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FINAL SAMPLING AND ANALYSIS PLAN FOR LOW LEVEL RADIOACTIVE WASTE BURIAL  
SITE NAS FORT WORTH TX  
4/1/1996  
METCALF AND EDDY

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**NAVAL AIR STATION  
FORT WORTH JRB  
CARSWELL FIELD  
TEXAS**

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**ADMINISTRATIVE RECORD  
COVER SHEET**

AR File Number 289

**UNITED STATES AIR FORCE  
INSTALLATION RESTORATION PROGRAM**

**FINAL  
SAMPLING AND ANALYSIS PLAN**

**INTERIM REMEDIAL ACTION  
LOW-LEVEL RADIOACTIVE WASTE  
BURIAL SITE**

**CARSWELL AIR FORCE BASE, TEXAS**

April 1996

**UNITED STATES AIR FORCE  
INSTALLATION RESTORATION PROGRAM**

**FINAL SAMPLING AND ANALYSIS PLAN**

**INTERIM REMEDIAL ACTION  
LOW LEVEL RADIOACTIVE WASTE BURIAL SITE**

**Carswell Air Force Base, Texas**

**April 1996**

**Prepared for:**

**Air Force Center for Environmental Excellence  
Base Closure Restoration Division (AFCEE/ERB)  
3207 North Road  
Brooks Air Force Base, Texas 78235-5000  
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- APPENDIX B Thermo NUtech  
Laboratory Quality Assurance Plan
- APPENDIX C Radiological Monitoring Equipment Descriptions and Calibration  
Procedures.

## SAMPLING AND ANALYSIS PLAN

### 1.0 INTRODUCTION

This Sampling and Analysis Plan (SAP) describes field and laboratory procedures to be followed during the performance of the low-level radioactive waste (LLRW) removal project at Carswell Air Force Base (AFB). The SAP consists of the Quality Assurance Project Plan (QAPP) and the Field Sampling Plan (FSP).

The QAPP, which is Section 2.0 of this SAP, describes the data quality objectives and the corresponding quality assurance standards for both field and laboratory analyses. The QAPP presents the detailed protocols to be followed to ensure quality and integrity of data collection, accuracy and precision of the analyses, representativeness of results, and completeness of information.

The FSP, which is Section 3.0 of this SAP, provides a guide to the field activities to be conducted at the site and incorporates field investigation methods with appropriate quality assurance/quality control (QA/QC) requirements. The FSP is prepared to ensure that field activities are performed in accordance with applicable Environmental Protection Agency (EPA), Texas Natural Resource Conservation Commission (TNRCC), and United States Air Force (USAF) regulatory requirements and guidance.

The SAP will be used by field team members to perform the sampling and analysis associated with the removal and disposal of the LLRW. Copies of the SAP will be made available to the field team and the analytical laboratory. The collection and analysis of environmental samples and other data from the LLRW excavation area are needed to characterize the LLRW for subsequent disposal, to document the condition of the excavation after LLRW removal, and to determine the background radionuclide concentrations near the burial site.

### 1.1 SITE BACKGROUND - SWMU 60, Carswell AFB

Under a contract with the Air Force Center for Environmental Excellence (AFCEE), Brooks AFB, Texas, the Contractor has been issued a delivery order (0012) to remove and dispose of low level radioactive wastes and affected soils buried at SWMU 60 at Carswell AFB in Fort Worth, Texas. Figure 1-1 is the location map for Carswell AFB. Figure 1-2 shows the site location for SWMU

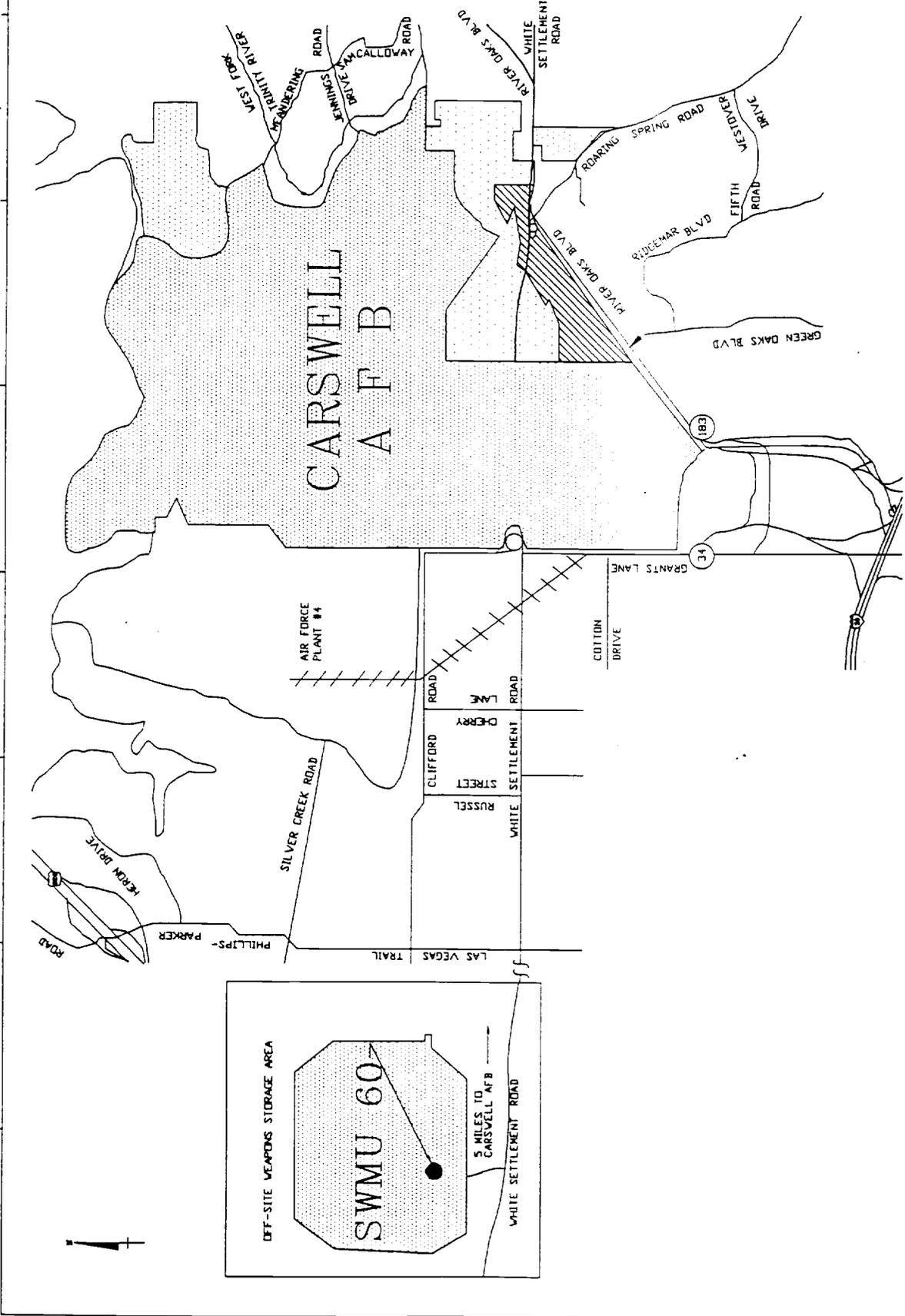
60. Figure 1-3 shows the site layout, soil staging area, and temporary facilities for SWMU 60. The following sections describe the site and the activities to be performed at the site.

SWMU 60 at Carswell AFB is located five miles west of Carswell AFB at the Off-Site Weapons Storage Area. A chain-link fence approximately 10 feet by 20 feet encompasses the site which contains three buried tubes. The tubes are reported to contain radium-painted luminous dials from aircraft instruments. According to "as built" drawings provided by the Air Force, the tubes are cast iron with a diameter of 12 inches and extend approximately 12 inches above the ground surface. The length of each tube is 18 feet, thus extending approximately 17 feet below the ground surface. The bottom end of each tube was capped with a cast iron plug and lead caulk. At the surface, each tube was closed with a welded steel cap set over the top of the tube. Each tube is surrounded by approximately 3 inches of grout. The LLRW material consisting of radium-painted aircraft instrument dials was disposed of in the tubes according to rules and practices acceptable at the time of construction. Based on visual inspection by the Air Force representatives, no evidence of any release of hazardous constituents to the environment has occurred.

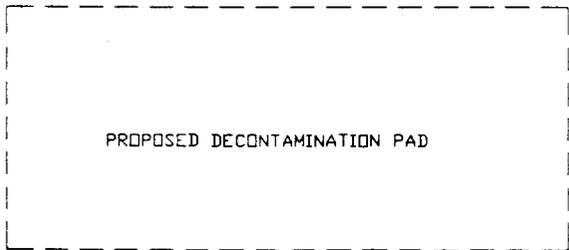
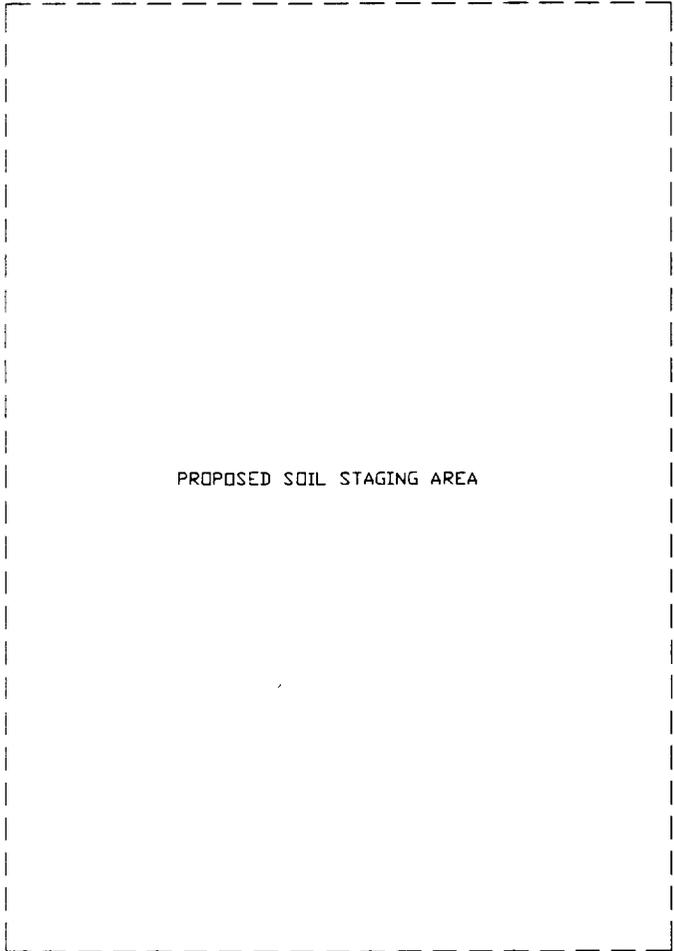
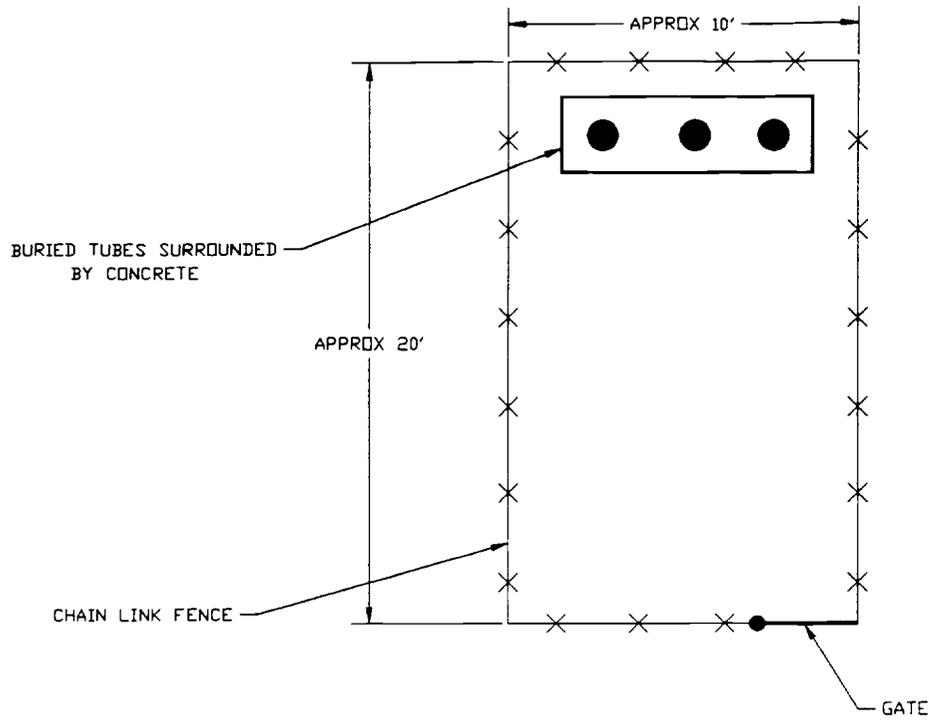
The field activities to be performed include the following:

