closed when the activities documented are completed or carried over to another logbook page. The person responsible for performing the closure shall be the one who performed the last activity documented. Closure shall occur at the end of the last activity performed or as soon as practicable thereafter.

Electronic notebooks are permitted and shall meet the same requirements for change protection and controls as handwritten hardcopy notebooks.

Data output shall be retained as a part of the project records (see Volume 1, Section 6.0). Information on the dates of sample collection, sample preparation, and analysis run; sample identification numbers; analyst or instrument operator; type of analysis; and procedure number (including the revision number) shall be traceable to the raw data output.

## **6.2 DATA REDUCTION AND REVIEW**

Data reduction is defined as the mathematical operations that are applied to raw data to produce a final reportable result. Data resulting from analyzing samples shall be reduced according to procedures that address the concepts discussed in this section. Data reduction includes activities that convert instrument and computer responses into reportable results. These activities may involve calculations, changes to the units or data values, and statistical and mathematical analysis. Certain field measurements and process monitoring measurements such as those made by hand-held probes or Hach Kits may require minimal data reduction activities. Other measurements, such as those in a mobile laboratory using analytical instruments identical to those in a fixed laboratory, may require extensive data reduction activities.

The following practices shall be established in the field analytical organization's data review and/or verification procedures or QA plan to ensure accuracy of data entry, proper calculation, and appropriate data reduction:

- Verify that all readings/outputs are accurate.
- Ensure proper error correction or data change (i.e., one line through, dated, initialed, and explained, as appropriate).

- Select appropriate formulas for calculating final results, to correct for background and/or interference (e.g., Compton effects for gamma energy), and to document calculations and results. These formulas shall be included as an integral part of each method's SOP.
- Verify that data are accurately transcribed into notebooks, forms/benchsheets, spreadsheets, or other electronic formats (e.g., databases).

### 6.2.1 Significant Figures

The number of significant figures reported is a function of the limits of the particular analysis method. Basic rules for significant figures and for calculating values and retaining the number of significant figures shall be based upon an authoritative source or accepted standard such as ASTM E29, *Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications*.

Reported values should contain only the appropriate number of significant figures. Recognizing that vendor-supplied software may not meet the general rules for significant figures, the field analytical organization should work with the client to determine the best way to report results based on the project's needs.

### 6.2.2 Rounding-Off Methods

When a figure is to be rounded to fewer digits than the total number available, the rounding-off procedure shall be based upon an authoritative source or accepted standard such as that described in ASTM E29. A brief description of the procedure follows.

- When the first digit discarded is less than five, the last digit retained should not be changed.
- When the first digit discarded is greater than five, the last figure retained should be increased by one.
- When the first digit discarded is exactly five followed only by zeros, the last digit retained should be rounded upward if it is an odd number, but no adjustment made if it is an even number.

Recognizing that vendor-supplied software may not meet the general rules for rounding-off figures, the field analytical organization should work with the client to determine the best way to report results based on the project's needs.

### 6.2.3 Data Verification and Review

Data verification is the process used by the analytical service organization to confirm that all work requested by the client has been performed properly. The SAP (FSP and QAPjP), work plan or other planning document, or procedure shall specify how data verification and review is to be performed. Verification is performed in accordance with these requirements using the

information contained in the analytical report(s) to the client and all supporting documentation generated and retained by the analytical organization.

Data review refers to the process of determining whether data conform to requirements specified in the project DQOs, SAPs, or other planning documents. All individuals involved in generating the data are responsible for the quality of the work in the final report. Initial data review is conducted by the analyst during data collection. Individuals involved in steps such as data entry, data transcription, reduction, and project file assembly should review their work product before forwarding it to the next stage in the reporting process. If questions arise about the work product from preceding steps in the process, steps should be taken to resolve the questions before forwarding the work product to the next stage.

All data reported to the client should be technically reviewed by an individual other than the individual(s) who generated the results. Analysis performed by a field analytical organization should receive independent review prior to being released to the project staff. In applications where data are being used in real-time to support project activities (e.g., field screening supporting site remediation), procedures that describe the types of real-time calibration confirmation and/or QC performance shall be in place and documented by the field analyst. The QC performance documentation shall be in place before providing the data directly to project personnel in real-time. If the data generation is sufficiently complex or the intended use is critical to the project (e.g., pass/fail regulatory criteria or health and safety), it is recommended that a second qualified individual be available to conduct an independent review within the timeframe needed by the project.

The data review process shall be documented with the records retained and available for review. The data review process shall incorporate the following elements:

- Data shall be reviewed according to the analytical organization's approved procedures to verify that calculations are correct and to detect transcription errors.
- Data shall be reviewed against applicable criteria for calibration, CCV, QC, and other method criteria, as appropriate, to verify that the preparative and/or analytical system is performing acceptably (see Section 5.0 of this volume for further details). If QC samples do not meet established criteria, data within the batch shall be evaluated to determine if there were any adverse effects with respect to the client's requirements. If applicable, the sample(s) shall be re-prepared and/or rerun, or the data shall be reported with an explanation and appropriate qualification(s), which will be detailed in the narrative.
- Random checks shall be performed to verify calibration, data entry, calculations, and QC criteria.
- Process monitoring measurements may be taken very frequently at the same sample collection points in treatment facilities. Accordingly, robust data trends may be established. In these situations, data are reviewed by comparing newly generated data with the established trends. Newly generated sample data out of trend may indicate an upset process condition,

but may also indicate a problem with the measurement or with the representativeness of the sample. Procedures should indicate what measures are taken when out of trend data occur.

