Hanford Sampling Quality Management Plan

J. E. Hyatt

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Department of Energy

P.O. Box 550
Richland, Washington 99352

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Department of Energy

Richland Operations Office

P.O. Box 550

Richland, Washington 99352

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JUL 14 1995

Contractor, Richland, Washington

Director
Pacific Northwest Laboratory

President
Westinghouse Hanford Company

Addressees:

HANFORD SAMPLING QUALITY MANAGEMENT PLAN (HSQMP)

The purpose of the attached document is to provide assistance to project managers and field organizations when performing environmental sampling in support of the Environmental Management Mission. The HSQMP is formatted as a guidance document to enable the appropriate use of the key elements in obtaining project specific Data Quality Objectives. The use of the HSQMP implements the DOE-HQ Sampling Quality Assurance Guidance Document issued in May 1994.

The HSQMP will be revised as applicable regulations change and as comments are received from the field warrant.

If you have any questions, please contact M. L. Burrell, of my staff, on 373-7285.

Sincerely,

A handwritten signature in dark ink, appearing to read "Thomas K. Teynor", is written over a horizontal line.

Thomas K. Teynor, Director
Waste Programs Division

ASP:MLB

Attachment

cc w/attach:
J. L. Deichman, WHC
W. J. Bjorklund, PNL

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A handwritten mark, possibly a signature or initials, is located at the bottom left of the page.

Document Title:

HANFORD SAMPLING QUALITY MANAGEMENT PLAN

Approved by:

J. E. Deichman
Acting Manager
Analytical Services - WHC

6-30-95
Date

P. M. Morant
Office of Quality Assessment
Analytical Services - WHC

6/29/95
Date

msb
R. P. Carter
Analytical Services
Department of Energy - RL

6/29/95
Date

T. K. Teynor
Waste Programs Division
Department of Energy - RL

7/11/95
Date

Concurrence:

J. W. Yokel
Washington State Department
of Ecology - Kennewick

6/29/95
Date

A. M. Hopkins
Sample Data Management - BHI

6/30/95
Date

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GLOSSARY

Acronyms

ALARA	as low as reasonably achievable
ANSI	American National Standards Institute, Inc.
ASQC	American Society for Quality Control
ASTM	American Society for Testing and Materials
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	<i>Code of Federal Regulations</i>
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DQO	Data Quality Objective
EM	Environmental Restoration and Waste Management
EPA	U.S. Environmental Protection Agency
HASQAP	Hanford Analytical Services Quality Assurance Plan
HEIS	Hanford Environmental Information System
HQ	DOE Headquarters
HSQMP	Hanford Sampling Quality Management Plan
HSRCM	Hanford Site Radiological Control Manual
NRC	U.S. Nuclear Regulatory Commission
NSTS	National Sample Tracking System
OSHA	Occupational Safety and Health Administration
QA	quality assurance
QAPjP	Quality Assurance Project Plan
QAPP	Quality Assurance Program Plan
QC	quality control
RCRA	Resource Conservation and Recovery Act
RL	DOE Richland Operations Office
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
Tri-Party Agreement	Hanford Federal Facility Agreement and Consent Order
VOA	volatile organic analysis
VOC	volatile organic compound
V/DUA	Validation/Data Useability Assessment
WAP	Waste Analysis Plan
WHC	Westinghouse Hanford Company

GLOSSARY (continued)

Definition of Terms

Collecting--In the context of this document, collecting is the process of withdrawing or taking samples from a designated population.

Contractor-- A company that provides services and or products to the U.S. Department of Energy.

Data Usability--The process of ensuring or determining whether the quality of the data produced meets the intended use of the data.

Environmental Medium--Any of six environmental matrices in which physical and chemical reactions and other phenomena occur: air, water, soil, debris, bottom sediment, waste. See medium.

Equipment Reinstall (blank)--A volume of project-specified media collected using sampling equipment and the technique used in the actual sample collection event.

Field Blank--A volume of project-specified media transported to the field in bulk, then partitioned into sample containers in the environment that the samples are collected in.

Graded Approach--The process of basing the level of application of managerial controls applied to an item or work according to the intended use of the results and the degree of confidence needed in the quality of the results.

Group¹--Two or more individuals, interacting and interdependent, who have come together to achieve particular objectives.

Heterogeneous--Consisting of dissimilar or diverse parts or constituents.

Holding Time--The amount of time allowed to elapse from sample collection until laboratory analysis and/or extraction as specified by the contract, statement of work, method, or regulatory requirement.

Listed Waste--A material that satisfies the definition of waste as described in WAC-173-303-080.

Medium (pl. media)--Any material through which energy and/or chemicals move or in which chemicals are dispersed or in which a chemical reaction takes place. In the present document, the term medium refers to environmental medium.

¹As defined in **Organization Behavior: Concepts, Controversies, and Applications**, 6th edition, Stephen P. Robbins, Prentice Hall, Englewood Cliffs, New Jersey.

GLOSSARY (continued)

Organization¹--A consciously coordinated social unit, composed of two or more people, that functions on a relatively continuous basis to achieve a common goal or set of goals.

Program--A defined collection of organizations that are responsible for the completion of projects that together accomplish a company goal.

Project²--Usually a one-time activity with a well-defined set of desired end results.

Quality Assurance (QA)--An integrated system or program of activities involving planning, quality control, quality assessment, reporting and quality improvement to ensure that a product or service meets the defined standards of quality with a stated level of confidence.

Quality Control (QC)--The overall system of routine technical activities whose purpose is to measure and control the quality of a product or service so that it meets the needs of its users.

Radioactive material--Any material that spontaneously emits radiation.

Radioactive waste--Solid, liquid, or gaseous materials, of no commercial value that emit ionizing radiation. Discarded items such as clothing, containers, equipment, rubble, residues, or soils that contain radionuclides.

Representative sample--A sample of a universe or whole (e.g., waste pile, lagoon, groundwater) that can be expected to exhibit the average properties of the universe or whole.

Representativeness--Qualitative variable that expresses the degree to which data accurately and precisely represent some characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition.

Sample--(1) Material or a set of samples drawn from a larger set or population that is taken to represent the larger. A single sample can comprise a sample; however, statistical constraints generally require that a sample be comprised of no less than three samples. (2) A portion or subset of a population selected to be representative of the population.

Sampling--The process of selecting a set of samples from a given population in accord with a preselected scheme for determining which samples to take and when to take them. At some level the selection of samples should be fully randomized.

²As defined in *Project Management: A Managerial Approach*, 2nd edition, Jack R. Meredith and Samuel J. Mantel Jr., John Wiley & Sons, New York, New York.

GLOSSARY (continued)

Sediment--Solid material deposited by water, wind, or glaciers.

Soil--Naturally occurring geo-organic materials with an average particle size of less than 2 mm.

Split Sample--Samples taken from a single homogenous medium, placed in separate laboratories for analysis by the same method/protocol.

Standard Operating Procedure (SOP)--A SOP is recognized as a standardized procedure for performing field operations and other routine work in support of field and analytical operations.

Subcontractor--A company that provides services and or products to the contractors of the U.S. Department of Energy.

Subsample--That portion of an individual sample that is analyzed.

Trip blank--An analyte sample container filled with ASTM Type II water, which is transported to the sampling site and returned to the laboratory with the samples. Trip blanks are filled in the laboratory and are not to be opened in the field.

Validation--An activity that demonstrates or confirms that a process, item, data set, or service satisfies the requirements defined by the user.

HANFORD SAMPLING QUALITY MANAGEMENT PLAN

1.0 INTRODUCTION

This document, the *Hanford Sampling Quality Management Plan* (HSQMP), is issued by the U.S. Department of Energy (DOE), Richland Operations Office (RL). The HSQMP establishes quality requirements in response to DOE Order 5700.6C, *Quality Assurance*, and 10 *Code of Federal Regulations* (CFR) 830.120, "Quality Assurance Requirements." The HSQMP is designed to meet the needs of RL for controlling the quality of services provided by sampling operations.

The HSQMP is issued through the Analytical Services Program of the Waste Programs Division. The RL Analytical Services Program is designated by the RL as having the responsibility for oversight management of laboratory, sampling, and field analysis operations under the Waste Programs Division. Sample collection are conducted to support several regulatory statutes, such as the *Clean Air Act* and the *Clean Water Act*. Sample collection in support of the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1994) is a major role of the field operations.

This document describes the Environmental Sampling and Analysis Program activities considered to represent the best management activities necessary to achieve a sampling program with adequate control.

The Analytical Services Program's Environmental Sampling and Analysis Program strategy is designed to comply with DOE Order 5700.6C, 10 CFR 830.120 and *Environmental Restoration Remedial Action Quality Assurance Requirements Document* (DOE 1991a), DOE/RL-90-28, to ensure the production of data readily acceptable to regulatory agencies. This law, the DOE Order, and DOE/RL-90-28 establish quality assurance requirements for DOE and its contractors for sampling operations.

1.1 REQUIREMENTS TO ESTABLISH A SAMPLING QUALITY MANAGEMENT PROGRAM

Requirements for the establishment of the Sampling Quality Management Program originate from the following sources:

- The need to address compliance with laws and regulations as they pertain to environmental and safety issues.
- The desire to ensure the technical validity of DOE projects as part of its overall responsibility to achieve environmental protection.
- DOE Order 5700.6C, which establishes Quality Assurance (QA) requirements for DOE.
- 10 CFR 830.120, *Quality Assurance Requirements*

- The guidance provided by DOE/EM-0158, *Sampling Quality Assurance Guidance in support of EM Environmental Sampling and Analysis Activities*, (DOE/EM 1994).
- *The Hanford Facility RCRA Part B Permit* is issued for each facility and the Tri-Party Agreement.

1.2 PURPOSE

This document introduces expectations and guidance pertaining to the design and implementation of sampling procedures and processes for collecting environmental data. The guidance is developed to be consistent with, and supportive of, DOE Order 5700.6C, 10 CFR 830.120, and consensus with American National Standards Institute/American Society for Quality Control (ANSI/ASQC) QA requirements (ASQC 1993).

The document addresses the following goals:

- Identify key sampling issues and program elements
- Provide non-prescriptive guidance consistent with regulatory and DOE requirements and a compilation of pertinent references
- Create a foundation for the integration of sampling activities and services
- Promote standardization of sampling methods, training, and documentation
- Provide assistance to management to help ensure that all sampling is conducted in a credible and defensible manner.

The goal of this plan is to provide management with oversight of the sampling process to ensure data quality objectives (DQO) are met. The overall intent of both field sampling and analytical activities is the acquisition of quality, defensible data for decision making purposes.

This plan is intended to assist in minimizing sampling inconsistencies and provide data that is considered representative and of known quantity and quality. The elements and processes presented can be integrated into an effective field operation. Each major project/program should have a QA plan. This document provides assistance in defining the elements of a sampling program that must be addressed in the QA documentation (Quality Assurance Program Plan [QAPP], Quality Assurance Project Plan [QAPjP], etc.). Field assessments should reflect emphasis on cost-effective quality and performance of all sampling activities.