1. Mobilization of personnel, equipment, and materials;
2. Installation of four boreholes to approximately 18 feet below ground surface (bgs) and the collection of four soil samples from each borehole. These boreholes will be located so as to collect background soil samples for laboratory analysis to determine the concentration of naturally-occurring isotopes in background soils;
3. Excavation of the tubes and stockpiling of approximately 50 cubic yards of soil;
4. Monitoring of the tubes and overpacking them into PVC containers for shipment to a disposal facility;
5. Collection and analysis of representative samples of the stockpiled soils and confirmation samples of soils remaining in the excavation;
6. Transportation and disposal of the stockpiled soil and the tubes to approved waste disposal facilities; and





JOB NO. 816821		SCALE: NTS		SWMU 60 SITE LOCATION MAP		FIGURE 1-2	
DATE: 10/64		DRAWN BY: JLS		CARSWELL AFB, TEXAS		FILE NO. 15-4	
CHECKED BY: MJI		APPROVED BY: MJI		DATE: 10/64		DATE: 10/64	



FILE NO.

STD A - 08-07-97



METCALF & EDDY

SWMU 60 SITE LAYOUT AND  
TEMPORARY FACILITIES  
CARSWELL AFB, TEXAS

SCALE: NONE

DAP

4-18-96

FIGURE 1-3

7. Restoration of the site by backfilling the excavation and demobilization.

At this time the stockpiled soils are scheduled to be disposed of at Envirocare, Inc.'s waste disposal facility in Utah, while the tubes will be disposed of at U.S. Ecology's facility in Richland, Washington.

## **1.2 PROJECT ORGANIZATION AND RESPONSIBILITIES**

The Project Organization is summarized in Figure 1-4. The Contractor's key personnel include the following staff members:

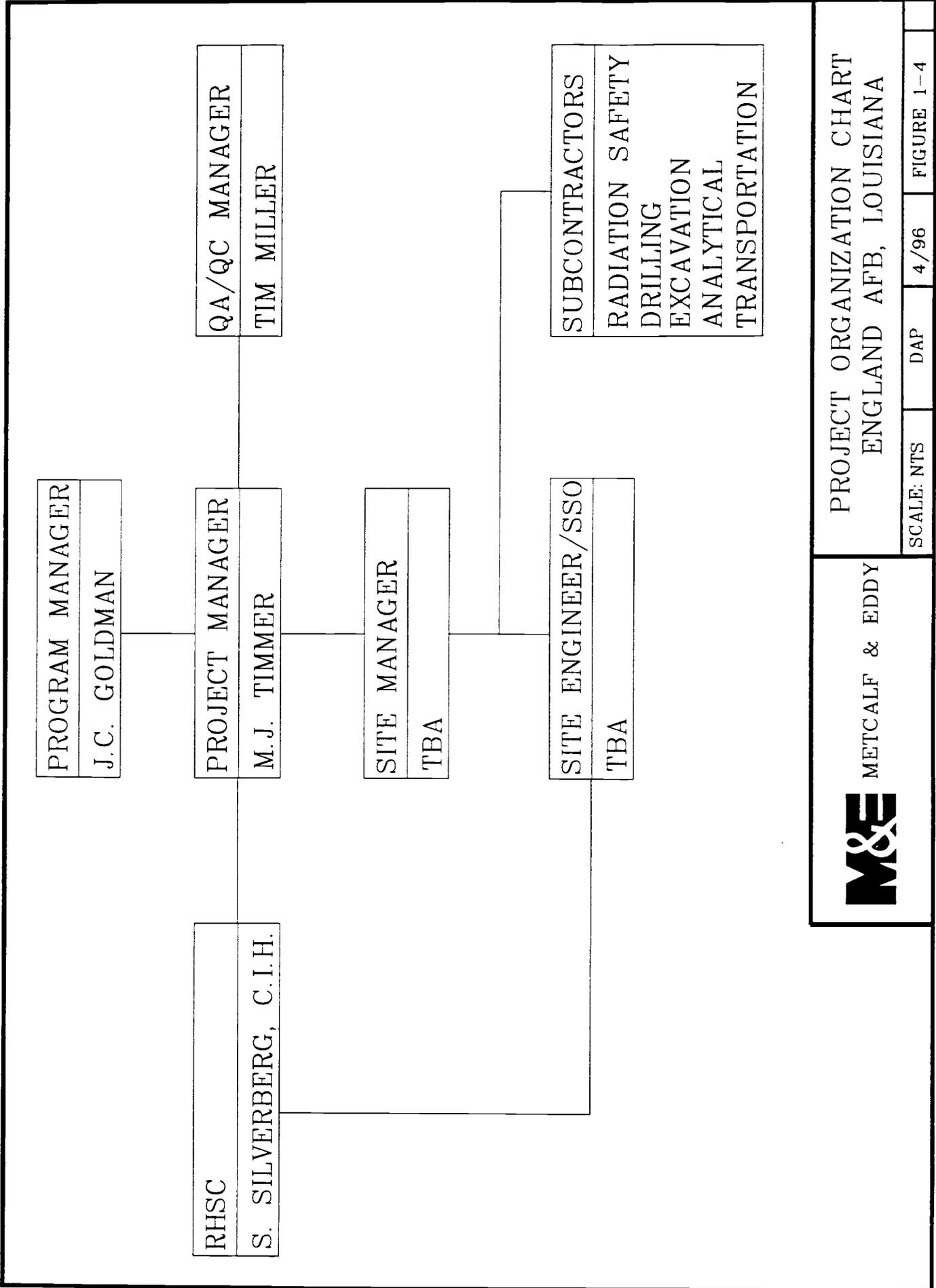
- Program Manager
- Project Manager
- Site Manager
- Quality Assurance/Quality Control Manager
- Regional Health and Safety Coordinator
- Site Engineer/Site Safety Officer
- Radiation Safety Officer
- Analytical Laboratory

### **1.2.1 Program Manager**

The Program Manager (PM), Mr. JC Goldman, Jr., P.E., reports to AFCEE's Contracting Officer Technical Representative (COTR). Mr. Goldman is responsible for the overall management of the Program Management Office. The Program Management Office receives the delivery orders, screens these delivery order requests for conflict of interest, and then directs the delivery orders to the regional level. The Program Management Office is comprised of a Support Team which includes a Contract/Subcontract Manager, a Cost/Schedule Manager, a Documents/Data Manager, and a Regulatory Specialist. These individuals are available, as necessary and appropriate, to ensure conformance with contract requirements and to track and report on contract performance.

### **1.2.2 Project Manager**

The Project Manager, Mr. Michael J. Timmer, reports to the PM. Mr. Timmer is responsible for managing the implementation of the work order at the delivery order level. Mr. Timmer will



PROJECT ORGANIZATION CHART  
 ENGLAND AFB, LOUISIANA

M&E  
 METCALF & EDDY

SCALE: NTS      DAP      4/96      FIGURE 1-4

assign project staff, review all project deliverables, and manage the delivery order budget and schedule. He is responsible for developing task order work plans, budget, and schedules; managing the project to ensure that is performed precisely in accordance with the scope of work (SOW); maintaining close liaison, including meetings and conferences, with the AFCEE and other appropriate parties as directed; coordinating and communicating project requirements with all personnel assigned to and associated with the administration and execution of the project in order to ensure proper staffing and integration; continuously reviewing the status of all concerned personnel assigned to the project and keeping the AFCEE and the Site Manager informed of developments that may affect scope, quality, and financial performance; participating in negotiations of work plan changes with the AFCEE; properly documenting all meetings, agreements, and conversations; maintaining complete job records; ensuring that all designs, both preliminary and final, receive thorough technical and coordination checks; and ensuring the client's particular technical requirements scoped in the delivery order are satisfied.

### **1.2.3 Site Manager**

The Site Manager (SM) will be identified and will report to the Project Manager. The Site Manager is responsible for the performance of the field work including the mobilization of personnel, equipment and materials, management of subcontractors, adherence to construction schedules, liaison with the USAF representatives and cost tracking.

### **1.2.4 Quality Assurance/Quality Control Manager**

The Quality Assurance/Quality Control (QA/QC) Manager, Mr. Tim Miller, provides independent review of the technical adequacy of the project. The QA/QC Manager is responsible for ongoing surveillance of project activities and has the authority to recommend that work be stopped when that work appears to jeopardize data quality. The QA/QC Manager also follows up on corrective action and ensures resolution of any technical concerns.

### **1.2.5 Regional Health & Safety Coordinator**

The Regional Health & Safety Coordinator for this project is Mr. Steve Silverberg. He is responsible for oversight and administration of health and safety for review of the site-specific Health and Safety Plan (HSP), and will, on an unannounced basis, perform health and safety compliance audits at field work sites.

### **1.2.6 Site Engineer/Site Safety Officer**

The Site Engineer/ Site Safety Officer (SSO) will be identified and will assist the Site Manager in directing the subcontractors, preparing progress reports, and tracking costs. He will collect, screen, and handle the shipment of the environmental samples as well as direct the drillers and log the samples during the borehole installation at SWMU 60 at Carswell AFB. The SSO will be responsible for implementation of the Health and Safety Plan requirements.

### **1.2.7 Radiation Safety Officer**

A Radiation Safety Officer will be assigned by Source Environmental Services, Inc. and will provide safety training and radiological monitoring during all field activities.

### **1.2.8 Analytical Laboratory**

The analytical laboratory contracted by Metcalf & Eddy for sample analysis is Mountain States Analytical (MSA). Some analyses will be subcontracted to Thermo NUtech. MSA is a USACE approved laboratory and a State of Utah Certified laboratory according to the "Rules of Certification in Environmental Laboratories". The Laboratory Quality Assurance Plans (LQAPs) provide the laboratory names, addresses, QA procedures, required laboratory certifications, and project organization. The LQAPs for MSA and Thermo NUtech are provided in Appendix A and Appendix B, respectively.

## 2.0 QUALITY ASSURANCE PROJECT PLAN

### 2.1 PROJECT DATA QUALITY OBJECTIVES

Project Data Quality Objectives (DQO) must be established to ensure that the measurement and analytical data, obtained both in the field and at the laboratory, can provide the level of information necessary to satisfy the project objectives. DQOs are based on the concept that different data uses may require varying minimum levels of data quality. Data quality is defined as the degree of certainty of a data set with respect to precision, accuracy, representativeness, comparability and completeness. DQOs are qualitative and quantitative statements specifying the required quality of data needed to ensure the absence of contamination or document the presence of contamination in the area around the tubes containing the instrument dials.

#### 2.1.1 Analytical Support Levels

Analytical levels are distinguished by their grade of technology and documentation. The analytical levels appropriate to this project are described below.