### 6.3 DATA REPORTING

The analytical information reported shall include the measured parameters, the details of analysis, the reported data values, and associated data qualifiers in accordance with project requirements. If applicable, the method procedure will provide data qualifiers and will note any QC failures.

Field screening measurements and process monitoring measurements are generally reported as numeric values without data qualifiers.

Radiological measurement results should be reported based on calculated activity values (whether negative, positive, or zero) using the appropriate background correction. The measured activity should be reported with estimates of total propagated uncertainty.

#### 6.3.1 Data Reporting Documentation

The data reporting documentation requirements for analysis shall be identified in a SAP, work plan, procedure, etc. prior to field screening, process monitoring, or field testing.

##### 6.3.1.1 Report Requirements for Field Screening, Process Monitoring, and Field Testing

Project DQOs/requirements frequently identify activities that are driven by real-time data acquisition, reporting, and decision-making. Examples of this are field screening or field testing activities to identify areas of elevated contamination requiring remediation and providing data to support waste and site characterization, or process monitoring activities to assess treatment system performance. These types of data needs are normally performed at Hanford using field screening, process monitoring, and field testing measurements. The minimum report requirements for these types of data are as follows:

- Field analytical organization name
- Project name
- Unique sample identifier including sample date and time

**NOTE:** *This applies to field screening, process monitoring, or field analysis where the field analyst performs the field screening or collects the sample(s) and later performs the field analysis without the sample leaving their possession. See the additional requirements listed in Section 6.3.1.2 for samples collected by a third party and relinquished to the analyst in the field or fixed laboratory.*

- Analytical results and date of analysis (for each sample) with units (reported with an appropriate number of significant figures) and associated uncertainty, where appropriate

- Detection limits or screening levels, as appropriate
- Method references
- Calibration check and QC measurements
- Signature of person accepting responsibility for the report contents
- Date of issue.

### **6.3.1.2 Report Requirements for Field Analysis for Regulatory or Compliance Activities**

In addition to the information requirements listed in Section 6.3.1.1, the following information items are required to support activities associated with regulatory drivers such as waste characterization, waste shipment, permits, and site closure:

- Chain-of-custody form, including unique site identification, name, date and time of sample collection, unique client sample number, name of sampler(s), and names of people who accepted custody of the sample prior to arrival at the field laboratory or fixed laboratory

**NOTE:** *This information may be documented by providing a copy of the chain-of-custody form that is completed in the field.*

- Sample information including unique laboratory identifier (if used), which is cross-referenced to client identification number, and date of sample receipt

**NOTE:** *This information may be documented by providing a copy of the chain-of-custody form and associated sample receipt records after completion by the sample receiver.*

- Date(s) of sample preparation, if applicable
- Analytical units and results reported with an appropriate number of significant figures and associated uncertainty (for radiochemical measurements)
- Detection limits, if applicable
- Identification of any amended test results, if applicable
- Identification of subcontracted results, if applicable
- Appropriate QC results (correlation with sample batch shall be traceable and documented)
- Appropriate data qualifiers with definitions and a narrative on the quality of the results, if applicable

- Additional data reporting (e.g., the percent moisture/solid or correction for equivalent dry weight), as appropriate.

### **6.3.2 Emergency Reporting**

When applicable to a client's needs, an immediate data reporting system shall be established between the field analytical organization and the client to address emergency turnaround situations. The type of information, level of approval, data reporting format, and means of delivery shall be discussed and agreed upon between the field analytical organization and the client.

## **6.4 COMMON DATA QUALITY CALCULATIONS**

Volume 4, Section 7.0 should be consulted for formulas typically employed to compute QC parameters. Such formulas include, for example, those for accuracy, precision, various detection limits, minimum detectable activity, minimum detectable concentration, and uncertainty. Alternatively, manufacturer instructions may indicate how QC parameters are to be calculated for a given measurement using a given instrument.

### **6.4.1 Control Charts**

Control charts provide the analyst with early warning of impending problems in a preparative or analytical method and make bias trends more obvious. Each field analytical organization shall document its policy regarding the use of control charts. The organizational policy shall articulate the manner in which the organization will deal with statistical outliers. Blank spike/laboratory control sample performance for all routine preparations should be monitored using control charts. In cases where the analytical technique involves a large number of analytes (e.g., inductively coupled plasma or gas chromatography/mass spectrometry), the field analytical organization may select a subset representative of the total for control charting. Performance statistics can be tabulated in lieu of a control chart.

Control charts are useful for monitoring the performance of field radiological instruments and should be used to help control field measurement systems. A separate control chart for calibration checks, background measurements, and source checks should be developed for each instrument.

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## **7.0 DATA VALIDATION AND ASSESSMENT**

Field analytical data are not typically subjected to third party validation or data quality assessments. Volume 4, Section 8 should be consulted for guidance should these reviews be required by the project DQOs.

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## 8.0 BIBLIOGRAPHY

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