1.3 SCOPE

The Tri-Party Agreement binds the DOE to actions and commitments to comply with the *Resource Conservation and Recovery Act (RCRA)*, the *Comprehensive Environmental Response, Compensation, and Liability Act*

(CERCLA), and the *State of Washington Hazardous Waste Management Act*. The signatories (DOE, U.S. Environmental Protection Agency [EPA], and Washington State Department of Ecology [Ecology]) view the Hanford Site as a single entity and, as such, expect a uniform level of quality in all work supporting the Tri-Party Agreement.

The HSQMP has been prepared in support of field sampling activities in which the data generated are scientifically valid and defensible in terms of the criteria defined in the project DQOs, contractual requirements and in terms of data quality assessment activities. The variety of media to be sampled during discrete investigative tasks magnifies the importance of a controlled system. Individual characterization plans such as Sampling and Analysis Plans (SAP) or Waste Analysis Plans (WAP) should be developed where appropriate for specific field activities. As the specific WAPs/SAPs are developed, the HSQMP can be referenced as a guide during preparation. The Health and Safety Plan prepared for each sampling site is an additional document that establishes the safety procedures, level of personal protective equipment required, monitoring requirements and criteria to ensure that the field activities will be conducted in a manner that protects personnel who perform the work and others in the vicinity. The safety aspects of field sampling also should be addressed in the specific Standard Operating Procedures (SOP).

The HSQMP provides guidance to onsite contractor and subcontractor QA documents supporting Tri-Party Agreement sample collection and analyses. The document hierarchy is shown in the flow diagram (see Figure 1-1). The current or developed QA plans and/or QA manuals of the affected organizations should be reviewed against the best management practices outlined in the HSQMP.

The purpose of the HSQMP is not to require a separate QA program. The QA elements found in this document may already be incorporated into various existing field organization controlling documents and need not be located in one document. All items addressed in the HSQMP need not be incorporated into the sampling organization's documents; however, documentation as to why items are not incorporated into sampling documents is often useful in communicating with assessors. The development and maintenance of a summary document identifying where the QA elements are located in existing documents is recognized as the "best management practice" and is encouraged.

The HSQMP provides the following:

- A technical guide for Hanford Site sampling programs to meet the requirements of DOE Order 5700.6C and 10 CFR 830.120 for a quality measurement system
- A guide for Site contractor and commercial field organization QA documents and service contracts
- A guide for field services to meet the regulatory requirements of the Tri-Party Agreement, Sections 6.5 and 7.8.
- Facility and activity specific guidance supplementing DOE Orders, such as DOE Orders 5480.19 (DOE 1990) and 5480.20A (DOE 1994), specific to field organizations at the Hanford Site

Figure 1-1. Document Hierarchy Flow Diagram.

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- A flexible framework for meeting the client's special quality criteria based on the need of the data as determined by the DQO planning process.

This document describes the implementation of quality elements within a functional field sampling program. The development of the organization's quality management program is the responsibility of the field organization. The development of project-specific DQOs is the responsibility of the program requesting service. Section 3.0 and Appendix B of this document provide brief overviews of the DQO process. Further development of the QA elements, as applicable to Field Screening and Analysis, will be addressed in the *Field Measurement Quality Management Plan* which is being developed by DOE/RL and will be incorporated into future revisions of this document.

1.3.1 Activities Within the Scope of HSQMP

Best management practices for sample collection supporting RCRA, CERCLA, and *State of Washington Hazardous Waste Management Act*, as delineated in the Tri-Party Agreement, meet or exceed the QA protocols described in HSQMP.

Management practices described within this document also benefit sample collection in support of the following:

- hazardous waste treatment, storage, and disposal units
- hazardous waste facility permitting, closure, and post-closure
- remedial and corrective action activities.

Additional sample collection supporting RCRA and CERCLA can include, but is not limited to, treatment facilities' inlet and outlet streams and groundwater monitoring. Sample collection for other regulatory requirements not specified in the Tri-Party Agreement may also use this document as the minimum quality management program elements unless otherwise specified QA elements exist in codified regulations.

1.4 RELATIONSHIP TO REGULATORY REQUIREMENTS AND EXISTING PROGRAMS

The guidelines and best management practices provided in this document are designed to be compatible with existing regulatory QA requirements. However, this document may not address all specifications and requirements detailed in various local, state, and Federal programs, such as the U.S. Department of Transportation (DOT) and the U.S. Nuclear Regulatory Commission (NRC). To ensure that all specifications and regulatory requirements are met, the field organization should consult its specific regulatory program requirements, QA program requirements, project plans, state issued permits, and/or any other applicable site documents.

The HSQMP is recommended as a statement of the organizations' approach to ensure materials are collected in such a manner that the sampling process supports the generation of quality data. The organization performing the field activity is recommended to issue a organization-specific quality management plan that is designed to cover its responsibility at any given

location. Other documents that define areas of responsibility are the QAPjP and Characterization Plans (SAPs and WAPs).

The references provided in this document do not confer requirements on programs and projects. The user of the listed references also is advised to contact the issuing agency to determine if the reference has been superseded or updated. They are provided to identify existing materials and to provide sources of information for use by field management.

Employees and management should be trained sufficiently to have a thorough knowledge of applicable QAPjP and DQO requirements and concepts. The concepts of Total Quality Management and continuous quality improvement should be applied throughout the planning, implementation, oversight, and assessment phases of projects. Effective training emphasizes that the application of controls should be related directly to what is needed to satisfy project requirements, rather than implementing excessive controls that result in higher project costs.

1.5 SAMPLE COLLECTION CONTRACTING AND SUBCONTRACTING

To support integration of "laboratory need" requirements and to ensure the collection of acceptable field products, all project management offices responsible for environmental sampling and analysis are required by DOE-Headquarters (HQ) to provide specific information to DOE-HQ's Environmental Management National Sample Tracking System (NSTS). Currently, Westinghouse Hanford Company (WHC) provides a central office for all the site contractors for the collection, formatting, and submission of this data for RL through the National Laboratory Program Office of Analytical Services. This supports national Environmental Restoration and Waste Management (EM) program needs, and ensures that local contract selection and monitoring procedures are consistent with DOE and regulatory standards.

Free access to audit reports from other DOE organizations and Federal and States agencies is necessary. Contracted sampling organizations should agree to support free exchange of audit materials between organizations to decrease redundant audits.

If a program requires the support of a subcontractor for sampling or field analysis support, normal procurement practices outlined in DOE Order 5700.6C and 10 CFR 830.120 are expected to be followed.

1.6 USAGE OF THIS DOCUMENT

Management is encouraged to review this document and apply those best management practices that are commensurate with the defined data quality objectives for the program and/or project they support. Appendix C includes a checklist that was derived from the DOE-HQ DOE/EM-0158 *Sampling Quality Assurance Guidance* and the *Hanford Facility RCRA Part B Permit*. References noting the origin of the question are found in the second column. This checklist may not be all inclusive. The intent of its inclusion in the HSQMP is to provide a management tool for self-evaluation.

This document is intended to allow the application of best management practices that provide the appropriate level of rigor to the sampling program. It is imperative that the project management recognize that each project has different levels of appropriate rigor. Generally, the DQOs chart the path to either prove the negative (prove a site is not contaminated), determine further courses of action (assess current situation against available information) or prove the positive (prove the site is contaminated). Typically, a higher level of rigor is required to prove the negative than is required to prove the positive. The cost of waste handling and disposal provides valuable information in determining the initial DQO path to pursue.

1.7 REFERENCES

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2.0 SAMPLING AND ANALYSIS PROCESS FLOW CHART

It is important for all involved parties to be knowledgeable of the sampling and analysis process. A process flow chart has been developed to facilitate the understanding of the work flow process (see Figure 2-1). This document pertains to step 4 and 5. The Hanford Analytical Services Quality Assurance Plan (HASQAP) pertains to step 6 and 7.

Each company and organization involved with sampling an analysis likely will have their own work flow process within each step. The project-specific DQOs also will impact the work flow process. Appendix A includes is a brief description of the controlling documents, responsible organization, and essential inputs/outputs.

Figure 2-1. Sampling and Analysis Process Flow.

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3.0 DATA QUALITY OBJECTIVES

The DQO process is a validated planning tool that is used to support programs in the accomplishment of the Hanford cleanup mission. Properly applied, DQOs can save significant time and money by clearly defining programmatic objectives and decisions up front, getting stakeholder consensus, and optimizing data collection.

The DQO process is a logical method that clarifies the problems or questions that a program must solve. It further defines the information needed to answer questions and objectives including an assessment of risk or uncertainty. The DQO process may be applied to either programmatic or technical issues.

The DQO process is based on the principles of Total Quality Management, systems engineering, decision analysis, statistical experimental design, laboratory management and operations, and operations research.

The DQOs are developed by the stakeholders with technical support. The DQO process can be facilitated by a DQO specialist. RL has specialists available to programs for assistance in developing DQOs. The process fosters strong interface communication between the representative groups to achieve clear and commonly acceptable objectives required for the resolution of a question. The party ultimately responsible for the use and implementation of data quality objectives is the program. The seven steps in the DQO process are defined in Figure 3-1. Further discussion on DQOs can be found in Appendix B of this document and in EPA QA/G-4, *Guidance for the Data Quality Objectives Process* (EPA 1994).

Figure 3-1. The Seven Steps of the DQO Process*.

- STEP 1: State the Problem - Concisely describe the problem to be studied. Review prior studies and existing information to gain sufficient understanding to define the problem.
- STEP 2: Identify the Decision - Identify what questions the study will attempt to resolve, and what actions may result.
- STEP 3: Identify the Inputs to the Decision - Identify the information that needs to be obtained and the measurements that need to be taken to resolve the decision statement.
- STEP 4: Define the Study Boundaries - Specify the time periods and spatial area to which decisions will apply. Determine when and where data should be collected.
- STEP 5: Develop a Decision Rule - Define the statistical parameter of interest, specify the action level, and integrate the previous DQO outputs into a single statement that describes the logical basis for choosing among alternative actions.
- STEP 6: Specify Tolerable Limits on Decision Errors - Define the decision maker's tolerable decision error rates based on a consideration of the consequences of making an incorrect decision.
- STEP 7: Optimize the Design - Evaluate information from the previous steps and generate alternative data collection designs. Choose the most resource-effective design that meets all the DQOs.

*As defined in the EPA QA/G-4, *Guidance for the Data Quality Objectives Process*, September 1994, page 3.

3.1 REFERENCES

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- EPA, 1994, *Guidance for the Data Quality Objectives Process*, EPA QA/G-4, Quality Assurance Management Staff, U.S. Environmental Protection Agency, Washington, D.C.
- EPA, 1993, *Data Quality Objectives for Superfund*, EPA 540-R-93-071, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C.