**Screening (DQO Level I):** This level provides the lowest data quality, but the most rapid results. It is often used for health and safety monitoring at the site, initial site characterization to locate areas for subsequent and more accurate analyses, and for engineering screening of alternatives. For this project, Level I data will be generated on-site using direct reading instrumentation to screen the area for radioactive materials. Action levels and calibration procedures for screening equipment are described in the Site Specific Health and Safety Plan under separate cover. These instruments include the following:

1. Ludlum Model 3 and Model 44-2 Gamma Scintillator and a NaI 1x1 probe, or equivalent.
2. Ludlum Model 44-9 ratemeter/scaler coupled with a GM (Pancake) detector, or equivalent.
3. Eberline RAS-1 intermediate volume air sampling pump or equivalent.

A photo-ionization device (PID) will also be used to detect volatile organic contaminants in the soil. A Combustible Gas Indicator (CGI) may be used if confined space entry is necessary.

**Laboratory Analysis (DQO Level IV):** Level IV laboratory analyses are designed to provide identification of organic, inorganic, and radioactive materials and corresponding quantification in samples of various matrixes. This level of analysis typically provides data to support site characterizations, environmental monitoring, confirmation of field data, engineering studies, and in specific cases, risk assessments. For this project, Level IV analysis will be used to confirm the presence or absence of potential contamination, to help assess the extent of environmental contamination, and to characterize the LLRW material for disposal.

### **2.1.2 Data Quality Characteristics**

This project requires that five characteristics of data quality be considered in assessing the data produced during the sampling analysis activities. These five characteristics (precision, accuracy, completeness, representativeness, and comparability) are defined and discussed in this section.

All analytical data will be evaluated for precision, accuracy and completeness. The laboratory will compare precision and accuracy results to their internal acceptance criteria which are recorded and tracked using regularly updated control charts. Numerical control limits for precision and accuracy are presented in Tables 2.1 and 2.2.

Precision is a measure of agreement among individual measurements of the same property under similar conditions. It is expressed in terms of Relative Percent Difference (RPD) between replicates or in terms of the standard deviation when three or more replicate analyses are performed. The two precision values shown in Tables 2.1 and 2.2 are, first, the laboratory duplicate sample required precision and, second, the field sampling duplicate required precision.

Precision shall be determined through the use of Matrix Spike/Matrix Spike Duplicate (MS/MSD) analyses and control charts. For MS/MSD analysis, the RPD between the two results shall be calculated as a measure of analytical precision. Out of control situations will be evaluated to determine accuracy. Project-specific objectives for precision are listed in Tables 2.1 and 2.2.

Accuracy is defined as the degree of agreement of a measurement (or measurement average) with an accepted reference or true value. It is a measure of system bias and is usually expressed as a percentage of the true value.

**Table 2.1**  
**Summary of Precision, Accuracy and Completeness**  
**Objectives and Practical Quantitation Limits for TCLP Extract Analyses**

<b>Metals<sup>(1)</sup></b>	<b>Method No.<sup>(2)</sup></b>	<b>Precision RPD<sup>(3)</sup></b>	<b>Accuracy (Recovery)<sup>(4)</sup></b>	<b>Completeness</b>	<b>EQL</b>	<b>MDL</b>
Arsenic	SW6010A	20%/30%	75-125%	90%	100µg/L	320µg/lg
Barium	SW6010A	20%/30%	75-125%	90%	1000µg/L	500µg/lg
Cadmium	SW6010A	20%/30%	75-125%	90%	10µg/L	38µg/lg
Chromium	SW6010A	20%/30%	75-125%	90%	20µg/L	140µg/lg
Lead	SW6010A	20%/30%	75-125%	90%	100µg/L	150µg/lg
Mercury	SW7470	20%/30%	75-125%	90%	0.5µg/L	70µg/lg
Selenium	SW6010A	20%/30%	75-125%	90%	200µg/L	400µg/lg
Silver	SW6010A	20%/30%	75-125%	90%	20µg/L	500µg/lg
Copper	SW6010A	20%/30%	75-125%	90%	50µg/L	95µg/lg
Zinc	SW6010A	20%/30%	75-125%	90%	250µg/L	75µg/lg

<b>Volatiles<sup>(1)</sup></b>	<b>Method No.<sup>(2)</sup></b>	<b>Precision RPD<sup>(3)</sup></b>	<b>Accuracy (Recovery)<sup>(4)</sup></b>	<b>Completeness</b>	<b>EQL</b>	<b>MDL</b>
Benzene	SW8260A	11%/30%	37-151%	90%	5µg/L	0.32µg/kg
Carbon Tetrachloride	SW8260A	ARM/30%	70-140%	90%	5µg/L	0.38µg/kg
Chlorobenzene	SW8260A	13%/30%	37-160%	90%	5µg/L	0.20µg/kg
Chloroform	SW8260A	ARM/30%	51-138%	90%	5µg/L	0.22µg/kg
1,2-Dichloroethane	SW8260A	ARM/30%	49-155%	90%	5µg/L	0.32µg/kg
1,1-Dichloroethane	SW8260A	14%/30%	1-234%	90%	5µg/L	1.22µg/kg
Methyl Ethyl Ketone	SW8260A	ARM/30%	58-162%	90%	20µg/L	µg/kg
Tetrachloroethane	SW8260A	ARM/30%	64-148%	90%	5µg/L	0.20µg/kg
Trichloroethane	SW8260A	14%/30%	52-162%	90%	5µg/L	1.39µg/kg
Vinyl Chloride	SW8260A	ARM/30%	1-251%	90%	10µg/L	1.43µg/kg

**Table 2.1 (Cont.)**  
**Summary of Precision, Accuracy and Completeness**  
**Objectives and Practical Quantitation Limits for TCLP Extract Analyses**

Metals <sup>(1)</sup>	Method No. <sup>(2)</sup>	Precision RPD <sup>(3)</sup>	Accuracy (Recovery) <sup>(4)</sup>	Completeness	EQL	MDL
O-Cresol	SW8270A	ARM/30%		90%	40µg/L	26µg/kg
M-Cresol	SW8270A	ARM/30%		90%	40µg/L	µg/kg
P-Cresol	SW8270A	ARM/30%		90%	40µg/L	29µg/kg
2,4 Dinitrotoluene	SW8270A	ARM/30%	39-139%	90%	40µg/L	30µg/kg
Hexachloro-benzene	SW8270A	ARM/30%	1-152%	90%	40µg/L	45µg/kg
Hexachloro-butadiene	SW8270A	ARM/30%	24-116%	90%	40µg/L	46µg/kg
Hexachloroethane	SW8270A	ARM/30%	35-180%	90%	40µg/L	58µg/kg
Nitrobenzene	SW8270A	ARM/30%	14-176%	90%	40µg/L	63µg/kg
Pentachloro-phenol	SW8270A	ARM/30%	14-176%	90%	200µg/L	107µg/kg
Pyridine	SW8270A	ARM/30%		90%	40µg/L	µg/kg
2,4,5-Trichlorophenol	SW8270A	ARM/30%		90%	40µg/L	48µg/kg
2,4,6-Trichlorophenol	SW8270A	ARM/30%	37-141%	90%	40µg/L	41µg/kg
1,4 Dichloro-benzene	SW8270A	ARM/30%	20-124%	90%	5µg/L	60µg/kg

Pesticides	Method No.	Precision RPD	Accuracy (Recovery)	Completeness	EQL	MDL
Chlordane	SW8080	ARM/30%	ARM	90%	30µg/L	0.57µg/kg
Endrin	SW8080	21%/30%	30-147%	90%	20µg/L	0.33µg/kg
Heptachlor	SW8080	20%/30%	34-111%	90%	8µg/L	0.33µg/kg

**Table 2.1 (Cont.)  
Summary of Precision, Accuracy and Completeness  
Objectives and Practical Quantitation Limits for TCLP Extract Analyses**

Pesticides	Method No.	Precision RPD	Accuracy (Recovery)	Completeness	EQL	MDL
Heptachloro-Epoxide	SW8080	ARM/30%	34-111%	90%	8 $\mu$ g/L	0.20 $\mu$ g/kg
Lindane	SW8080	ARM/30%	52-127%	90%	400 $\mu$ g/L	
Methoxychlor	SW8080	ARM/30%	76-120%	90%	10000 $\mu$ g/L	1.95 $\mu$ g/kg
Toxaphene	SW8080	ARM/30%	ARM	90%	500 $\mu$ g/L	34.1 $\mu$ g/kg

Pesticides	Method No.	Precision (RPD)	Accuracy (Recovery)	Completeness	EQL	MDL
2,4 D	SW8150A	30%	43-156%	90%	10000 $\mu$ g/L	1.03 $\mu$ g/kg
2,4,5 - TP (Silvex)	SW8150A	30%	45-170%	90%	10000 $\mu$ g/L	1.95 $\mu$ g/kg

NOTES:

1. The listed Analyte's for TCLP Analysis are required by Envirocare for solid/soil disposal.

2. ANALYTICAL METHODS:  
SW1000-9000

Methods: Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, SW-846, U.S. EPA, July 1992

The method 901.1 is, in fact, a drinking water method. There is no guidance for solid samples; therefore, we will use method 901.1 MOD, a modification for solid samples. The QA requirements will be based on established QC Criteria as determined from historical data. However, if the client suggests a method with specified requirements, we would review the feasibility of using that method.

3. Precision - Relative percent difference (RPD) between laboratory replicates for inorganic analyses and between matrix spike and matrix spike duplicates for organic analyses/field duplicate analyses.

4. Accuracy - Acceptable laboratory control sample recovery range for inorganic analyses and matrix spike recovery range for organic analysis.

ARM = As Required by Method

RPD = Relative Percent Difference

EQL = Estimate Quantities Limit

**Table 2.2**  
**Summary of Precision, Accuracy and Completeness**  
**Objectives and Practical Quantitation Limits for Soil Samples**

Parameter	Method No. <sup>(1)</sup>	Precision (RPD) <sup>(2)</sup>	Accuracy (Recovery) <sup>(3)</sup>	Completeness	EQL	MDL
Radioisotopes <sup>(4)</sup>	EPA 901.1 MOD	30%	75-125%	90%	1pCi/g	1pCi/g <sup>(5)</sup>
Hydrogen Sulfide <sup>(4)</sup>	SW846/ 9030A	30%	75-125%	90%	50 $\mu$ g/kg	7.92 $\mu$ g/kg
Hydrogen Cyanide <sup>(4)</sup>	SW846/ 9010A	30%	75-125%	90%	50 $\mu$ g/kg	0.045 $\mu$ g/kg
pH <sup>(4)</sup>	SW846/ 9045	$\pm$ 0.1 pH units	0.05 pH units	90%	0.01pH units	0.0 pH units
Total Organic Halogen <sup>(4)</sup>	SW846/ 9010A	30%	75-125%	90%	50 $\mu$ g/kg	0.0 $\mu$ g/kg
Print Filter Test <sup>(4)</sup>	SW846/ 9095	30%	N/A	90%	N/A	

NOTES:

1. ANALYTICAL METHODS:

Methods: Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, SW-846, U.S. EPA, July 1992

The method 901.1 is, in fact, a drinking water method. There is no guidance for solid samples; therefore, we will use method 901.1 MOD, a modification for solid samples. The QA requirements will be based on established QC Criteria as determined from historical data. However, if the client suggests a method with specified requirements, we would review the feasibility of using that method.

2. Precision - Relative percent difference (RPD) between laboratory replicates for inorganic analyses and between matrix spike and matrix spike duplicates for organic analyses/field duplicate analyses.
3. Accuracy - Acceptable laboratory control sample recovery range for inorganic analyses and matrix spike recovery range for organic analysis.
4. As required acceptance of material at Envirocare, Inc. the site characterization samples are being analyzed for the listed parameter.
5. Minimum Detectable Activity.

Accuracy shall be determined in the laboratory through the use of MS/MSD analyses. Sampling accuracy shall be maintained by the implementation and adherence to strict procedural protocols. Equipment blanks shall be collected and analyzed to ensure that samples are representative of site conditions and not contaminated by transportation or sampling methods. Project-specific objectives for accuracy are listed in Tables 2.1 and 2.2.

Completeness is a measure of the amount of valid data obtained compared to the amount expected to be collected under normal correct conditions. It is usually expressed as a percentage. The completeness criteria for the project is 90 percent.

Completeness is calculated as the percentage of valid data points obtained compared to the quantities of valid data that were to be collected to achieve particular project requirements. Data points may not be valid if samples exceed holding times, if quality control sample criteria were not met and reanalysis of samples were not possible, or if sample containers were broken or otherwise destroyed.

Representativeness expresses the degree to which data accurately and precisely represents a characteristic of a data population, process condition, sampling point, or an environment. Representativeness is a qualitative parameter of the sampling program. Sample collection procedures are described in detail in Section 3.0, Field Sampling Program.

Representativeness is also dependent on proper sample collection techniques that can be evaluated through the analysis of field duplicate samples.

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared to another. To achieve comparability in this project, the data generated shall be reported using units of  $\mu\text{g/L}$ ,  $\text{mg/L}$  and  $\text{mg/kg}$ . All sample analysis procedures used shall be consistent with EPA and the USAF protocols.

## **2.2 Sampling Procedures**

### **2.2.1 Sampling Protocols**

The rationale for sample location and frequency is described in the FSP., Section 3.3. All sampling methods used are standard procedures that adhere to USAF protocols and are based on recognized EPA protocols when available. Step-by-step sample collection procedures and project-specific standard operating procedures for the collection of samples for both laboratory and field analyses are also discussed in the FSP.

### 2.2.2 Sample Handling

Table 2.3 summarizes the sampling parameters, containers, holding times and preservation requirements for the aqueous and soil samples collected during this project. All sample containers and preservation kits will be obtained from the laboratory.

**Table 2.3**  
**Sampling Parameters, Containers and**  
**Preservation Requirements**

Parameters	Soil/Solids	Aqueous	Preservation	Holding Time
TCLP Metals	1 x 1000 ml glass jar	1000 ml amber glass jar	Cool to 4°C	6 months after extraction
TCLP Mercury	Use above sample	Use above sample	Cool to 4°C	28 days after extraction
TCLP Volatiles	Use above sample	2 x 40 ml amber glass jar	Cool to 4°C	14/14 days after extraction
TCLP Semi-Volatiles	Use above sample	3 x 1000 ml amber glass jar	Cool to 4°C	7/40 days after extraction
TCLP Pesticides	Use above sample	2 x 1000 ml amber glass jar	Cool to 4°C	7/40 days after extraction
TCLP Herbicides	Use above sample	Use above sample	Cool to 4°C	7/40 days after extraction
Hydrogen Sulfide	1 x 4 oz. glass jar	1 x 500 ml glass jar	Cool to 4°C	7 days
Hydrogen Cyanide	1 x 4 oz. glass jar	1 x 1000 ml plastic jar	Cool to 4°C	14 days
Total Organic Halogen	1 x 4 oz. glass jar	3 x 250 ml glass jar	Cool to 4°C	N/A
Radioisotopes	1 x 500 ml plastic jar	1 x 1000 ml plastic jar	N/A	N/A

## **2.3 Sample Custody**

### **2.3.1 Field Operations**

Field sample identification, custody, and packaging procedures are presented in the FSP in Section 3.3.

### **2.3.2 Laboratory Operations**

Sections 6 and 7 of MSA's LQAP (Appendix A) and Sections 6 through 9 of Thermo NUtech's LQAP (Appendix B) describe the laboratory procedures for sample identification, handling, and tracking.

## **2.4 CALIBRATION PROCEDURES AND FREQUENCIES FOR FIELD TEST EQUIPMENT**

Before any test equipment is used in the field, it must be calibrated. Calibration procedures and frequencies for various field test equipment are discussed in detail in the FSP in Section 3.4.2. Calibration of laboratory equipment is discussed within Section 2.5.

## **2.5 ANALYTICAL PROCEDURES**

### **2.5.1 Standard Analytical Methods**

The standard analytical methods to be used for analyzing samples collected at the site are provided in Section 10 of MSA's LQAP (Appendix A).

### **2.5.2 Project-Specific Detection Limits**

Detection limits are determined using procedures outlined in 40 CFR 136 or EPA SW846. The Instrument Detection Limit (IDL) is determined by ascertaining the minimal concentration of an analytic that can be reliably detected by the instrument under maximum security. The Method Detection Limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the analytic concentration is greater than zero. The MDL is then determined by multiplying a standard deviation of the replicate analyses by a student t value for a one-sided 99% confidence level. The Estimated Quantitation Limits (EQL) is defined as the lowest level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions and is derived from a multiple of MDL.

Method detection limits are determined prior to analyzing any samples, and recalculated each time the instrument is changed or modified in some form. Records of instrument detection limits are maintained so that the condition and performance of the instruments can be monitored. The EQL limits will be verified to ensure that they are reliably achieved.

### **2.5.3 Method Calibration**

Instruments and equipment used by the laboratory(ies) are controlled by a formal calibration program. The program verifies that equipment is of the proper type, range, accuracy, and precision to provide data compatible with specified requirements. All instruments and equipment which measure a quantity, or whose performance is expected at a stated level, are subject to calibration. Section 9 of MSA's LQAP (Appendix A) and Section 11 of Thermo NUtech's LQAP (Appendix B) describe the laboratory calibration procedures.

### **2.5.4 Laboratory Standards and Reagents**

All standards, reagents, and solvents are dated upon receipt. The preparation and use of all standards are recorded in bound laboratory notebooks that document standard traceability to EPA or National Institute of Standards & Tests (NIST) standards. Additional information recorded typically includes the date of preparation, concentration of the prepared standard, and the name of the preparer.

## **2.6 LABORATORY DATA REDUCTION, VALIDATION, AND REPORTING**

### **2.6.1 Data Management**

Section 11 of MSA's LQAP (Appendix A) and Section 12 of Thermo NUtech's LQAP (Appendix B) describe the data reduction, review, and reporting procedures that will be used at the laboratory. Primary responsibility for implementation of these procedures within the laboratory resides with the Laboratory QA/QC Director. The Laboratory QA/QC Director approves all data reports before transferring the information to the Project Manager and QA/QC Manager. The Project Manager and QA/QC Manager ensure that laboratory data are in compliance with QAPP specifications. Final responsibility for assessing and reporting of data resides with the QA/QC Manager.

Data produced for internal records and not reported as part of the analytical data include laboratory worksheets and notebooks, sample tracking system forms, instrument logs, standard records, maintenance records, calibration records, and associated quality control.

## 2.6.2 Field and Non-Laboratory Data Reduction

Data reduction consists of compiling and summarizing data collected during field activities. Field and analytical data will typically be summarized in a tabular format. All information and data will be reported and verified for accuracy with the original sources of data. For analytical data, units designated by the analytical method will be reported. Mathematical formulas used for calculations are specified in the field and analytical methods.

Data produced for internal records and not reported as part of the analytical data typically includes field logbooks, sample and QC sample tracking sheets, instrumentation and calibration logs and geological boring logs. This data is generated during the field activities, and where relevant, is summarized for interpretation or use throughout the data evaluation process.

## 2.6.3 Data Quality Assessment

The procedures that will be used for data quality assessment are described in Section 2.1.

## 2.6.4 Data Validation and Reporting

Quality control data provided by the laboratory will enable the Contractor to evaluate the validity of the analytical data in terms of accuracy, precision and environmental significance. The Contractor will apply validation criteria specific to the analytical level specified in Section 2.1.

No data evaluation and assessment will be performed on data generated from field screening methodologies. However, care will be taken to ensure that all field screening equipment is operated and maintained according to procedures outlined in the operation manual. In addition, duplicate samples will be collected at a frequency of approximately 5 percent as a check on measurement precision. If results from duplicate samples are found to vary by more than 50 percent, resampling will take place.

All data generated from laboratory analyses will be evaluated for precision, accuracy, and completeness. The acceptability of the analytical precision and accuracy in satisfying the project requirements will be determined by comparing them to the QC objectives presented in Section 5 of MSA's LQAP (Appendix A) and Section 3 of Thermo NUtech's LQAP (Appendix B). The types of evaluation activities which will typically be performed include:

Precision - comparison of field duplicate and laboratory duplicate data

**Accuracy** - analysis of MS/MSDs, surrogates, and LCS samples and comparison to know concentration in these samples; analysis of trip blanks to determine potential contamination of field samples collected

**Completeness** - comparison of the amount of valid data points obtained compared to the quality of data points collected (Note: Data points may not be valid if holding times are grossly exceeded, if QC sample criteria were exceeded, or if sample containers were broken or samples are otherwise destroyed.)

Laboratory data will be reviewed and evaluated by the QA/QC Manager to ensure that the data requirements specified in the SW846 analytical procedures are met. While SW846 does not specifically define the actions to be applied to the analytical data should they not meet the data requirements, the following are typical actions that will be applied to the data following evaluation:

**Holding Times:** If the holding time is exceeded, all positive results will be flagged as estimated (J) and all non-detects will be flagged as estimated (UJ). If holding times exceed 20% of the allowable time, the data may be rejected (R). If the holding times are exceeded, AFCEE has the final authority for deciding whether the exceeded holding times will be accepted or rejected.

**Calibration:** If the calibration criteria are exceeded, all positive results will be flagged as estimated (J) and all non-detects will be flagged as (UJ). If the calibration criteria are exceeded, all non-detects may be flagged as unusable or rejected (R).

**Blanks:** If the blank analysis concentration is greater than 3 times the analyte detection limit, an action level of 5 times the blank containment concentration will be set. If the sample analyte concentration is greater than the action level, the concentration will be reported unqualified. If the sample analyte concentration is less than action level, the concentration will be reported and flagged to be the qualified detection limit (B).

**Sample Duplicate:** If laboratory or field duplicate analyses result in a RPD greater than 30% for aqueous samples and 50% for soil samples, all positive results will be flagged as estimated (J) and all non-detects will be reported unqualified. If one value is non-detected and the other is above the detection limit, all non-detects will be flagged as estimated (UJ).

**Matrix Spike/Matrix Spike Duplicates, Laboratory Control Samples, Surrogates:** If the analytical result is greater than 10% above the true concentration, all positive results

will be flagged as estimated (J) and all non-detects will be reported as unqualified. If the analytical result is more than 10% below true concentration, all positive results will be flagged as estimated (J) and all non-detects will be flagged as estimated (UJ) or as unusable or rejected (R).

All data will be tabulated for inclusion in the reports.

## **2.7 LABORATORY INTERNAL QUALITY CONTROL CHECKS**

Quality Control (QC) samples generated in the laboratory are used internally to ensure the quality of all sample analyses. All analyses performed in support of this investigation shall use standardized laboratory procedures. The QC program uses both known and unknown (or "blind") QC samples. Laboratory QC samples include: continuing calibration verification, method/reagent blanks, matrix spike/matrix spike duplicates, surrogate spikes and laboratory control samples. The laboratory shall comply with the QC sample requirements for each analytical method specified. The QC sample types required are described in Section 12 of MSA's LQAP (Appendix A) and Section 14 of Thermo NUtech's LQAP (Appendix B).

## **2.8 FIELD INTERNAL QUALITY CONTROL CHECKS**

Quality control (QC) samples generated in the field are used internally to ensure the quality of laboratory samples analysis. Field QC samples include trip blanks, equipment blanks and field duplicates. The various types and frequency of analysis of field generated QC samples that will be collected in the field and submitted to the laboratory along with the field samples are described in detail in the FSP in Section 3.5.

## **2.9 PERFORMANCE SYSTEM AUDITS**

An audit is a systematic check to determine the quality of operation of some function or activity. Quality assurance audits play an important role in the QA/QC program. This section describes the role of the QA auditor and the nature of the QA audits.

### **2.9.1 Contractor Auditing Practices**

#### **2.9.1.1 Performance Audits**

The performance audit is a small scope audit of specific environmental data collection activities (EDCAs) performed by project specialists or the QA/QC Manager. Performance audits shall be

performed on an ongoing basis during the project as field data are generated, reduced and analyzed. All numerical manipulations, including manual calculations, shall be documented. All records of numerical analyses must be legible, of reproduction quality and sufficiently complete to permit logical reconstruction by a qualified individual other than the originator.