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4.0 SAMPLING SYSTEMS

Project management, in conjunction with personnel knowledgeable in the relevant analytical criteria, should develop, establish, and update requirements for sampling organizations and personnel qualifications, personnel training, site guidelines, sampling methods, SOPs, corrective actions, document control, and field assessments. Documented procedures should be in place. If project management determines that existing sampling SOPs are sufficient to meet or exceed project needs, new documents need not be developed. For most projects, existing sampling SOPs will meet or exceed project requirements.

4.1 SAMPLING ORGANIZATION AND PERSONNEL

Each sampling organization performing data collection efforts should clearly define and document the operational organization, lines of authority, and reporting responsibilities.

Direct and ultimate responsibility for assuring quality sample collection resides with line management. QA functions provide technical support to management for review and assurance of data quality. Generally, independent lines of authority and reporting routes are recommended for QA functions within the organization.

All significant changes in the sampling organization or personnel should be reported to project management. Such changes may include: facility mergers or acquisitions; expansions; relocation; management adjustments; and/or changes in primary, technical, or QA personnel. Regulatory actions toward the sampling organization or its parent corporation should be reported immediately to cognizant management. This includes actions, such as suspension of contracts with other Federal agencies, notices of investigations, and legal actions against the organization or its personnel.

4.1.1 Personnel Qualification

Years of sampling experience often may equate to or outweigh academic achievement. Each organization is encouraged to document the competency of experienced individuals. Each sampling organization is strongly encouraged to establish policy and requirements for individual qualifications and competencies for positions (e.g.; sampler, technician, engineer). The minimum training records that are recognized as essential for field personnel are the following:

- Attendance sheets
- Training logs
- Records of course content, including dates of training and name of instructor

- Personnel training records
- Formal qualification (certification) records, as applicable.

Best management practices for field organizations include maintenance of comprehensive information on each employee regarding the individual's formal education, training, and experience. This may include such documentation as copies of up-to-date resumés, degrees earned, certificates of courses completed, and records of in-house training. It also may include records of the individual's performance. In-house or contracted training may be documented through attendance records, individual instruction verified through the instructor's signature or certificate, or actual written or practical testing sources.

4.2 PERSONNEL TRAINING

Safe work practices should be stressed during preparation and implementation of a sampling event. The nature of field work is such that the work conditions are always changing. Management and field personnel should communicate often regarding any change of conditions and potential safety issues. Those field personnel who sample and handle hazardous and/or radioactive materials may require additional training addressing safe work practices as related to the project-specific environment and hazards.

Project management is responsible for ensuring that all personnel who perform tasks and functions have the needed education, training, and experience, and are aware of and perform quality work. Personnel should be provided continuous training to ensure that job proficiency is maintained.

Best management practice includes field personnel training to ensure the following:

- Personnel receive awareness training regarding the hazards associated with the specific site to be investigated and the specific tasks to be performed
- Training includes both education in principles and enhancement of skills
- Training emphasizes correct completion of work and provides an understanding of why specific project quality requirements exist. Training should provide an understanding of the fundamentals of the work and its context to the QA Plan and project DQOs. Training instruction should address potential consequences of improper work, for both over-application of requirements as well as under-application of requirements, and focus attention on "doing the right thing right the first time."

Minimum training requirements include applicable Occupational Safety and Health Administration (OSHA) Site Health and Safety training. Radiation control training is required if a field organization handles radioactive materials or is located at a DOE facility that requires radiation control training. Field personnel who package samples for transport are required to

complete DOT training. Various levels of DOT training are available specific to the classification of materials normally encountered.

4.3 FACILITY MANAGEMENT

Best management practices suggest that the following conditions be considered:

- Site facilities are secure. The buildings, field laboratories, and controlled sampling points (e.g., monitoring wells) have access limited to authorized personnel.
- Instrumentation, equipment, and utilities are maintained to perform the required/contracted sampling operation. Safety equipment will be available and readily accessible. Sampling equipment should be kept secured when not in use.
- Surface disturbances such as pits, holes, excavations, and trenches will be clearly marked or barricaded. Addition of new surface features such as well heads, pumps, piping, and electrical traces also will be clearly marked.
- Sampling designs should minimize interactions between high and low concentration areas, as well as minimize common utilization of equipment, instrumentation, and facilities. A formal, active contamination control that minimizes the potential spread of contamination between sample processing and sample storage areas will meet the fundamental elements of an active as low as reasonably achievable (ALARA) program. Specially controlled facilities or areas should be established, as specified in the Hanford Site Radiological Control Manual (HSRCM), for the receipt of highly contaminated materials and storage of waste (see EPA's SW-846 Chapter 9, Sampling Plan for more information).
- Design and implementation of sampling programs should address situations or conditions necessary for the controlled use, storage, and disposal of sample material rejects (e.g., soil discards, purged waters), equipment decontamination residues, and/or remnants of samples. These programs also ensure that all activities that may impact environmental data are documented and recorded in a field logbook (see WAC 173-303-210 and 380 for more information).

4.4 SAMPLING METHODS

Documentation of sampling procedures is critical to the technical defensibility and the legal defensibility/admissibility of the resulting data. Whenever possible, industry-recognized sampling methods from agency published source documents, such as DOE, EPA, and American Society for Testing Materials (ASTM), should be employed. Sample collection and processing procedures may also use methods published by the U.S. Geological Survey, U.S. Department of Agriculture, and professional groups such as the American Water Works

Association. Current DOE, EPA, and ASTM sampling methods are detailed in the following sources:

- *DOE Methods for Evaluating Environmental and Waste Management Samples*, DOE/EM-0089T, October 1992.
- *DOE EML Procedures Manual*, 27th Edition, Volchok 1992.
- *DOE Environmental Survey Manual*, Appendix E, Field Sampling Protocols and Guidance, Office of Environmental Audit, 1987.
- EPA, *Representative Sampling Guidance*, Vol. 1, Soil, 1991.
- EPA, *Soil Sampling Quality Assurance User's Guide*; 1989.
- EPA, *Sampling of Water and Wastewater*, Shelley 1977.
- EPA, *Practical Guide for Groundwater Sampling*, 1985.
- EPA, *Compendium of Superfund Field Operations Methods*, 1987.
- ASTM, *Sampling Surface Soils for Radionuclides*, ASTM C-998-83, 1983.
- ASTM, *Standard Practices for Sampling Water*, Method D 3370-76, 1977.
- ASTM, Standard Practices for various sampling methods currently are being developed and when issued will be incorporated into this document.

Methods employed that are not found in the above references should be thoroughly reviewed and approved by the cognizant project management prior to implementation. Complete and well documented method references should be available for all methods. If specific method references do not exist, appropriate documents, such as suppliers manuals, equipment manufacturer instructions, and instrumentation specifications are recommended for use. Such documents should include adequate descriptions and criteria to ensure the required quality of work performed.

4.5 STANDARD OPERATING PROCEDURES

Standard operating procedures encompass administrative, operational, and sampling procedures of the sampling organization. When SOPs are developed or reviewed, the following areas are typically considered:

- References to source documents published by agencies, such as the EPA and the ASTM, should be included
- Administrative control of SOPs
- Review and revision of SOPs as required to address changes in data quality requirements, technology and equipment changes, and/or changes in regulatory requirements.

4.5.1 Operational Standard Operating Procedures

The number and type of operational SOPs instituted by a particular sampling organization will vary greatly, depending on the scope of the operation.

Best management practice of field organizations requires the following operational SOPs be in place:

- Sample identification
- Chain-of-custody
- Sample preservation
- Sample packaging and shipping
- Sample tracking
- Field notebooks
- Documentation control and documentation practices
- Logbooks (e.g., temperature logs, balance logs, equipment maintenance logs, instrument run logs, sample storage logs, standards logs, health and safety logs, etc.)
- Identification of equipment used (e.g., Material and Test Equipment Identification numbers)
- Equipment cleaning, maintenance, and decontamination procedures
- Establishment and maintenance of clean and "dirty" zones
- Site access and controlled entry
- Emergency response
- Work area monitoring, personal protective equipment, and medical monitoring
- Data management and handling
- Data review and verification
- QA and quality control (QC) procedures
- Corrective action management for contractual deficiencies found during DOE authorized onsite inspections, surveillances, audits, or other oversight functions
- Subcontracting procedures for sample collection and field analysis, as appropriate
- Waste minimization and disposal.

4.5.2 Sampling and Field Analysis Standard Operating Procedures

Sampling and field analysis activities may be conducted at the sites using a variety of equipment and procedures, (e.g., well drilling procedure for ground water sampling, soil sampling procedures, sampling from wells, pipes, pits, and lagoons, sampling containerized wastes [tanks, trucks, drums etc.]). Each sampling method performed in the field should have an SOP associated with the particular activity. The equipment and procedures should be selected on a site-specific basis, depending on the media and nature of the contaminant to be sampled.

The SOP should describe in detail the equipment needed, and how to use and maintain the equipment properly. The SOP should address typical difficulties associated with the sampling activity, limitations, and any precautions required to complete the task successfully. The SOP also should specify the required documentation to make the activity comply with established criteria. Company-specific procedure requirements may also apply.

Best management practice suggests consideration of the following areas within each sampling SOP:

- Applicability of method to the matrix or sample type
- Survey and identification of sample collection points
- Preparatory procedures, such as subsampling and compositing, should address the various individual sample matrices and the associated heterogeneity
- Accuracy, precision, and sensitivity of the procedure
- Equipment performance specifications and proper operating conditions
- Equipment decontamination
- Related QC sample type, frequency, and acceptance criteria
- Sample packaging and shipping.

4.6 VARIANCES TO STANDARD OPERATING PROCEDURES

Sampling should be performed in accordance with established and approved SOPs unless specific needs dictate a temporary and immediate variation. Whenever possible, any variations to approved SOPs should be approved by project management in advance of implementation. When advanced approval is not possible, project management should be notified of the variation by the sampling team at the earliest possible opportunity. The reason for the variation from the SOP, and all specific associated actions, should be documented. All data associated with a method variation or a temporarily modified method should be evaluated for useability based on project DQOs.

4.7 OUT-OF-CONTROL EVENTS AND CORRECTIVE ACTIONS

Any deviations from the SOPs not covered by a variance may be considered an out-of-control event or variation. Equipment malfunctions, misidentifications, or mishandling of samples are examples of deviations. A corrective action SOP should be in place. Deviations should be documented at the time of occurrence and reported to the field team leader/site manager and project management.