Other indicators of the field performance quality are the analytical results of the equipment blank and field duplicate samples. Each blank analysis is an indirect audit of the effectiveness of measures taken in the field to ensure sample integrity (i.e., field decontamination procedures). The results of the field duplicate analyses may be an indirect audit of the field team's ability to collect representative sample portions of each matrix type.

#### 2.9.1.2 Quality Assurance Audits

Quality Assurance audits will be performed as field activities are being completed and analytical results are received. As tasks are completed, the site engineer shall submit copies of all field data for review. The following list provides some of the field data the QA/QC Manager will review.

- Field Log Book
- Daily Field Activity Report
- Daily QA/QC Report
- Laboratory Chain of Custody Forms
- Schedule of Completeness
- Health and Safety Forms
- Applicable Air Force Forms
- Equipment Calibration Form.

The QA/QC Manager will review and provide comments for corrective actions to be completed by field and laboratory personnel. The QA/QC Manager will verify that the corrective actions have been implemented and are being adhered to as outlined in Section 2.12.

#### 2.9.1.3 System Audits

The system audit is a review of the entire project or program using performance audits as key information. Unscheduled system audits will be performed on a routine basis for the following items:

- Health and safety (including personnel decontamination);
- Sampling activities;

- Document control activities;
- Planning activities.

System audits of the site activities are accomplished by an inspection of all field site activities by the Program Manager. The auditor shall compare current field practices with standard procedures. On completion of the audit, any deficiencies are discussed with the field staff and corrections are identified. If any of these deficiencies affect the quality or integrity of the information being collected or work performed, the auditor shall inform the field staff immediately so that corrections can be implemented immediately.

### **2.9.2 Laboratory Auditing Practices**

Section 13 of MSA's LQAP (Appendix A) and Section 15 of Thermo NUTech's LQAP (Appendix B) describe performance and system audits to be performed by the laboratory.

## **2.10 PREVENTATIVE MAINTENANCE**

### **2.10.1 Laboratory Equipment**

The ability to generate valid analytical data requires that all analytical instrumentation be properly and regularly maintained. The laboratory maintains full service contracts on all major instruments. These service contracts provide not only routine preventative maintenance, but also emergency repair service. The laboratory also has more than one of each particular type of equipment; therefore, in the event one piece of equipment is out of service a back up instrument may be used. All the chemists are trained to perform preventative maintenance on the major equipment. The elements of the maintenance program are outlined in Section 14 of MSA's LQAP (Appendix A) and Section 10 of Thermo NUTech's LQAP (Appendix B).

### **2.10.2 Field Equipment**

Preventative maintenance of field equipment is also required in order to ensure the collection of valid field measurements. All necessary maintenance procedures are fully documented in the project-specific field logbook. The type and frequency of such preventative maintenance is outlined in the FSP in Section 3.4.

## **2.11 PROCEDURES FOR ASSESSING DATA PRECISION, ACCURACY, AND COMPLETENESS**

The following procedures will be used for evaluating the precision, accuracy and completeness of analytical data generated during laboratory analysis for this project. Data quality and QA objectives were further discussed in Section 2.1, and data validation requirements are described in greater detail in Section 2.6. The laboratory procedures are provided in Section 15 of MSA's LQAP (Appendix A) and Section 16 of Thermo NUtech's LQAP (Appendix B).

A review of data quality is conducted following the validation of analytical data. The purpose of the review is to provide the following types of information pertinent to characterizing data quality:

- Adequacy of data recording and transfer;
- Precision or bias of data;
- Adequacy of data calculation, generation, and processing;
- Documentation of procedures;
- Identification of data qualifiers to define the useability and limitations of the data.

Details describing documentation of data quality review are described in Section 2.6.

## **2.12 CORRECTIVE ACTION PROCEDURE**

### **2.12.1 Field Corrective Action Procedures**

Corrective action procedures will be initiated when a failure to properly follow project plans is recognized. Errors in following sampling protocols or improperly or inadequately decontaminating sampling equipment may make it impossible to meet the data quality objectives. Therefore, the deficiencies noted in the following standard protocol will be addressed immediately upon recognition.

Corrective action procedures for this project may be the result of a field surveillance activity, a direct result of performance and/or system audits as described in Section 2.9 or an observation made by a field team member or other trained personnel. The person recognizing the failure is responsible for bringing the error to the attention of the responsible party (i.e., the person improperly following procedures), making note of the problem in the field notebook, and, if appropriate, orally notifying the project manager of the error. If the problem reoccurs, the person recognizing the deficiency will address the error through reports maintained by the Laboratory QA Directors. The project QA/QC Manager, in turn, will file the original report, send a memo along

with a copy of the report to the person in a position to effect the corrective action (be it Contractor or subcontractor personnel), and request a written response to the memo within a specified period of time. The issue addressed in the report is subject to follow up by the QA/QC Manager during the next field surveillance or audit.

### **2.12.2 Laboratory Corrective Action Procedures**

Corrective action procedures in the laboratory are often initiated by the analysts directly involved with the analysis of the samples. The laboratory analyst shall verify that all quality control procedures are followed and that the results of the analysis of quality control samples are within the acceptance criteria. The laboratory procedures for corrective action are described in Section 16 of MSA's LQAP (Appendix A) and Section 17 of Thermo NUtech's LQAP (Appendix B).

## **2.13 QUALITY ASSURANCE REPORTS**

The intention of the sampling analysis effort is to produce data of acceptable quality to allow for an accurate evaluation of the site characterization, risk assessments and subsequent evaluations. Comprehensive QA objectives, which are discussed in earlier sections of this report, provide guidelines for field and laboratory procedures as well as for data reduction, assessment, and reporting. Quality assurance of laboratory data is ensured by both internal laboratory procedures and data review and evaluation processes performed at the contractor's office. The laboratory is responsible for providing the contractor with a full data report including the analytical results of all QC check samples, as well as the method detection limits. Section 16 of MSA's LQAP (Appendix A) and Section 18 of Thermo NUtech's LQAP (Appendix B) describe the laboratory procedures.

Once the analytical laboratory report is submitted to the contractor, the Laboratory QA/QC Manager will review the report and evaluate the data. The data review will be consistent with the National Functional Guidelines for Evaluating Organics Analyses, U.S. EPA, December 1990 and the National Function Guidelines for Evaluating Inorganics Analyses, U.S. EPA, July 1988, but will not constitute a formal validation; it will include an evaluation of such items as:

- Review to ensure sample holding times met;
- Evaluation of data with respect to reporting limits;
- Examination of chain-of-custody records to ensure that custody was properly maintained;

- Evaluation of data with respect to method and field blank contamination;
- Evaluation of matrix spike/matrix spike duplicate (MS/MSD) recoveries;
- Evaluation of surrogate compound recoveries, where appropriate;
- Evaluation of field duplicates analyses;
- Evaluation of laboratory control samples.

Results of this evaluation, including flagging of out-of-control data and determination of overall data quality, will be presented within the final Closure Report to be provided to AFCEE.

Performance and system audits conducted during field activities and throughout the work assignments are used to monitor QA. The types and frequency of audits are discussed in Section 2.9. The results of the audits, including QA issues that may arise, are addressed in reports and corrective action procedures that are discussed in Section 2.9.

### **3.0 FIELD SAMPLING PLAN**

#### **3.1 INTRODUCTION**

The Field Sampling Plan (FSP) provides requirements and procedures for field-sampling work associated with the removal of LLRW material at Carswell AFB. The overall objectives of the FSP are as follows:

- Identify environmental sampling procedures;
- Identify necessary field instruments, their use, calibration, and maintenance;
- Present field QA/QC procedures;
- Identify recordkeeping requirements.

#### **3.2 FIELD OPERATIONS**

Field operations associated with this project are summarized in Section 1.1 of the SAP and detailed in the Remedial Action Plan. Details specific to the field activities requiring sample collection, field screening and/or laboratory analyses are described below and summarized in Table 3.1.

##### **3.2.1 Excavation of Tubes**

The soil removed during excavation of the tubes will be screened to determine whether they have been affected by radioactive materials or organic chemicals. Screening for radioactive impacts will be performed using a Ludlum Model 2241 ratemeter/scaler coupled with a Ludlum Model 139 air proportional probe and a NaI 2x2 probe, or equivalent. Screening for organic chemicals will be performed using a photoionization device (PID) to measure total organic vapor (TOV) emissions from the soil.

Excavation of affected soils will continue in the area around the tubes as directed by the AFCEE representative until the field screens indicate that the affected soil has been removed. Four confirmation samples will then be collected by an independent party from the side walls and one from the bottom of the excavation to verify the absence of radioactive materials. Table 3.1 summarizes the number of samples to be collected. The radioisotope concentrations of these soils will be determined by gamma spectroscopy.

TABLE 3.1 SUMMARY OF SAMPLING AND ANALYSIS ACTIVITIES

Sample	Analytical Method	Field QC Samples				Total Samples	
		Field Samples	Field Duplicates	Equipment Blanks	MS/MSD	Soil/Solid	Aqueous
SMWU 60, Carswell AFB							
Confirmation Soil Samples from Excavation							
Radioisotopes	EPA 600/14-75-008	5	1	1	2	8	1
Soil from stockpile							
Radioisotopes	EPA 600/14-75-008	2	0	0	0	2	0
TCLP, Full	SW846/8260A, 8270A, 8080, 8150A, 6010A, 7470	2	0	0	0	2	0
Hydrogen Sulfide *	SW846/9030A	2	0	0	0	2	0
Hydrogen Cyanide *	SW846/9010A	2	0	0	0	2	0
pH	SW846/9045	2	0	0	0	2	0
Total Organic Halogen *	SW846/9010A	2	0	0	0	2	0
Paint Filler Test	SW846/9095	2	0	0	0	2	0
Soil from borings							
Radioisotopes	EPA 600/14-75-008	16	2	2	2	20	2

\* NOTE: Required by Envirocare, Inc. for waste disposal.

### **3.2.2 Characterization of Stockpiled Materials**

Following the stockpiling of the excavated soils, samples will be collected to characterize the materials for disposal. Table 3.1 summarizes the analyses that will be performed. This list of analysis is based on the waste characterization requirements of Envirocare, Inc., the waste disposal facility selected for disposal of the LLRW materials.

### **3.2.3 Collection of Subsurface Soils from Boreholes**

Four soil borings will be installed at SWMU 60, Carswell AFB to serve as background locations. Each boring will be installed to a depth of approximately 18 feet. Samples will be collected continuously using any of the following methods: 2-inch diameter, 24-inch long split spoon samplers in combination with hollow-stem augers; chip sampling from solid-stem auger methods; core drilling using a rotary drill rig and clear water as the drilling fluid. Samples will be field screened for radioactivity using the direct reading instrument listed in Section 3.2.1 and TOV emissions from the soil using the PID. Four samples from each borehole will be submitted for laboratory analysis. These samples will be collected from the intervals from 0-1 feet, 5-6 feet, 11-12 feet and 17-18 feet below ground surface.

## **3.3 ENVIRONMENTAL SAMPLING**

### **3.3.1 Collection of Environmental Samples**

This section describes the protocols that will be followed by field personnel during sample collection. The methods described include the protocols for collecting confirmation soil samples from the excavation, samples from the stockpiled soils, and soil samples from the boreholes. Sampling equipment will be decontaminated using the procedures outlined in Section 3.4.4 before the collection of any samples.

#### **3.3.1.1 Soil Sampling from the Excavation**

Composite soil samples will be collected along the sides and bottom of the excavated areas using a backhoe. One composite sample will be collected from each of the four sidewalls of the excavation, and one composite sample will be collected from the base of the excavation. The following equipment and procedures will be used to obtain the samples.

## Equipment

- Backhoe;
- Stainless steel trowel or scoop;
- Sample containers;
- Stainless steel bowls;
- PID;
- Radioactivity direct reading instrument.

## Sampling Procedures

1. Record the physical characteristics of the soil (i.e., color, odor and texture).
2. Make a sketch of the excavation area boundaries and sampling locations in relation to site landmarks. Record and/or sketch the excavation area dimensions and describe the materials encountered.
3. Photograph the sampling locations and conditions as deemed necessary.
4. Excavate the test site with the backhoe in order to facilitate tube removal. During excavation, field screen the excavated soil at a rate of 1 screen every 5 cubic yards.
5. Measure and record the dimensions of the excavation.
6. Collect a soil sample from each sidewall using the backhoe. Monitor each soil sample contained in the backhoe with a PID and radioactivity direct reading instrument. Wearing a new pair of nitrile disposable gloves, collect a representative sample from the backhoe bucket using a hand trowel or scoop. Never enter the excavation.

If the PID and/or radioactive screening indicates a positive instrumental response above site background, continue excavation of the surface from which the sample was collected. Do not submit these screened samples for laboratory analyses.

7. For each confirmation sample to be analyzed in the laboratory, collect about 0.5 kilograms of soil from three locations along each surface and mix the soil thoroughly in a stainless steel bowl to obtain a composite. Fill the sample container full for analyses.

8. Immediately label and tag (as required) the sample container; refrigerate/ice; and log the samples into the bound field logbook and complete the sample chain of custody form.
9. Repeat the sample collection procedures for the other sides and bottom of the excavation.

#### 3.3.1.2 Stockpiled Soil Sampling

A total of two composite soil samples will be collected from the stockpile estimated to consist of 50 cubic yards. The following equipment and procedures will be used to obtain the samples.

##### **Equipment**

- Stainless steel trowel or scoop;
- Stainless steel bowl;
- Sample containers;
- PID;
- Radioactivity direct reading instruments.

##### **Sampling Procedures**

1. Make a sketch of the stockpiled soil in relation to site landmarks. Record the stockpile dimensions.
2. Photograph the stockpile and conditions as deemed necessary.
3. For each composite sample to be analyzed in the laboratory, collect equal volumes of soil from three locations within the stockpile and mix the soil thoroughly in a stainless steel bowl. Fill the sample container full for analyses.
4. Immediately label and tag, as required, the sample container; refrigerate/ice; and log the samples into the bound field logbook and complete the chain of custody form.

### 3.3.1.3 Borehole Soil Sampling

Subsurface soil samples will be collected from boring locations and at the sampling frequency with depth at each location as identified in Section 3.2.3. The following equipment and procedures will be used to obtain the samples.

#### **Equipment**

- Split spoon sampler (supplied by drilling contractor);
- Stainless steel spoon or spatula;
- Stainless steel bowl;
- Sample containers;
- PID;
- Radioactivity direct reading instruments.

#### **Sampling Procedures**

1. Record the physical characteristics of the soil (i.e., color, odor, percent recovery, and texture).
2. Make a sketch or description of the borehole boundaries and sampling locations.
3. Photograph the sampling locations and conditions as deemed necessary.
4. Drive the split spoon sampler twenty-four (24) inches into the ground at the test site using a 140-pound hammer falling thirty (30) inches.
5. Withdraw the split spoon and its contents from the ground. Monitor each soil core with PID and radioactivity direct reading instrument immediately after opening the sampler. Log all samples.
6. At the sampling interval, collect approximately 10 oz. of soil and mix soil thoroughly in a stainless steel bowl. Fill the sample containers to the top with soil from the selected zone. Complete this task at each sampling interval.
7. Immediately label and tag the sample containers (as required); refrigerate/ice; and log the samples into a bound field notebook and complete the chain of custody form.

8. Auger to the next sampling interval and repeat the sample collection procedures.
9. If the auger cannot be advanced, switch to solid stem augering and collect chip samples from the zones of interest.
10. If the solid stem auger cannot be advanced, switch to core drilling using clear water as the drilling fluid. Handle the core as if it was retrieved by the split spoon sampler.

### 3.3.2 Sample Identification

In order to aid Carswell AFB, AFCEE, and Contractor personnel in recordkeeping, a project-specific sample identification system will be used. The sample identification number will be a non-hyphenated number containing sampling interval/depth information. For example:

Sample Type	Location ID	Sample ID
Surface Soil Sample from Boring #1	BMEIMN001	000010 (0 to 1 foot bgs) 050060 (5 to 6 feet bgs) 110120 (11 to 12 feet bgs)
1st Characterization Sample from Stockpile	SMEISS001	001 (Number of samples only - no depth association)

### 3.3.3 Sample Handling

The samples collected are expected to contain less than 2 nCi/g of radium. Since DOT only regulates radioactive material with a specific activity greater than 2 nCi/g, these samples may be handled as environmental samples unless other regulated hazards are identified or presumed to exist in the sample.

Because the DOT specifies curie amounts, which are not field readings, Table 3.2 indicates some approximate disintegrations per minute (d/m) for radium. The RSO can convert d/m to counts per minute (c/m) for field readings. In this way, the RSO will be able to determine if a sample is above 2 nCi/g or approximately  $4.4 \times 10^3$  d/m.

Action levels of radioactivity have been set to alert the RSO and SSO of increased requirements for workers protection. Action levels for radioactivity monitoring as noted Table 7.1 of the HSP are below the DOT-regulated radioactivity. Even though these action levels of radioactivity are

TABLE 3.2 TRANSPORTATION REQUIREMENTS FOR RADIUM<sup>1</sup> CONTAMINATED MATERIAL

NOT REGULATED	LIMITED QUANTITY	TYPE-A QUANTITY	TYPE-B QUANTITY
Above background level but <500 cpm/probe $\alpha$ and <5000 cpm/probe $\beta$	$5 \times 10^{-5}$ Ci (Upper limit)	A1 = Not applicable <sup>2</sup> A2 = $5 \times 10^{-2}$ Ci (Upper limit)	$>5 \times 10^{-2}$ Ci
Packaging : Not Applicable	Packaging: Strong, tight, leakproof. External Rad $\leq 0.5$ mrem. Outside package marked "Radioactive" if no inner packaging; otherwise, inner packaging marked in this manner.  Excepted from: Shipping papers and certification, specification packaging; labeling; marking	Packaging: See 49CFR173.431	Packaging: See 49CFR173.431

<sup>1</sup> Assumes that form of material is normal by definition of 49 CFR 173.421 and that the isotopes present are Ra-226.

<sup>2</sup> A1 applies only to special form.

not regulated by DOT, special safety precautions must be taken if the activity at a sample location indicates one of the action levels.

Sampling handling procedures pertinent to containers, holding times and preservation requirements for the samples collected during this project are summarized in Table 2.3 of the QAPP. All sample containers and preservation kits will be obtained from the laboratory.

Sampling handling procedures pertinent to packaging and shipping are included in Section 3.3.5.

### **3.3.4 Sample Custody**

Custody of samples must be maintained and documented from the time of sample collection to completion of the analysis. The Site Engineer is responsible for overseeing and supervising the implementation of proper sample custody procedures in the field. The Site Engineer is also responsible for ensuring sample custody until the samples have been transferred to a courier or directly to the laboratory. A sample is considered to be under a person's custody if:

- The sample is in the person's physical possession.
- The sample is in view of the person after that person has taken possession.
- The sample is secured by that person so that no one can tamper with the sample.
- The sample is secured by that person in an area which is restricted to authorized personnel.

The chain of custody procedures are initiated in the field following sample collection. The procedures consist of: 1) preparing and attaching a unique sample label to each sample collected, 2) completing the chain of custody form, and 3) preparing and packing the samples for shipment. These procedures are further described in the following sections.

#### **3.3.4.1 Sample Labels**

Field personnel are responsible for uniquely identifying and labeling all samples collected during a field investigation. All labeling must be done in indelible/waterproof ink. Any errors are crossed out with a single line, dated and initialed.

A sample label shall be affixed to each sample container. The label shall contain the following information:

- Sample identification number;
- Sample location;
- Depth interval;
- Date of collection;
- Time of collection;
- Name or initials or personnel collecting the sample;
- Analysis requested;
- Types of preservatives (if any);
- Any other information pertinent to the sample.

#### 3.3.4.2 Chain of Custody Form

A chain of custody form must be completed for each sample set collected. The form is maintained as a record of sample collection, transfer, shipment, and receipt by the laboratory. The forms must also contain pertinent information concerning sampling location, date, and times; signatures of the sampling team members; types of samples collected along with a unique sample identification number; the number of samples collected and shipped for analysis in each lot; the project name and number; and the name of the laboratory to which the samples are being sent. A sample Chain of Custody Form is provided in the LQAP (Appendix A).

#### 3.3.4.3 Transfer of Custody

Samples shall be accompanied by an approved and completed chain of custody form during each step of custody, transfer, and shipment. When physical possession of samples is transferred, both the individual relinquishing the samples and the individual receiving them shall sign, date, and record the time on the chain of custody form. In the case of sample shipment by an overnight courier, a properly prepared airbill shall serve as an extension of the chain of custody form while the samples are in transit.

Once received at the laboratory, laboratory custody procedures will apply. It is the laboratory's responsibility to maintain custody records throughout sample preparation, and analysis.

### 3.3.5 Sample Packaging and Shipping

Following sample collection, all samples shall be taken to an on-site location for batching and paperwork checks. At this central location, like sample types are matched (i.e., solids, liquids, etc.) from all sample locations. Labels and log information are checked to be sure there is no error in sample identification. The samples are packaged to prevent breakage and/or leakage, and the shipping containers are labeled in accordance with the Department of Transportation (DOT) regulations for transport.

As soon as field personnel are ready to transport samples from the field to the laboratory, the laboratory point of contact (POC) shall be notified by telephone. An overnight courier service shall pick up the samples at the base and deliver them to the laboratory. The breakdown of required analysis by matrix and concentration level should be included.

All samples shall be delivered directly to the laboratory by the courier service. In order to ensure safe, secure delivery of all collected samples to the laboratory, packaging and shipping procedures have been prepared. These procedures presented below are written to comply with applicable DOT regulations for transportation by surface and/or air.

Because of the expected non-hazardous nature of the collected samples, packaging and shipping criteria have been designed only to maintain chain of custody protocol as well as to prevent breakage of the sample containers. The packaging and shipping procedures shall be as follows:

- Place a layer of cushioning material (i.e., vermiculite) in the bottom of the watertight insulated metal or equivalent strength plastic shipping containers.
- Wrap the properly labeled and secured glass sample bottles and purgeable vials with plastic bubble wrap, if deemed necessary. Place the wrapped containers into watertight zip-lock bags and seal the bags closed, if deemed necessary.
- Place sample bottles (top side up) into the shipping container arranging the bottles so that the glass bottles are surrounded by plastic bottles.
- Using the necessary packing material, pack the sample bottles to ensure that they do not shift during transport.
- Place the sealed plastic bags of ice cubes or chips around and on top of the sample bottles to keep the samples cool during delivery.

- Seal the appropriate chain of custody form(s) in a zip-lock plastic bag and tape it securely to the inside of the shipping container lid.
- Close and lock/latch the shipping container. Seal the space between the container body and lid with waterproof tape. (If the shipping container used is a picnic cooler, tape the drain plug closed to prevent any leakage of water as the ice packs melt during transport.)
- Apply several wraps of chain of custody tape around the shipping containers perpendicular to the seal to ensure that the lid remains closed if the latch is accidentally released or damaged during shipment. Do not obscure any stickers or labels on the shipping container with the chain of custody tape.
- Each shipping container must not weigh more than 150 pounds.

### 3.3.6 Quality Control Samples

During each sampling episode, a number of quality control (QC) samples will be collected and submitted for laboratory analysis. The types of QC samples that will be collected along with a brief description of each sample type and frequency of collection are outlined in the following sections.

#### 3.3.6.1 Equipment Blanks

Equipment blanks are collected for equipment used in the collection of samples when devices other than the sample bottle itself are required. The analysis of these blanks serves to verify the cleanliness of the sampling equipment and the effectiveness of the decontamination procedure. Typically, equipment blanks are analyzed for the same parameters as the associated samples and are collected at a frequency of 5 percent of the associated samples.