Best management practice suggests the following areas be addressed in a corrective action SOP:

- Capability to effectively deal with errors or defects at any point in the sampling activity
- Protocols for reporting, including format, content, timing of reports and actions, specification of individuals responsible for corrective measures, and lines of communication to management
- Ability to identify, tally, and track defects to their origin; to plan and implement measures to correct identified defects; and to document the results of the corrective actions with the use of corrective action forms or reports
- Corrective action forms or reports should be maintained and controlled by the field QA function, and documentation of events affecting sample data should be reported with, and archived in, sample records
- Corrective action reports should contain at least the following information:
 - When and where the out-of-control event occurred
 - Who discovered the out-of-control event and who has taken or will take responsibility for corrective action
 - An explanation for the out-of-control event. Copies of relevant information, control charts, sample data, etc., may be included as part of the corrective action report
 - Identification of all samples affected, and a discussion of sample problems and possible effects
 - Corrective actions should be described and measures enacted to prevent a recurrence of the problem should be identified.

4.8 DOCUMENT AND RECORD CONTROL

Company-specific document control policies should be reviewed as they apply to field activities.

4.8.1 Records Control System

A records control system should be established consistent with DOE Order 1324.2A, *Records Disposition*. Best management practice considers the following areas for records control SOPs addressing field organizations:

- Specification of items, data, and processes of which records are to be controlled
- Preparation, review, approval, and maintenance of records to accurately reflect completed work and to fulfill statutory requirements
- Requirements and responsibilities for record transmittal, distribution, change, retention, protection, preservation, traceability, archival, retrieval, and disposal
- Verification that records received are legible and are in agreement with the transmittal document
- Requirements for access to and control of the files
- Procedures for the control and accountability of records removed from the storage location
- Procedures for filing of supplemental information and disposing of superseded records
- Storage of records in a manner approved by the organizations responsible for the records
- Replacement, restoration, or substitution of lost or damaged records.

4.8.2 Documents and Records Retention

The project-specific documents (QAPPs, QAPjPs, WAPs, SAPs, etc.) should identify and direct the retention of quality affecting documents. These QA documents should specify which organization is responsible for the quality records and their handling.

The generally accepted practice is that the field organization maintains original logbooks and original field analysis records. Copies of all data packages, calibration records, and other QA/QC-related records are maintained until they are dispositioned in accordance with company-specific procedures.

4.8.3 Data Correction

The field organization should have in place a data correction SOP, which establishes who is authorized to change and correct data. Changes or corrections to information, including data entries, notebook and log entries, and computer or data systems output, should be corrected by drawing a single

line through the incorrect information and initialing and dating the new entry. Correction tape or fluid should not be used. Changes to computerized data records should be identified such that original and corrected entries are retrievable and the individual initiating the changes can be identified.

4.9 FIELD ASSESSMENTS

During the actual performance of field activities, in-process audits, self-assessments, and surveillances should be performed by either an internal or external assessment organization. These assessments will ensure that the sampling organization's activities are being conducted according to approved procedures, by qualified personnel, using specified equipment. Results of all assessments, including the corrective actions taken, should be reported to the project manager on a regular basis.

The audit/self-assessment/surveillance of sampling activities should evaluate, at a minimum, the following subjects:

- **Equipment**--Collection, measurement, and test equipment should meet the applicable standards (e.g., ASTM) or have been evaluated as being acceptable to the procedures, requirements, and specifications.
- **Verification of Sampling Activities**--That the elements of the sampling program are in compliance with the applicable technical and quality standards, specifications, and SAP and Work Plan requirements. The elements to be verified include, but are not limited to, the following:
 - Implementation of the QA Program
 - Qualification of sampling personnel
 - Identification, control, and storage of samples and project documents
 - Implementation of methods or procedures conforming to applicable specifications and Work Plan requirements
 - Documentation and verification of conditions and observations.
- **Completeness of Sampling Records**--Examination of whether:
 - All samples required by the QAPjP have been collected and submitted to the laboratory
 - Complete records exist for each sample set and the associated QC samples
 - The procedures specified in the QAPjP have been implemented and that changes have been noted according to the established procedures

- The results of the internal completeness check have been documented, and data affected by incomplete records have been identified
- Anomalous field data are identified and appropriately qualified.
- **Evaluation of Data with Respect to Control Limits**--Examination of corrective action reports 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**--Examination of sample holding times in comparison to those required by the QAPjP and the SAP. Determine whether any samples associated with deviation from holding time requirements are identified in a written record of the sampling activities.
- **Implementation and Effectiveness of Corrective Actions**--Examination of corrective action reports to determine whether sampling activities associated with findings from previous audits/self-assessments/surveillances of similar activities are identified in a written report. Determine if the facility response to previous findings was effective and properly implemented.

4.10 REFERENCES

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5.0 SAMPLING OPERATIONS

Project management, in conjunction with personnel knowledgeable in the relevant sampling criteria, should develop, establish, and update requirements for management of documentation, sample collection, waste disposal, chain-of-custody, subsampling, holding times, sample containers, and preventative maintenance. If project management determines that existing sampling SOPs are sufficient to meet or exceed project needs, new documents need not be developed. For most projects, existing sampling SOPs should meet or exceed project requirements.

5.1 SITE/FIELD DOCUMENTATION

Site and field logbooks and data forms are means for providing a daily handwritten record of all field activities at an investigation site and are generally considered the primary record for sampling activities. The project specific quality assurance plan determines the type of documentation (site and field logbook, data forms, and/or others as specified) needed at a site.

All logbooks should be permanently bound, and field logbooks should be waterproof. Logbooks should be ruled with sequentially numbered pages. All logbook entries will be made in indelible ink. Corrections are made by marking the erroneous data through with a single line, entering the correct data, and initialing and dating the changes. Correction fluid and erasers are not to be used. Pages will not be removed from logbooks for any reason. Space left on pages should be lined through and initialed and dated. This indicates the completion of the entry as well as prevents non-related information from being added. Blank pages should be marked "page intentionally left blank." Only authorized persons may make entries in logbooks.

Automated data entry systems for field data collection are frequently used. Computer notebooks and data loggers reduce repetitive data entry and transcription errors. Guidance is available in the EPA report *Good Automated Laboratory Practice* (1990).

5.1.1 Site Logbook

A site logbook is the master reference document for activities performed at a site. In small investigations, the field logbook may also serve as the site logbook. Entries should be made and initialed on a real-time basis, with summaries completed at the close of each work day. The front cover of the site logbook should bear the project name and number, contractor or subcontractor name, and contract number, if appropriate. Start and completion dates also should appear on the front cover.

The following items should be recorded in the site logbook:

- The day, date, time arrived onsite, weather conditions; names, titles, organizations of personnel present onsite; and individuals responsible for field logbooks should be listed with their assigned logbook number.
- The name, title, organization represented, and the purpose of the visit.
- Forms, including computer data files or logbooks that register the details of tasks performed on site (e.g., well installation logs).
- All site activities, including field tests. The site logbook summarizes daily activities and should therefore not be as detailed as field logbooks.
- Chain-of-custody details, and all activities and variances relating to chain-of-custody.
- Equipment decontaminated, number of decontaminations, and the decontamination procedures followed when different from the QAPJP or SOPs. The site log references the field logbook where specific information is documented.
- Any equipment failures or breakdowns, with a brief description of repairs or replacements made, and indications of the impact of the equipment failure.
- Any deviations from the QAPJP or SOPs, including the reasons for the change, the detail of the change, and a discussion of the possible impacts of the change.
- A record of telephone calls relating to field activities. If a separate phone log is maintained, the site log should reference the page containing the specific details.

The field manager, supervisor, or cognizant scientist/engineer should review entries, sign, and date the bottom of each page.

5.1.2 Field Logbook

In addition to the information contained in the site logbook, field logbooks contain area- or task-specific information. The field logbook cover should indicate the particular tasks or areas within the site (or the specific individuals) to which the logbook is assigned.

Information to be recorded in the logbook, as appropriate, include the following:

- The day and date, time the task started, weather conditions, and the names, titles, and organizations of personnel performing the task.

- The name, title, organization, and purpose of the visit to the task area.
- Site activities in specific detail or show which forms were used to record such information (e.g., soil boring log or well completion log). It is good practice for the site engineer or geologist to duplicate the most important information in the field logbook and also on data forms.
- Details of any field tests that were conducted. Reference any forms that were used, other data records, and the procedures followed in conducting the test. Results of any field activity should be annotated in the field logbook.
- Details of any field calibrations and surveys that were conducted. Reference any forms that were used, other data records, and the procedures followed in conducting the calibrations and surveys. Results of any field calibrations and surveys should be annotated in the logbook.
- Details of any samples collected and indicate the preparation, if any, of splits, duplicates, matrix spikes, or blanks. Reference the procedure(s) followed in sample collection or preparation. List all label or tag numbers, sample identification, sample containers and volume, preservation method, packaging, chain-of-custody form number, and the analytical request form number pertinent to each sample or sample set. Note the time and the name of the individual to whom custody of samples was transferred.
- The time, equipment type, and serial or identification number, and the procedure followed for decontaminations and equipment maintenance carried out. Reference the page number(s) of any logbook (if any) where detailed information is recorded; detailed information should otherwise appear in the field logbook.
- Any equipment failures or breakdowns that occurred, with a brief description of repairs or replacements.
- The project field geologist or task leader should review and sign the field logbook at the bottom of each page.

5.1.3 Data Forms

It is often convenient to document field information on pre-made data forms. A copy of any data form to be used with a detailed key/legend describing the content of each space or block on the form should be included in the QAPjP and/or the SOP. As with logbooks, data forms should be completed with indelible ink.

5.2 MANAGEMENT OF SAMPLES

Samples may be collected from known or suspected hazardous sites that may contain hazardous organic, inorganic, and/or radiochemical materials. Sampling organizations must be aware of potential hazards associated with the collection, handling, and disposal of these samples. The sampling team should be provided with historical and background information on the potentially contaminated site to give them guidance on health and safety precautions that should be initiated. It is the responsibility of the sampling organization to take necessary measures to ensure the health and safety of its employees, to follow as low as reasonably achievable (ALARA) principles and to meet regulatory requirements.

During the pre-job planning phase the field organization should be cognizant of any special requirements that come into effect when working with listed waste, environmental media that contains listed waste, and hazardous debris containing a listed waste. Communication with the laboratory pertaining to these issues should occur prior to sample collection and delivery.

5.2.1 Sample Identification

Project-specific QA plans or SOPs should describe methods to ensure samples are identified and controlled in a consistent manner. The identification system should ensure traceability of samples from time and place of collection through shipment to authorized persons or organizations and/or disposal. The identification of QC samples should be contained within project documentation to allow the relationship of QC data to specific samples to be traceable.

Samples have their own unique identification numbers. The sample identification number is a critical link in the traceability of analytical data to the project. This number should be recorded in the appropriate field and project documentation (i.e., chain-of-custody and/or field data sheets) with information describing the sample. Each sample is identified by affixing a standardized label or tag on the container. This label or tag should contain the sample identification number, date and time of collection, media, preservative used, analysis required, and the collector's initials or signature.