Equipment blanks are comprised of organic-free deionized reagent water, which is transported to the sample collection site, opened, poured onto the sampling device following equipment decontamination procedures and transferred to a sample bottle.

For this project, equipment blanks will be collected and submitted for laboratory analysis along with subsurface soil samples collected from soil borings. No equipment blanks will be submitted with samples being analyzed for the sole purpose of characterization for waste disposal or for samples collected for field screening only.

### 3.3.6.2 Field Duplicates

Field duplicates are defined as two samples collected independently of each other at the same sampling location during a single sampling episode. Duplicate analysis provides statistical information relating to sample variability and serves as a check on the precision of any sample collection method. Typically, five percent of all samples requiring field screening and ten percent of all samples submitted for laboratory analysis will be collected in duplicate. Field duplicates will be labeled in such a manner that persons performing laboratory analyses are not able to distinguish duplicates from other collected samples.

### 3.3.6.3 Trip Blanks

Trip blanks are necessary for assessing potential sample contamination by three pathways: interaction between the sample and the container, contaminated bottle rinse water, or a handling procedure that alters the sample analysis results. Two organic sample bottles will be filled in the laboratory with Type II reagent grade water, transported to the site, handled like a sample, and returned unopened to the laboratory for analysis. One trip blank per shipping container that contains volatile organics will be prepared and shipped with the other samples.

### 3.3.7 Sample Analysis Summary

A summary of all field samples and their associated QA/QC samples is presented in Table 3.1. The quantities in this table represent estimated numbers of samples. The actual number of samples may change. Equipment blanks will be collected at a rate of 5 percent of the samples collected for laboratory analysis and duplicate samples will be collected and analyzed at a minimum rate of 10 percent of the total number of samples.

## 3.4 FIELD MEASUREMENTS

### 3.4.1 Parameters

Field measurement parameters will consist of: 1) total organic vapor (TOV) concentration using a photoionization detector (PID) and 2) radiation using direct reading instruments. Prior to the use of any test equipment in the field, proper calibration shall be ensured. Specific calibration procedures for various instruments are described in the following sections.

### 3.4.2 Equipment Calibration

The PID will be calibrated at the beginning of each day using a single point calibration of 100 ppm, isobutylene. High purity air will be used to zero the meters. The calibration procedures directed by the PID manufacturer shall be followed. All equipment calibrations will be recorded in the Field Log Book or Calibration Log Form. The information recorded will include, but not be limited to, the following:

- Date
- Time
- Equipment
- Serial Number
- Calibrations Standard
- Comments
- Operator's Initials

### 3.4.3 Equipment Maintenance

Preventative maintenance of field equipment is required in order to ensure the collection of valid field measurements. All necessary maintenance procedures will be fully documented in the project-specific field logbook. The type and frequency of such preventative maintenance for PID is as follows: clean UV lamp and ion chamber at the frequency recommended in the manufacturer's operation and maintenance manual; replace lamp as necessary as described in the manufacturer's operation and maintenance manual. No maintenance is required for the direct reading instruments.

### 3.4.4 Decontamination Procedures

Section 9.2, of the Site Health and Safety Plan describes procedures to be used in decontaminating sampling equipment.

## 3.5 FIELD QA/QC PROGRAM

### 3.5.1 Control Parameters

During sampling activities, several different types of quality control samples will be collected. The types and frequency of quality control sample collection are discussed in Section 3.3.6. Upon receipt of reports from the analytical laboratory, results from control samples will be evaluated using the procedures described in the QAPP.

Other data quality control techniques that will be used during the drum, tube and soil excavation, and soil sampling tasks include the use of certified or NIST traceable standards, sample analysis by a certified laboratory, and occasional field or performance audits by the Project QA/QC Manager to verify that field personnel are adhering to the procedures specified within this SAP.

### 3.5.2 Corrective Actions

Corrective action procedures for field activities are described in Section 2.11 of the QAPP. In addition, Table 3.3 describes the corrective actions that will be taken to remedy out-of-control conditions associated with the analytical results of field QC samples and the use of field instruments, should they occur.

**Table 3.3 Typical Conditions and Corrective Actions  
For Field Parameters**

Parameter	Condition	Corrective Action(s)
Equipment blank sample	Contains detectable amount of target compounds	Verify that trip blank from sample batch contains no detectable contamination.  Modify decontamination procedure.  Resample location, if necessary.
Duplicate sample	Precision outside limit	Modify sample collection procedure.  Evaluate other results for other QC samples for potential matrix effects.
Field instruments	Out of calibration or not calibrating	Clean probes and recalibrate.  Obtain fresh calibration standard solutions.  Perform maintenance check on instrument.  Obtain new instrument.

### **3.6 RECORDKEEPING**

Information generated through field sampling and screening efforts will be recorded in both field logbooks and field data sheets.

#### **3.6.1 Field Logbooks**

Field logbooks for the project will be maintained at a minimum by the Project Managers. Field logbooks will be bound with sequentially numbered waterproof pages. All logbook entries will be recorded in indelible ink. Corrections made to any entry will be performed by drawing a single line through the incorrect information and inserting the new information at the same location. Entries made by persons other than the Project Managers will be initialed and dated by the person making the entry.

All entries should clearly identify the date and time of the entry.

#### **3.6.2 Field Data Sheets**

Field data sheets associated with the sampling activities for this project include:

- Chain of Custody Form
- Borehole Log

# TAB

APPENDIX A

**APPENDIX A**

**MOUNTAIN STATES ANALYTICAL, INC.**

**LABORATORY QUALITY ASSURANCE PLAN**



## **LABORATORY QUALITY ASSURANCE PLAN**

**This document is a generic quality assurance plan.  
No specific project information is mentioned.  
This Mountain States Analytical, Inc. Quality Assurance Plan  
conforms with the following guidelines:**

**EPA QAMS 005/80  
ASME NQA-1  
DOE Draft Order 5700.6C**

**among others.**

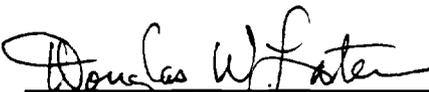
**Mountain States Analytical, Inc.  
1645 West 2200 South  
Salt Lake City, UT 84119  
Telephone (801) 973-0050  
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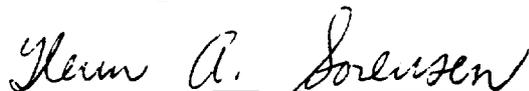
## LABORATORY QUALITY ASSURANCE PLAN

Mountain States Analytical, Inc.  
Revision 0.0  
March 1, 1996

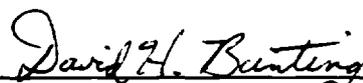
**Warning:** The information contained herein is of a highly confidential and proprietary nature. Mountain States Analytical, Inc. (MSAI) specifically prohibits the dissemination or transfer of this information to any person or organization not directly affiliated with the project or purpose for which it was prepared.

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These individuals received official copies of the MSAI Laboratory Quality Assurance Plan and should receive any subsequent official revisions.

Laboratory Quality Assurance Plan

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This document provides the laboratory portion of the response to EPA's "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans" QAMS-005/80, Sections 5.1 - 5.16 as revised December 29, 1980, and EPA-600/4-83-004, February 1983. Guidance was also obtained from:

"Preparation Aids for the Development of Category 1 Quality Assurance Project Plans," Office of Research and Development, USEPA, EPA/600/8-91/003, February 1991.

"Requirements for Quality Control of Analytical Data for the Environmental Restoration Program," Martin Marietta Energy Systems, Inc., ES/ER/TM-16

As much as possible, the procedures in this document have been standardized to make them applicable to all types of environmental monitoring and measurement projects. However, under certain site-specific conditions, all of the procedures discussed in this document may not be appropriate. In such cases it will be necessary to adapt the procedures to the specific conditions of the investigation.

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## Introduction and Description

It is the policy of Mountain States Analytical, Inc. (MSAI) to provide clients with scientifically valid and legally defensible analytical data. This Laboratory Quality Assurance Plan (LQAP) describes quality assurance and quality control procedures used during the generation of analytical data. Tests will be performed according to analytical methodologies approved by the U.S. Environmental Protection Agency (EPA) as specified in 40 CFR (Code of Federal Regulations). Typically, the most recently promulgated reference versions will be used unless there is a specific requirement to use earlier versions. Method sources include USEPA SW-846<sup>1</sup>, USEPA method publications (600/4-79-020, 600/4-91-010, 600/R-93/100, 600/4-88/039, etc.), Contract Laboratory Program (CLP) Statements of Work<sup>2</sup> for Inorganic and Organic analytes, and Standard Methods for the Analysis of Water and Wastewater, 18th edition. Proven instruments and techniques will be used to identify and measure the concentrations of volatiles, semivolatiles, and pesticide compounds, inorganic elements, and general chemistry test analytes. The laboratory will employ state-of-the-art GC/MS and GC procedures to perform organic analyses. Also, instrument procedures for total organic carbon (TOC), total organic halides (TOX), and infrared (FTIR) spectroscopic methods will be used for analysis of organic compounds. Inorganic analyses will be performed using graphite furnace atomic absorption (GFAA) spectrophotometry, inductively coupled plasma (ICP) spectroscopy, cold vapor AA (CVAA), flame AA (FAA), or hydride generation AA (HAA). General chemical analyses will use appropriate instrumentation, as applicable; such as a UV/Vis spectrophotometer, turbidimeter, pH meter, conductivity

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<sup>1</sup> Test Methods for Evaluating Solid Waste - Physical/Chemical Methods. SW-846 (3rd Edition, Update IIB, January 1995).

<sup>2</sup> USEPA Contract Laboratory Program, Statement of Work for Inorganics Analysis, Multi-Media, Multi-Concentration, ILM04.0  
USEPA Contract Laboratory Program, Statement of Work for Organics Analysis, Multi-Media, Multi-Concentration, OLM03.1

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meter, and so forth. The client is responsible for providing specific requirements for any given project, especially if the requirements differ from the information presented in this document.

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## Laboratory Organization and Personnel

The objectives of the Laboratory Quality Assurance Plan (LQAP) are to establish procedures which will ensure that data generated in the laboratory are within acceptable limits of accuracy and precision, to ensure that quality control measures are being carried out, and to ensure accountability of the data through sample and data management procedures. To this end, a Quality Assurance Department has been established at Mountain States Analytical, Inc. (MSAI). The Director of Quality Assurance reports directly to the Laboratory Director and has no direct responsibilities for data production, thus avoiding any conflict of interest.

The attached organizational chart shows the key personnel of Mountain States Analytical, Inc. Qualifications of key individuals may also be found in Appendix A.

The Client Services Group is responsible for sample management, client services, field sampling, and waste management. The Sample Administration group, within Client Services, is responsible for receiving samples, signing the external chain-of-custody, checking sample conditions, assigning unique laboratory sample identification numbers, initiating internal chain-of-custody forms, assigning storage locations, checking and adjusting preservation, homogenizing the sample as needed, and sample storage and disposal. Each client is assigned a Client Manager to enhance communication and to ensure that the client's needs are met. Trained field samplers are available on staff.

The Laboratory Operations Group is responsible for performing laboratory analyses, quality control as specified in the methods, instrument calibration, and technical data review. Data is reported using a computerized Laboratory Information Management System (LIMS), which tracks sample progress through the

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laboratory and generates client reports when all analyses are complete. Quality control data are entered onto the same system, or other computerized systems, for purposes of charting and monitoring data quality.

The Quality Assurance Department is responsible for reviewing quality control data, conducting audits in the laboratory and reporting findings to management, controlling all analytical methods and standard operating procedures, submitting blind samples to the laboratory, and ensuring that appropriate corrective action is taken when quality problems are observed.

In addition, the Quality Assurance Department reviews the contents of the deliverables, when data packages are requested, for completeness and to be sure that all quality control checks were performed and met specifications. This step includes review of holding times, calibrations, instrument tuning, and results of blanks, duplicates, matrix spikes, surrogates, and laboratory control samples. Every attempt to meet specifications will be made, with any item outside of the specifications noted in the case narrative of the data package. The laboratory will not validate data with regard to useability since this generally requires specific knowledge about the site.