Best management practice suggests that identification records contain the following information:

- Unique sampling number
- Date and time collected
- Analysis required
- Name of collector
- Source of sample (including name, location, etc.)
- Method of preservation (if any)
- Field data (pH, dissolved oxygen, radiation readings etc.)
- Serial numbers and transportation cases.

5.2.2 Sample Preservation

Chemical analyses of samples generally should be conducted as soon as possible after collection. Because samples are normally transported from the field to an analytical laboratory, some preservation is necessary to maintain the integrity of the samples. Samples should be preserved in a manner consistent with regulatory requirements and with the established SOP. Any use of chemical preservatives should be indicated on the sample label.

The introduction of preservative is conducted prior to sample collection by addition to the sample container, to the sample matrix upon collection or at the laboratory. Case-by-case preservation decisions should be made based on laboratory requirements, matrix concerns, DQOs, and state or Federal regulations. DOT regulations apply to pre-preserved containers, preservatives transported to the field, and preserved samples. Sample preservation and extension of holding times may be negotiated with the regulators to support cost-effective collection of data with known and controlled sources of variability. This analyte- and sample-specific approach is consistent with EPA processes of DQOs and Data Quality Assessment.

Methods of preservation are relatively limited and generally are intended to: (1) retard biological action, (2) retard hydrolysis and radiolysis of chemical compounds and complexes, (3) reduce volatility of constituents, and (4) reduce absorption and adsorption effects. Preservation methods generally are limited to pH control, chemical addition, refrigeration, and freezing. No single standard method of preservation and storage can be recommended for samples. The analytical method procedure will specify the acceptable preservation technique.

Best management practices call for the method of preservation being recorded in the field documentation with the pertinent information required by the SOP. Preservatives should be tracked by lot number, date of receipt, and date opened.

5.2.3 Sample Storage

Site storage can be minimized by coordinating a sample shipment schedule with the laboratory. Storage areas should be dedicated to samples only and controlled to prevent damage or loss, and to maintain sample container and identification integrity. Measures should be taken to avoid sample contamination during storage. Measures also should be taken to contain and avoid material spills during storage.

Best management practices indicate that when storage is necessary, the samples should be stored in predetermined physical and environmental conditions commensurate with the intended analysis and regulatory requirements specific for the analyte and matrix. Daily verification and documentation of storage temperature should be maintained in accordance with project DQOs. Storage blanks should be used as appropriate.

5.2.4 Sample Handling and Transfer

The number of persons involved in collecting and handling samples should be kept at a minimum. One member of the sampling team should be identified as the field custodian. It also is acceptable that the person who collects the sample remains the custodian until delivery at the laboratory; in these cases no field custodian is identified. Samples should be turned over to the field custodian by team members who collected the samples. The field custodian documents each transaction and the sample remains in the custodian's possession until shipped/delivered to the laboratory.

Standard operating procedures should establish methods to control samples during handling and transfer to preclude loss of identity, damage, deterioration, and loss of sample. Chain-of-custody documentation accompanying samples will be maintained at all times.

Custody seals should be placed on the containers to prevent opening without breaking the seal. The sample identification number should be marked on the sample container and the chain-of-custody form. Samples should be packaged and shipped in accordance with the applicable state and Federal regulations.

The field custodian is responsible for properly packaging and dispatching samples to the appropriate laboratory or facility. This responsibility includes completing, dating, and signing the appropriate portion of the chain-of-custody record, sample transfer, and shipping forms (as applicable). Verification of sample identification and integrity should be performed prior to acceptance of sample from another staff member or organization for field analysis, introduction into storage, or delivery to designated laboratory. When transferring the samples, the person who accepts the samples should legibly print and sign their name and record the date and time of the transfer on the chain-of-custody record. If the transfer of custody is between companies, the company affiliation along with the signatures must be noted.

Best management practices for sample handling and transfer are further discussed in the following paragraphs.

Precautions should be taken not to contaminate samples or field personnel. The outside of the container should be wiped clean of any visible dirt, grime, or liquid after the sample has been placed in the container. When working in a radiologically controlled area the container should be surveyed according to site-specific procedures. The container should be placed in a plastic bag to ensure that the outside of the container does not become contaminated.

The field custodian should seal the cap of the individual sample container so that any tampering is easy to detect. Custody seals should be used to verify that sample integrity has been maintained during transport. Custody tape should be selected that is not removable from the shipping container without breaking the seal. Samples should be shipped in insulated containers with either synthetic ice or ice packed in leak-proof plastic bags when samples require cooling to $4 \pm 2^{\circ}\text{C}$.

The sample container(s) should be placed in a transportation case, with the pertinent field records, analysis request forms, and chain-of-custody record. A copy of each form should be retained by the originating office. The transportation case should be secured, labeled, and marked in accordance with appropriate DOT regulations.

5.2.5 Sample Screening, Packaging and Shipping

Instructions for screening, packaging, and shipping of samples should be established in the SOP. These instructions will ensure compliance with OSHA and state regulations regarding the protection of personnel and the environment. The transportation of samples should be accomplished not only in a manner designed to protect the integrity of the sample, but also to prevent any detrimental effects from potentially hazardous samples. Regulations for packaging, marking, labeling, and shipping hazardous materials, hazardous substances, and hazardous wastes are enforced by the DOT and described in 49 CFR 171-177. Packaging and transportation of Hanford materials along public roads or in the public domain should be in compliance with DOT regulations and DOE requirements. Other packaging and transportation of Hanford Site materials should be in compliance with DOE requirements. Packaging and transportation of Hanford Site materials should adequately protect personnel, the public, and the environment.

All sample containers and shipping containers, except those obtained from documented non-radioactive areas, should undergo field radiological screening to determine proper shipping and handling requirements. The field sampling organization's SOPs should specify protocols for actual radioactivity screening, action levels, and shipping procedures. (See the HSRCM for further detail related to radiological control requirements.)

The SOPs should address sample collection, preparation (if required), counting protocols, and QC considerations. The SOPs also should define action levels that will determine which samples are considered nonradioactive, which samples will require further screening, and which samples should be submitted to a licensed laboratory. The action levels should meet or exceed current Federal, state, and local regulations.

Radiological survey instruments should be calibrated and maintained as specified in the HSRCM.

5.2.5.1 Hazardous Samples. Samples expected to contain hazardous material should be considered hazardous substances and transported according to DOT requirement 49 CFR 172.101. If the material in the sample is known or can be identified, then it should be packaged, marked, labeled, and shipped according to the specific instructions for that material. For potentially hazardous samples with unknown contents, the selection of the appropriate transportation category is based on the DOT Hazardous Material Classification, a prioritized system of transportation categories.

5.2.5.2 Radioactive Samples. Materials are classified by the DOT as radioactive material if the specific activity is greater than 0.002 mCi/g. Samples should be screened to determine if they have a specific activity greater than 0.002 mCi/g. When screening indicates the samples are

radioactive, they are to be transported according to DOT requirement 49 CFR 172.310 for marking, 49 CFR 172.436, 438, and 440 for labelling, and 49 CFR 172.556 for placarding and shipping.

Limited quantities of radioactive materials (whose activity per package does not exceed the limit specified in 49 CFR 173.423) are excepted from the specification packaging, shipping paper and certification, marking, and labeling requirements if they meet the requirements detailed in the CFR.

Prior to shipping radioactive samples to the laboratory, the organization responsible for shipping should notify the laboratory of the approximate number and radiological level of the samples. This notification is conducted through a laboratory coordination office. However, the laboratory is responsible for assuring that applicable license limits are not exceeded. The shipment of the samples also should be reviewed to ensure that the established DOE limits for offsite shipment are not exceeded.

5.3 WASTE DISPOSAL

Waste materials are generated during sample collection, processing, and subsampling activities. The method of identification, storage, and disposal of these waste materials and unused samples should be specified when hazardous, radioactive, or mixed waste is generated. These policies and guidelines apply to personnel who generate, handle, manage, and/or dispose of waste in the field activities. Program and project managers should ensure their waste management plan for the sampling and field analysis event has addressed the return of unused sample material and/or the wastes generated from analysis inside the laboratory upon completion of the work.

Best management practices indicate that consultation with a health physicist or waste management specialist should be considered when policies and guidelines for waste management are being developed. The waste management plan should detail the responsibilities for waste management and handling, along with the approved disposal methods for derived wastes.

5.4 CHAIN-OF-CUSTODY

A major consideration for the legal credibility of analytical data generated from a field sampling activity and subsequent sample analysis is the ability to demonstrate that samples have been obtained by the sampling group and reached the laboratory without alteration. Evidence of collection, temporary storage, and shipment to the laboratory should be documented. Documentation is accomplished through chain-of-custody procedures and records that describe and document how physical custody is maintained, how custody is transferred, the identity of individuals responsible for sample collection, processing, shipment, storage, and disposal. A sample is considered in custody if it is in the person's actual possession, is in view after being in physical possession, is locked so that no one can tamper with it after having been in physical custody, or is in a secured area restricted to authorized personnel.

The field sampling organization will establish SOPs that describe the interface and custody responsibilities for sample collection, temporary storage, custody transfer, shipping of the samples to the final destination, and disposal.

The following information is required on the completed chain-of-custody form at a minimum:

- Project name
- Signature of sampler
- Sampling station or sample point identifier
- Unique sample number
- Date and time of collection
- Grab or composite designation
- Matrix
- Preservatives
- Signatures of individual involved in sample transfer.

Chain-of-custody forms initiated in the field should be protected from tampering or other damage. This may be accomplished by placing the chain-of-custody form in a plastic cover and taping it to the inside of the shipping container used for sample transport from the field to the laboratory.

Often chain-of-custody forms are altered to meet the needs of specific organizations. The chain-of-custody form is a document that provides consistent information to user parties. Due to the large variety of sampling organizations and the relatively few numbers of laboratories, only company-approved chain-of-custody forms should be used by the field organizations. Chain-of-custody forms should accompany samples delivered to the laboratory facility(ies) that are performing the analyses. These forms should be signed and dated upon receipt in the facility.

When samples are relinquished to a shipping company for transport in a custody-sealed shipping container, the shipping company should provide a shipping bill/receipt. Employees of the shipping firm do not sign the chain-of-custody. The tracking number from the shipping bill/receipt is to be recorded on the chain-of-custody form or in the project documentation. See Section 5.2.4, "Sample Handling and Transfer", for further information related to the transfer of samples.

Agreement should be reached between the laboratory and customer regarding disposition of the "original" custody form (i.e., should it be retained by the laboratory, returned immediately to the customer, delivered to the customer as part of the final data deliverable). If copies of the chain-of-custody forms associated with the samples are not maintained as part of the formal analytical data package, the reason for this should be documented by the project manager. Chain-of-custody forms are to be reviewed for accuracy by the cognizant lead person.

5.5 SUBSAMPLING AND COMPOSITING

Processing, compositing, and subsampling of bulk materials collected in the field are key links in the sampling and analytical chain, and can have a substantial impact on the usability of resulting analytical data. When the entire content of a sample container is subjected to analysis by a single method, processing and subsampling in the laboratory are not required. When more than the analytical sample size is collected, processing and subsampling in the laboratory is required.

It is important that participants in a sampling effort are aware of proposed and implemented field compositing and subsampling methods, including their impact on data usability and the achievement of DQOs. The collection of samples from a population for the purpose of compositing generally is used as a cost saving method. Proper attention to population variability, sample collection techniques, compositing, and subsampling for submission to the analytical laboratory enhances the representativeness of the data.

During the pre-planning stages the sampling organization should be cognizant of the laboratory analysis volume requirements. This information is very useful in ensuring that sufficient material for analysis, and its associated QC, is submitted to the laboratory, as well as minimizing the submission of excess sample to aid in the reduction of waste generation. This information aids in determining the proper choice of compositing and subsampling methods.

The field sampling organization should establish SOPs to attain the following:

- Minimize the possibility of subsampling bias and non-representative subsampling
- Recognize benefits that can be realized using compositing to enhance representativeness and drive costs down
- Ensure that processing, compositing, and subsampling is completed correctly
- Ensure that the samples shipped to the laboratory are representative of the material of interest.

5.6 HOLDING TIMES

Holding times identified in each project plan or scope of work for each parameter or group of parameters to be analyzed should be met when implementing work for projects, including the following:

- Sample shipment and delivery should be coordinated between the field supervisor/site manager and the laboratory to meet sample holding times, where applicable.
- Sample holding time begins at the time and date the bulk sample is collected in the field.

- The use of preservatives may extend the acceptable holding times. This approach can be negotiated with the regulators to support the collection of cost-effective data of known and controlled variability.

5.7 SAMPLE CONTAINERS

The project plan and laboratory guidance should specify those types of containers and the level of cleanliness required.

Best management practices indicate that when bottles or containers are provided by the laboratory, the field sample collection record should indicate the laboratory lot number of the bottle. When commercially precleaned containers are used in the field, the name of the manufacturer, the lot identification, and certification should be retained for documentation. Containers should be capped and stored in a contaminant-free area. Samples should be collected, where and when appropriate, in break resistant containers. Samples in glass containers should be transported using secondary containment (e.g., coolers, sealed cans) as specified in the SOP and in accordance with DOT requirements.

5.8 PREVENTIVE MAINTENANCE PROGRAM

An adequate preventive maintenance program increases the reliability of collection equipment and minimizes down time. Those pieces of equipment that are defined as Measurement and Test Equipment should be considered in a preventive maintenance program.

Best management practice for preventative maintenance recommends that the following be considered:

- SOPs encompass actions to be taken to maintain proper instrument and equipment performance and to prevent instruments and equipment from failing during use.
- A stock of critical spare parts are maintained and documented. Preventive maintenance should be scheduled and documented and a maintenance record should be maintained for instruments and equipment used in field analytical work.
- It may be more cost-effective to have replacement equipment available rather than utilizing a preventive maintenance program.

5.9 REFERENCES

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6.0 QUALITY CONTROL FOR THE SAMPLING PROCESS

Several control samples are introduced into the collection system to monitor the adequacy of the sampling system and the integrity of samples during their journey from the field collection point through laboratory analysis. These samples are defined below with their mode of collection and purpose.

6.1 TRIP BLANKS

Trip blanks are used to detect contamination during sample shipping and handling. A trip blank consists of an analyte sample container filled with ASTM Type II water or silica sand, which is transported to the sampling site and returned to the laboratory with the samples. Trip blanks are filled in the laboratory and are not to be opened in the field. Trip blanks can either be Volatile Organic Analysis (VOA) only or a complete set of sample containers. Project-specific QA documents should define the type and frequency of trip blank use.

Trip blanks are primarily used for volatile organic compounds (VOC). Trip blanks, however, may be used whenever there is concern that concentration of the parameter may be biased by contamination. A trip blank not only will detect contamination during the shipping and handling of the containers, but also will serve to detect contamination from containers (i.e., function as a bottle blank), which is important if non-certified sample containers are being used.

One VOA trip blank should accompany each cooler containing site samples or as specified in the site-specific controlling documents. Each trip blank should be stored at the laboratory with associated samples and analyzed with those samples. Trip blanks are sent whether soil or water samples are to be collected. Analyte-free solid matrices should be employed when collecting soil samples. If a solid matrix is not available for a trip blank, ASTM Type II water may be used.

These samples are to be reviewed at the completion of the analysis to determine if any cross-contamination occurred that could affect sample results. Sample results should be evaluated to determine the possible effects of any contamination detected in the trip blank.

6.2 EQUIPMENT REINSTATES (BLANKS)

Equipment blanks are samples of ASTM Type II water passed through decontaminated sampling equipment prior to use of the equipment in the same environment. They are used as a measure of decontamination process effectiveness. Equipment blanks should be collected in the field and at the rate specified in the QAPjP. An equipment blank should be collected from each type of sampling equipment used to ensure that the decontamination procedures are applicable to the specific equipment types.

Equipment blanks are analyzed for the same analytes as samples collected using that equipment. Sample results should be evaluated to determine the possible effects of any contamination detected in the equipment blank.

Equipment blanks should be employed throughout the course of the project to monitor the efficiency of the decontamination procedures. If contamination is detected and the field source water blank is free of the analytes of interest, it may be necessary to monitor the field crew to ensure adherence to the procedures. If it is determined that the crews are properly following the decontamination procedure, it may be necessary to change the procedure.

6.3 FIELD SOURCE WATER BLANKS

Field source water blanks are samples of source water used for decontamination and steam cleaning. At a minimum, one sample for each source of water for a given event should be collected for analysis. Normally, there will be two field source water blanks per event: (1) a sample of the potable water used for steam cleaning, and (2) a sample of the ASTM Type II water used for decontamination. If more than one batch or lot number of ASTM Type II water is used or if potable water is taken from more than one location, then additional field source water blanks should be taken since these are different sources.

The field source water blanks should be monitored throughout the project to detect any possible contamination present in the decontamination water. The field source water blanks should be monitored for the same analytes as the samples being analyzed.

This may prevent the introduction of contaminants to the site samples. If contamination is detected, a different source of water should be used. Sample results should be evaluated to determine the possible effects of any contamination detected in the field source water blank.

6.4 FIELD DUPLICATES (REPLICATES)

Field duplicates are two samples produced from material collected in the same location. Each will be numbered uniquely. Field duplicates provide information regarding the homogeneity of the matrix. A matrix includes soil, sediment, water, biota, or waste from a given site. Field duplicates may also provide an evaluation of the precision of the analysis process. Field duplicates for soil are collected and homogenized before being divided into two samples in the field. Field duplicates normally will be collected at a frequency of 5 to 10% of the samples collected per matrix. Soil samples submitted for VOC analyses are not to be homogenized or split; instead, it is necessary to collect collocated samples as defined in Section 6.5.

Field duplicates should be sent to the laboratory in the same manner as the routine site samples. They may or may not be identified to the laboratory as field duplicates. It may maximize the utility of information to submit extra samples from the field duplicates for the laboratory to use as duplicates. This will help distinguish between variability resulting from sample heterogeneity and laboratory manipulation.

Field duplicate data should be reviewed for agreement. Data should meet the precision criteria established in the QAPJP. If the duplicate data do not meet the established criteria, they should be examined to ascertain the source of disagreement. The laboratory QC data should be reviewed to determine if the laboratory was operating in control. If the laboratory was in control, the sampling data should be reviewed to determine if there were any matrix anomalies that could contribute to differences in the concentrations. Additionally, the process used to collect and duplicate the samples should be reviewed to determine if it is the source of imprecision.

6.5 FIELD SPLIT SAMPLES

Split samples are a variation of field duplicate samples. The frequency and method for collection of field split samples is directed by the project plan or implementing procedure. Split samples are collected for the purpose of comparing data from different laboratories. Usually, the volume needed is homogenized and subsequently placed in separate, identically prepared containers, numbered uniquely, and forwarded to separate laboratories for analysis using the same method/protocol. The data generated by field split samples is used during the data assessment process to evaluate the data from the analyses performed by the primary laboratory on samples from the same source.

6.6 COLLOCATED SAMPLES

Collocated samples are independent samples collected as close as possible to the same point in space and time and are intended to be identical. Because of the possible loss of volatile analytes when generating field duplicates, it is necessary to collect soil samples for VOA analysis as collocated samples. Collocated soil cores collected for VOA analyses should be sealed immediately and shipped to the laboratory.

Collocated sample data are to be reviewed in the same manner as duplicate sample data as discussed in the previous section.

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7.0 SAMPLING DATA

Project management, in conjunction with personnel knowledgeable in the relevant analytical criteria, should develop, establish, and update data deliverable requirements based on project DQOs. Each project or program should identify and clearly define specific data deliverables expected from the sampling organization supporting its work. These deliverables should be designed to ensure project information contains the appropriate QC and documentation. Documented procedures should be in place that address data deliverable requirements to meet project requirements. Sampling organizations providing projects with samples and data should be aware of deliverable requirements and be able to provide the stated deliverables in a consistent and timely manner. If project management determines that existing SOPs are sufficient to meet or exceed project needs, new documents need not be developed.

Best management practices allow for the deliverables to include electronic files. Reporting formats should be compatible with the project's system. Standard formats for transmission and database structure requirement should include consistency with Hanford Site standards (i.e. Hanford Environmental Information System [HEIS]) for collecting, storing, transmitting, and evaluating environmental data.

7.1 SAMPLING DATA REVIEW

QA in the sampling process is normally provided by frequent (daily) review of the site and field logs, and comparison with the data quality requirements of the project plan. Frequently, the selection of sampling points and/or samples for more detailed examination is based on field analytical data (qualitative and/or semi-quantitative) so it is necessary to review the field analytical results as well. Field documentation should be reviewed to ensure that the proper number of field QC samples were submitted to the laboratories. The principal acceptance criteria for this QA review of sampling activities are the following:

- Correct number and locations of the sampling points were documented
- Selected sampling points indicate the presence/absence of the target analytes
- Samples were collected and shipped properly
- Field records and documents are complete
- Data reporting requirements for the day's activity were met.

The data in the field logbook are first reviewed and signed by the person generating the data and then by the field engineer, scientist, or geologist leading the activity in the field. The critical data from the field logs are entered in the site log by the field supervisor or other authorized person. The project manager should review the data in the site log upon receipt, then evaluate the field data against the project objectives.

7.2 REFERENCES

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APPENDIX A

**DESCRIPTION OF THE SAMPLING AND
ANALYSIS PROCESS FLOW CHART**

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APPENDIX A

Description of the Sampling and Analysis Process Flow Chart

Information pertaining to the (a) identification of controlling documents, (b) responsible organization, and (c) the essential inputs/outputs of each step are conveyed. It is important to note that each company and division will likely have specific groups responsible for these basic tasks. The intent is to provide the overall understanding of how each step is related to the overall accomplishment of the sampling and analysis task.

1. Data Quality Objectives

a. Controlling documents

DOE-HQ directive set forth in a September 7, 1994 letter from Assistant Secretary Thomas Grumbly requiring the use of the Guidance for the Data Quality Objectives Process, September 1994, EPA QA/G-4.

DOE-RL direction to Hanford contractors to use the DQO process set forth in a January 19, 1995 letter from John Wagoner, Manager, to Pacific Northwest Laboratory and WHC, and in a December 12, 1994 letter from Roger Freeberg, Director, Environmental Operations Division to Bechtel Hanford, Inc.

Contractor-specific management control and implementing procedures such as BHI-EE-01, Volume 1, Environmental Investigations Procedures, Data Quality Objectives.

b. Responsible organization(s)

The program charged with the responsibility of making decisions based on the recommendation of the planning team to "own" the DQO process.

The essential component contributing to the success of the DQO process is the selection of the planning team. This team is the group that will develop DQOs for the study. Organizations that base their work process on the agreed on DQO are to be considered as participants in the DQO process. This includes project managers, laboratories, sampling organizations, data management groups, etc.

c. Essential inputs and outputs

The inputs to the DQO process are defined as information that add to the generation of a decision rule. Each application of the DQO process will require different types of information. Generally inputs include historical data, process information, technical knowledge of current situation, regulatory or contractual driver, and sampling and analysis data.

Figure A-1. Sampling and Analysis Process Flow.

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The output of the DQO process is the development of a quantitative and qualitative framework for a study. Much of the information that is developed in the DQO process can be used directly and indirectly as inputs for the QAPjPs. A report is issued (approximately 5 to 50 pages depending on the complexity of the study) to the project management office by the planning team. More detail on this step in the process is provided in Appendix B of this document and in EPA-QA/G-4, Guidance for the Data Quality Objectives Process, September 1994.

2. Define Requirements

a. Controlling documents

QAPjPs and Characterization Plans (i.e., Work Plans [WP], Sampling and Analysis Plans [SAP], Waste Analysis Plans [WAP], Statements of Work [SOW], and Contractor Work Plans [CWP]) are the formal documentation and communication of the DQO requirements.

b. Responsible organization(s)

The program needing information to assist decision-makers or responsible for authorship of the requirement documentation.

c. Essential inputs and outputs

Inputs to the definition of the requirements is based on the DQO process.

The output of this stage is controlled formal documents that define the QA parameters to enable the DQOs to be met.

3. Analytical Services Requisition

a. Controlling documents

Analytical services are arranged through well defined programmatic procedures. Each contractor is likely to have specific methods of requiring analytical services. In some cases, divisions and/or organizations may have specific agreements or contracts directing the method to be used to request analytical services.

b. Responsible organization(s)

Analytical services are arranged to meet the programmatic needs by Program Management and Integration in WHC.

Sample Data Management of the Environmental Restoration Contractor, and Analytical Services Program of Pacific Northwest Laboratories.

c. Essential inputs and outputs

The input for this step in the process is the direct communication from the program coordinators to the laboratory coordinators in the organizations listed above.

The output for this step is typically a Sample Authorization Form/Field Sampling Requirements communication to the laboratories, the sampling organizations, and the program requesting the work.

4. Prepare for Sampling or Field Analysis

a. Controlling documents

The preparation for the sampling event is controlled by internal procedures specifying how support functions for the event are coordinated within that company. When support is needed across company lines contracts, memorandums of understanding, letters of instruction, or basic ordering agreements are established. The usage of these documents are controlled in company-specific procedures.

b. Responsible organization(s)

The preparation for a sampling event requires parallel preparation efforts from the involved parties. Sampling organizations prepare paperwork, test and verify equipment and personnel availability; the support organizations (i.e., Health Physics, craft support, heavy equipment operators, facility operations, transportation) arrange for coverage; and the laboratories ensure equipment, personnel, and standards are available to conduct the requested analyses to generate the data within the specified time frame. Any additional documentation (National Environmental Policy Act [NEPA], cultural resource review, excavation permits, etc.) also should be prepared during this time. If required by permits or other regulatory agreements, notification of intent to sample may also be necessary.

c. Essential inputs and outputs

The primary input to this step is the work plan, SAP, or WAP.

The availability of this document is essential to the efficient preparation for a sampling event. New and unique sampling events may result in the input of safety concerns. Often a walk-through of the intended activities prior to the actual event clarifies the interactions that will be necessary to ensure a safe and successful sampling event.

The output of this step is a team fully prepared for the sampling event. Support functions and sampling team members are aware of their responsibilities and functions. In some organizations, a review of the preparation is conducted to ensure the pre-job planning is complete prior to the scheduled sampling event. Questions or concerns related to the safety of the planned sampling event are to be mitigated prior to the sampling event.

5. Collect Samples

a. Controlling documents

Sample collection is controlled by company and program specific procedures.

b. Responsible organization(s)

Organizations that are responsible for the collection should be responsible for generating their own program specific procedures when existing site procedures do not adequately address the sampling event.

c. Essential inputs and outputs

Input to sampling procedures is derived from the QAPjP, SAP, WAP, and facility-specific process configurations. The output is the generation of samples that are collected such that they meet the specified DQOs and provide the means for the generation of analytical data of sufficient quality.

Sample tracking is an essential component of the Sampling and Analysis process and is initiated during this step. Chain-of-custody is the documentation that travels with the sample to facilitate input to tracking systems.

6. Field or Fixed Laboratory Analysis

a. Controlling documents

Analytical specifications are defined in contracts or statements of work.

Field analytical requirements are specified in statements of work or letters of instruction.

b. Responsible organization(s)

Laboratories or field analysis organizations that have been reviewed as meeting the specifications necessary to ensure the readiness of their operation to meet the QA specifications, should perform requested analyses.

c. Essential inputs and outputs

The input to this process is the mutual agreement to the conditions of the contract, statement of work, or letter of instruction.

The DQO process and subsequent documentation should be forwarded to the analytical organization for review and approval as appropriate. The output of this step is data of sufficient quality.

7. Data/Data Package Delivered

a. Controlling documents

The contract, statement of work, or letter of instruction should specify the data deliverables for each analytical organization. The type of deliverable may vary based on the outcomes of the DQO process.

b. Responsible organization(s)

The analytical organization is responsible for providing the customer with the specified data deliverable.

c. Essential inputs and outputs

Inputs to this step are the DQOs as specified through the DQO process and subsequent QA documentation. The laboratory must verify that the project requirements and QC criteria have been met.

The output of this step is the report in specified format of the analytical results obtained from the submitted samples. Data deliverables may range from quantitative results to fully documented results and raw data. Usually the laboratory should be required to discuss any difficulties or anomalies encountered during the course of analysis.

8. Validation/Data Useability Assessment (V/DUA)

a. Controlling documents

The DQO document or similar project document should describe the key elements to be used to accept or reject field and laboratory data for the particular application or data use.

b. Responsible organization(s)

Each company has specific organizations that are responsible for the V/DUA of data. Project managers may also designate specific V/DUA procedures to be followed.

c. Essential inputs and outputs

The inputs to the V/DUA step are the laboratory and field deliverables and the agreement to which the analytical work was conducted (contracts, QAPP, QAPJP, descriptions of work, letters of instruction, etc.) The output of this step is a data package/report that has been V/DUA relative to the specifications.

9. Evaluate Data

a. Controlling documents

The DQO document or the project-specific plan should discuss the actions to be taken with the useable data.

b. Responsible organization(s)

The organization requesting the data is responsible for its use in determining the outcome of the decision rule.

c. Essential inputs and outputs

The input to this step is the validated/data useability assessed data.

This step involves a process referred to as Data Quality Assessment. This is a vital step in bringing the DQO process to closure. The output of this step is the verification of assumptions made in the DQO process. By drawing scientifically valid and meaningful conclusions from the data, the decision rule presented in the DQO process can be implemented.

10. Data to Report (flows to either)

End Point: No Action or Input to Choice of Remedy DQO.

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APPENDIX B

**DATA QUALITY OBJECTIVE
PROCESS USER GUIDE**

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APPENDIX B

Data Quality Objective Process User Guide

Overview

The result of the DQO process is a set of specific and detailed DQOs that are incorporated into program supporting documents. Often a DQO document is issued, and Quality Assurance Project Plans are built from the specifications outlined in the DQO document.

The implementation of DQOs at Hanford is oriented toward enabling programs to meet site requirements in a cost-effective and technically sound manner. This can be accomplished using the disciplined rigor of program decision identification and preplanning in the application of the DQO process.

The use of the DQO process is one part of the QA planning and the Data Life Cycle. The Data Life Cycle is composed of three distinct areas: Planning, Implementation, and Assessment. The Planning stage is comprised of the DQO process and the development of the quality assurance project plan. The Implementation stage consists of field data collection and associated quality assurance / quality control activities. The final stage, Assessment, focuses on the data validation/verification and data quality assessment activities.

These three areas are further broken down into areas of organizational responsibilities in Table B-1. The program has specific leadership roles in the process for initiation and utilization of the data generated. Analytical Services Program of DOE-RL is the primary point-of-contact with the program to identify areas where DQO application is appropriate. A graded approach in the application of DQOs should be considered as depending on the size and complexity of the program.

Table B-1. Data Quality Objective Implementation Process.

P L A N N I N G P H A S E	Process Steps	Product	Who is Responsible
	Advanced Data Quality Objective (DQO) planning	Identify Master strategy Questions Risk/uncertainty	Senior technical experts Decision makers
	DQO Preparation	Identify detailed data needs; Quantify risk/uncertainty; Accept and approve DQO documentation.	Personnel Program Regulator AS DOE
D A T A C O L L E C T I O N P H A S E	Logistics Personnel	Prepare Characterization documents; Sampling/analytical procedures; Integrated schedules/budgets; Personnel training.	Program lead AS personnel
	Sampling and Transportation	Determine sampling operations.	Program lead Support from others
	Historical and Process Data Collection	Compile available data.	Program lead Support from others
	Engineering and Technical Studies	Develop new data through studies and analysis.	Program lead Support from others
	Sampling and Analysis/Reporting Data	Verify/validate Laboratory Operations data reporting.	Analytical Laboratory
D E C I S I O N P H A S E	Data compilation into characterization report	Report preparation Data analysis/Interpretation Data validation.	Program lead Support from others
	Decision making	Implement decisions based on DQOs.	Regulators Program decision makers Support from others

NOTE: Feedback loops exist throughout this process but are not shown. Process steps will be complete so that handoffs from step to step are transparent.

Data Quality Objective Process Outline

I. State the Problem To Be Resolved

Purpose

Summarize the contamination problem that will require new data, and identify the resources available to resolve the problem.

Activities

- Identify members of the scoping team.
- Develop/refine the conceptual site model.
- Define the exposure scenarios.
- Specify available resources.
- Write a brief summary of the contamination problem.

II. Identify the Decision That Addresses the Problem

Purpose

Identify the decision that requires new data to address the contamination problem.

Activities

- Identify the key decision for the current phase or stage of the project.
- Identify alternative actions that may be taken based on the findings of the field investigation.
- Identify relationships between this decision and any other current or subsequent decisions.

III. Identify Inputs Affecting Decision

Purpose

Identify the information needed to support the decision and specify which inputs require new measurements and/or data.

Activities

- Identify the informational inputs needed to resolve the decision.
- Identify sources for each informational input, and list those inputs that are obtained through measurements and/or data.

- Define the basis for establishing contaminant-specific action levels.
- Identify potential sampling approaches and appropriate analytical methods.

IV. Define Boundaries of the Study

Purpose

Specify the spatial and temporal aspects of the media that the data must represent to support the decision.

Activities

- Define the geographic areas of the field investigation.
- Define each medium of concern.
- Divide each medium into strata having relatively homogeneous characteristics.
- Define the scale of decision making.
- Determine when to take samples.
- Determine the time frame to which the decision applies.
- Identify practical constraints that may hinder sample collection (reconsider previous steps as necessary).

V. Develop a Decision Rule

Purpose

Develop a logical "ifthen...." statement that defines the conditions that would cause the decision maker to choose among alternative actions.

Activities

- Specify the parameter of interest (such as mean, median, or proportion).
- Specify the action level for the decision.
- Combine the outputs of the previous DQO steps into an "if....then...." decision rule that includes the parameter of interest, the action level, and the alternative actions.

VI. Specify Limits on Uncertainty

Purpose

Specify the decision maker's acceptable limits on decision errors, which are used to establish appropriate performance goals for limiting uncertainty in the data.

Activities

- Determine the range of contaminant levels that may be encountered at the site.
- Define both types of decision errors and identify the potential consequences of each.
- Specify a range of contaminant levels over which the consequences of decision errors are relatively minor (the gray region).
- Assign acceptable limits on decision errors above and below the gray region.
- Check for consistency.

VII. Optimize the Design

Purpose

Identify the most resource-effective sampling and analysis design for generating data that are expected to satisfy the DQOs.

Activities

- Review the DQO outputs and existing data.
- Develop general sampling and analysis design alternatives.
- For each design alternative, verify that the DQOs are satisfied.
- Select the most resource-effective design that satisfies all of the DQOs.
- Document the operational details and theoretical assumptions of the selected design in the SAP or Characterization Plan.

Data Quality Objective Process Template

Step 1: State the Problem

- Purpose:
 - To clearly define the problem so that the study will be unambiguous
- Expected Outputs:
 - A list of the planning team members and identification of the decision maker
 - A concise description of the problem
 - A summary of available resources and relevant deadlines for the study
- Activities:
 - Identify members of the planning team
 - Size related to size and complexity of the problem
 - Include representatives from all groups associated in the project
 - Identify the primary decision maker(s) and define each member's role
 - Enable ultimate authority for making decisions based on team recommendations
 - Assign roles and responsibilities
 - Develop a concise description of the problem
 - Describe the conditions or circumstances that are causing the problem and the reason for understanding the study
 - Describe the problem as it is currently understood by briefly summarizing existing information
 - Study objectives/regulatory context
 - Persons or organizations involved in the study
 - Persons or organizations that have an interest in the study
 - Political issues surrounding the study
 - Sources and amount of funding
 - Previous study results
 - Existing sampling design constraints
 - Conduct literature searches and examine past or ongoing studies to ensure that the problem is correctly defined and has not been solved previously
 - If the problem is complex, consider breaking it into more manageable pieces
 - Specify the available resources and relevant deadlines for the study
 - Stipulate anticipated budget, available personnel and contractual vehicles
 - Enumerate deadlines for completion and any intermediate deadlines

Step 2: Identify the Decision

- Purpose:
 - To define the decision statement that the study will attempt to resolve
- Expected Outputs:
 - A decision statement that links the principal study question to possible actions that will solve the problem
- Activities:
 - Identify the principal study question
 - Identifies key unknown conditions or unresolved issues that reveal the solution
 - Examples:
 - "Is the permittee out of compliance with discharge levels?"
 - "Is the contaminant concentration significantly above background levels?"
 - Define the alternative actions that could result from resolution of the principal study question
 - Identify possible actions, including the alternative
 - Combine the principal study question and the alternative actions into a decision statement
 - Following a standard format is helpful in drafting decision statements (insert project specific information in brackets):
 - "Determine whether or not [unknown environmental conditions/ issues/criteria from the principal study question] require (or support) [taking alternative actions]."
 - Organize multiple decisions
 - List decision statements and sequence of resolution

Step 3: Identify Inputs

- Purpose:
 - To identify the informational inputs that will be required to resolve the decision statement and determine which inputs require environmental measurements
- Expected Outputs:
 - A list of informational inputs needed to resolve the decision statement
 - A list of environmental variables or characteristics that will be measured

- Activities:
 - Identify the information needed to resolve the decision statement
 - Determine environmental variables and information needed
 - Consider whether monitoring or modeling approaches will be used
 - Determine information sources for each item
 - Identify and list sources for information needed to resolve problem
 - Evaluate whether existing data is appropriate
 - Identify the information needed to establish action level
 - Define basis for setting action level
 - Determine criteria used to set numerical value
 - Confirm that appropriate measurement methods exist
 - Develop a list of potential measurement methods
 - Note method detection limit and limit of quantitation for each potential method

Step 4: Define Boundaries

- Purpose:
 - To define the spatial and temporal boundaries that are covered in the decision statement
- Expected Outputs:
 - A detailed description of the spatial and temporal boundaries of the problem
 - Any practical constraints that may interfere with the study.
- Activities:
 - Specify the characteristics that define the population of interest
 - Define attributes of population and state them so focus of study is unambiguous
 - Define the spatial boundary of the decision statement
 - Define the geographic area to which the decision statement applies
 - Region marked by physical features (i.e., volume, length, width, boundary)
 - When appropriate, divide population into strata that have relatively homogenous characteristics
 - Stratify or segregate elements of population into subsets or categories that exhibit homogeneous properties or characteristics that may influence outcome
 - Define the temporal boundary of the problem
 - Determine the timeframe to which the decision applies
 - Determine timeframe data should reflect

- Determine when to collect data
 - Determine when conditions are favorable for data collection and most appropriate time period
- Define the scale of decision making
 - Define smallest, most appropriate subsets of population based on spatial or temporal boundaries
- Identify any practical constraints on data collection
 - Identify constraints that could interfere with implementation of data collection design such as inability to gain site access or unavailability of personnel, time or equipment

Step 5: Decision Rule

- Purpose:
 - To define the parameters of interest, specify the action level and integrate previous DQO decision outputs into a statement that describes a logical basis for choosing among alternative actions
- Expected Outputs:
 - The statistical parameter (the parameter of interest) that characterizes the population
 - The action level
 - An "if...then..." statement that defines the conditions that would cause the decision maker to choose among alternative actions
- Activities:
 - Specify the statistical parameters that characterize the population
 - Specify parameter of interest
 - Specify the action level for the study
 - Specify numerical value to be used in choosing alternative actions
 - Confirm that action level is greater than detection and quantitation limits for identified measurement methods
 - Develop a decision rule
 - MEAN
 - Positive Attributes
 - Useful when action level is based on long-term, average health effects
 - Useful when the population is uniform with relatively small spread
 - Generally requires fewer samples than other parameters

- Negative Attributes
 - Not a very representative measure of central tendency for highly skewed populations
 - Not useful when the population contains a large proportion of values that are less than measurement detection limits
- MEDIAN
 - Positive Attributes
 - Useful when action level is based on long-term, average health effects
 - Provides a more representative measure of central tendency than the mean for skewed populations
 - Useful when the population contains a large number of values that are less than measurement detection limits
 - Relies on few statistical assumptions
 - Negative Attributes
 - Will not protect against the effect of extreme values
 - Not a very representative measure of central tendency for highly skewed populations
- UPPER PROPORTION/PERCENTILE
 - Positive Attributes
 - Useful for protection against extreme health effects
 - For highly variable populations, provides best control of the extreme values
 - Useful for skewed distributions
 - May be appropriate when the population contains a large number of values less than the measurement detection limit, as long as the limit is less than the action level
 - Relies on few statistical assumptions
 - Negative Attributes
 - Requires larger sample sizes than mean

Step 6: Decision Errors

- Purpose:
 - To specify the decision maker's tolerable limits on decision errors, which are used to establish performance goals for the data collection design
- Expected Outputs:
 - The decision maker's tolerable decision error rates based on a consideration of the consequences of making an incorrect decision
- Activities:
 - Determine the possible range of parameters of interest
 - Estimate upper and lower bounds of parameter of interest

- Identify the decision errors and null hypothesis
 - Define both types of decision errors and establish the true state of nature of each decision error
 - Specify and evaluate the potential consequences of each decision error
 - Establish which decision error has more severe consequences near the action level
 - Define the null hypothesis (baseline condition) and the alternative hypothesis and assign the terms "false positive" and "false negative" to the appropriate decision error
- Specify parameter values where the consequences of decision errors are relatively minor (gray region)
 - Establish boundary by evaluating consequences of not rejecting the null hypothesis when it is false
- Assign probability limits to points above and below the action level that reflect the tolerable probability for the occurrence of decision errors
 - Select value of parameter and choose a probability limit

Step 7: Optimize the Design

- Purpose:
 - To identify a resource-effective data collection design for generating data that are expected to satisfy the DQOs
- Expected Outputs:
 - The most resource-effective design for the study that is expected to achieve the DQOs
- Activities:
 - Review the DQO outputs and existing environmental data
 - Review DQO outputs to ensure they are internally consistent
 - Develop general data collection design alternatives
 - Find cost-effective alternatives that balance sample size and measurement performance such as:
 - Factorial design
 - Simple random sampling
 - Stratified random sampling
 - Sequential random sampling
 - Systematic sampling
 - Composite sampling
 - Formulate the mathematical expressions needed to solve the design problems for each design alternative
 - Define a suggested method for testing the statistical hypothesis and define a sample size formula that corresponds to the method, if one exists

- Develop a statistical model that describes the relationship of the measured value to the "true" value
- Develop a cost function that relates the number of samples to the total cost of sampling and analysis
- Select the optimal sample size that satisfies the DQOs for each design alternative
 - Increase the budget for sampling and analysis
 - Increase the width of the gray region
 - Increase the tolerable decision error rates
 - Relax other project constraints, such as the schedule
 - Change the boundaries
- Select the most resource effective data collection design that satisfies all the DQOs
 - Evaluate the design options based on cost and ability to meet DQO constraints
- Document the operational details and theoretical assumptions of the selected design in the sampling and analysis plan

Document statistical assumptions that could be violated through errors in or practical constraints on field sample collection procedures or analytical methods.

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