The responsibilities of the Support Services Group are accounting, payroll, human resources, computer information system management, human resources, communication, document control, and physical facilities maintenance. The document control function also includes the responsibility for mailing analysis reports to clients.

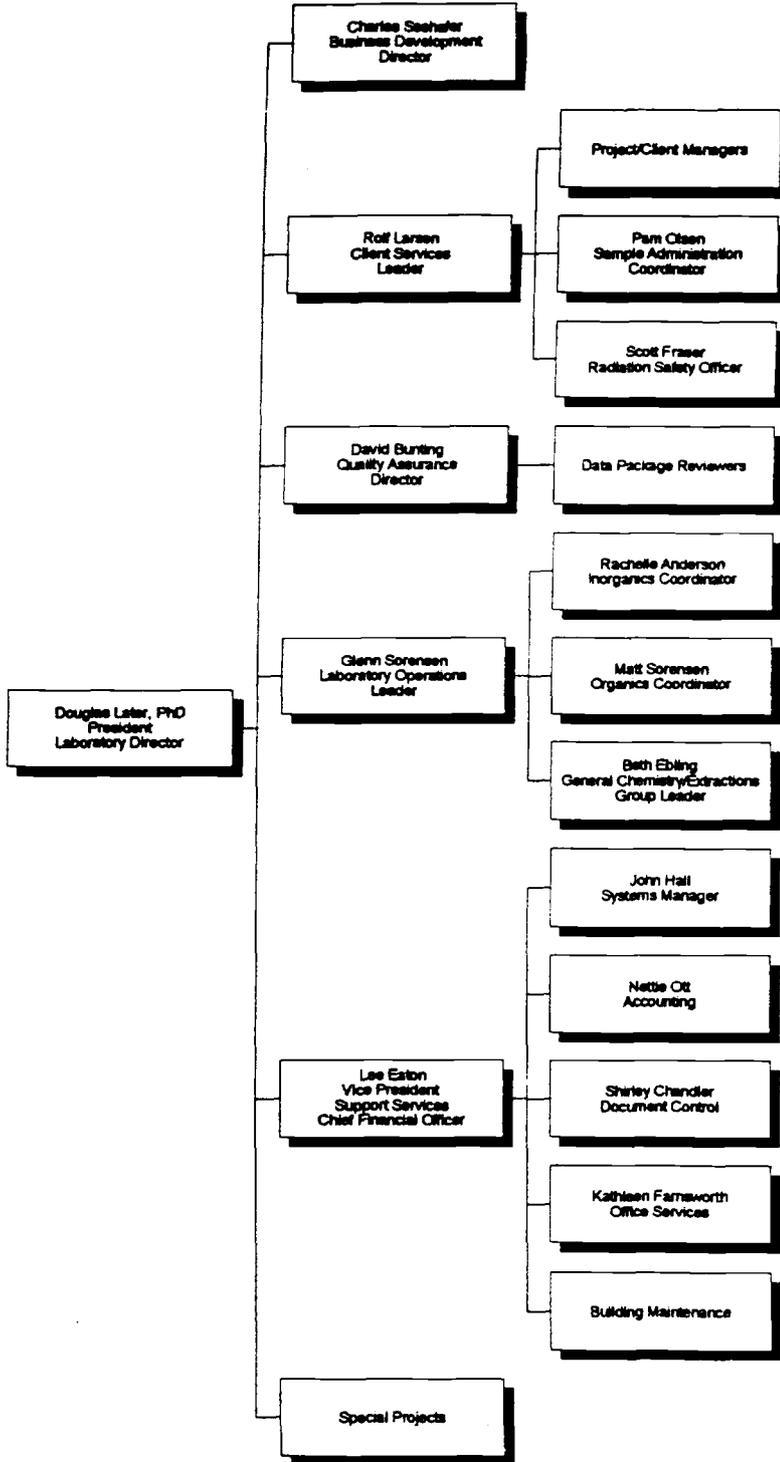
The Special Projects Group performs studies and analyses that fall outside the scope of the routine laboratory analyses. This group generated test data used by the USEPA to approve an advanced sample preparation device.

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The Business Development Group actively promotes the capabilities of Mountain States Analytical, Inc. to a growing number of clients and markets. This is done through participation in trade organizations and keeping apprised of new projects and business opportunities.

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Figure 4-1  
Organization of Mountain States Analytical, Inc.



**Training and Qualification**

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Mountain States Analytical, Inc. possesses a professional and well qualified staff. Every effort is made to hire the most qualified candidates. Internal training programs include not only technical on the job training, but value-added topics, such as total quality, ethics, and leadership. Weekly tests are conducted to ensure that employees have a good understanding of quality assurance and safety policies and procedures. Documentation of training and acquired skills is explained in the following policy and procedure.

**QUALITY ASSURANCE**  
**COMPANY POLICY AND PROCEDURE**  
**CPP-QA-016**

**289 68**

**Title:** Personnel Training Records

**Purpose:**

To ensure that technical personnel who influence the quality of MSAI's services are properly trained and that an appropriate record of that training is kept.

**Scope:**

This policy establishes training requirements, identifies who must keep Personnel Training Records, and explains how training is documented.

**Background Information:**

The training received by technical personnel is of increasing importance to clients, regulatory agencies, and accrediting bodies. Personnel Training records demonstrate that laboratory personnel have been adequately prepared for the duties they perform. Certain regulations governing our laboratory operations require that training records be kept. Personnel Training Records may also help present analysts' qualifications during court testimony.

**Policy/Procedure:**

A Personnel Training Record is kept for each technical staff member. Training records may also be kept for non-technical staff members at the discretion of the group leader and/or senior staff.

The group leader will ensure that the employee has a training record and understands this policy document. The group leader and the staff member are jointly responsible for maintaining the training record.

Training Requirements. The group leader will ensure that members of the group receive the necessary training. An entry in the training record authorizes the employee to perform an analysis or function that will affect an analytical result. Before an staff member's training is complete, execution of a function will be supervised by a group leader or an experienced person designated by the group leader.

Evaluation of competency will be based on **knowledge** and **performance**. **Knowledge** is verified by training completion date and a statement that the SOP, CPP or analytical method was read and understood. **Acceptable performance** is determined from an applicable test. For an analyst, the preferred test criteria are precision and accuracy of results when performing a quadruplicate study, or analyzing a quality control standard.

Record Keeping. The following items, if applicable, are to be recorded in the Personnel Training Record.

- Pertinent skills (i.e., analytical methods, instrumental techniques, calibrations, etc.). Include the date of training completion, the name of the trainer, and, whenever possible, evidence of competency. Evidence of competency may include favorable results of known quality control samples, quadruplicate studies, proficiency samples from internal and external performance evaluation studies, and comparison of the analyst's results to those of an experienced analyst.
- Previous laboratory experience. A copy of a résumé is acceptable.

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- Attendance at seminars or completion of special courses offered in-house or by outside organizations. A training certificate is acceptable.
- Comprehension of policies and procedures. Each employee must read designated policies and procedures relating to quality assurance, safety (general laboratory and radiation safety), and the SOPs that apply to his/her job.
- Scores from written tests on company policies and procedures and job-specific SOPs.

Each time a staff member's job description is changed due to training or promotion, a copy of the current job description must be included in the Training Record. The job description includes the position title and summary of duties of a staff member, and it differs from the job performance evaluation tool known as a job plan.

Prior to each performance evaluation, the employee should review the training record to ensure that all training received during the review period has been documented. The group leader will review, initial, and date each entry.

Knowledge of designated policies and procedures will be verified annually. Technical staff members will be retrained and retested before performing analytical methods and procedures for which they have no record of proficiency within one year.

**Forms:**

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This policy and procedure includes a set of forms for summarizing key information in the training record.

**Form I, MSAI Training Record Cover Sheet**

Use this form to list education, positions held and work experience.

**Form II, Training Courses**

This form is used to record completed training courses.

**Form III, Company Policies Read and Understood**

This is a record of policies and procedures that have been read and understood.

**Form IV, Instrument Training and Proficiency**

Training on maintenance, calibration, and use of instruments and equipment is summarized using Form IV.

**Form V, Method and SOP Training and Proficiency**

Use this form to record understanding, training, and proficiency in analytical methods and standard operating procedures.

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Form I

**MSAI Training Record Cover Sheet**

Employee: \_\_\_\_\_

Employee Number: \_\_\_\_\_

Starting Job Title: \_\_\_\_\_

Degree/Education: \_\_\_\_\_

\_\_\_\_\_

Previous Laboratory Experience: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Promotion Title: \_\_\_\_\_ Date Effective: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Additional Training Information:**

- ▶ Current Job Description
- ▶ Training Course Summary
- ▶ Company Policies Summary
- ▶ Instrument Proficiency
- ▶ Methods/SOPs/Proficiency Summary





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Form IV

Name: \_\_\_\_\_

**INSTRUMENT TRAINING AND PROFICIENCY**

INSTRUMENT	FUNCTION	TRAINING		LEADER SIGN/DATE
		TRAINER	DATE	
	CALIBRATION			
	MAINTENANCE			
	PERF. EVALUATION			



## Quality Assurance Objectives

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### General Policy Statement

The major function of an independent laboratory is to generate technical information. Mountain States Analytical, Inc. (MSAI) provides information from chemical analyses, along with whatever additional information is necessary for proper interpretation of the results.

MSAI's clients use this information for a variety of purposes. It may be used to demonstrate compliance with a government regulation; to evaluate a raw material for a manufacturer; to demonstrate the value or quality of a finished product; to establish the basis for a patent; or to settle a legal dispute. From the client's point of view, this information has an intrinsic value greater than its monetary cost. Since this information is so important, it is necessary to produce it under a program which will assure that it has the necessary "quality"—in other words, that it has a degree of accuracy commensurate with its intended use. This section describes the Quality Assurance objectives under which we operate at Mountain States Analytical.

### Quality Assurance Objectives

At Mountain States Analytical, a written Quality Assurance Program is followed with written Quality Assurance policies and procedures to insure the precision and accuracy of client data. The objectives of MSAI's Quality Assurance Program are:

- Establish and follow quality control procedures which will ensure that data generated in the laboratory are within acceptable limits of precision and accuracy.

- Establish and follow procedures to document that these quality control measures are being carried out.
- Establish and follow procedures to ensure the "accountability" of data for each sample submitted—that is, to ensure that the reported results actually apply to the sample as submitted.
- Establish and follow procedures to ensure that for any result reported to a client, we can determine the date of analysis, the analyst(s), the raw data generated, the condition of any instrument or equipment used, and the state of the quality control system at the time of the test.
- Establish and follow procedures which minimize the possibility of loss of, damage to, or tampering with samples or analytical data.

Quality Assurance (QA) is the overall program for assuring reliability of monitoring and measurement data. Quality control (QC) is the routine application of procedures for obtaining set standards of performance in the monitoring and measurement process. Data quality requirements are based on the intended use of the data, the measurement process, and the availability of resources. The quality of data generated and processed in the laboratory will be assessed for Precision, Accuracy, Completeness, Representativeness, and Comparability as defined in this section. These specifications will be met through precision and accuracy criteria specified in Section No. 12 and assessment procedures in Section No. 15. Detection limits are presented in Section No. 10 and the method by which they are obtained in Section No. 15.

**Precision** - Precision is determined by measuring the agreement among individual measurements of the same property, under similar

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conditions. The laboratory objective is to equal or exceed the demonstrated precision on comparable samples for the analytical method used. The degree of agreement for duplicate measurements is expressed as the relative percent difference (RPD).

Evaluation of the RPD is based on statistical evaluation of past laboratory data or guidelines within the methods for organic and inorganic analyses. The formula used to calculate the RPD is found in Section 15.

Accuracy - Accuracy is a measure of the nearness of an individual measurement or the mean of a set of measurements to the true or expected value. Analyzing a reference material of known concentration or reanalyzing a sample which has been spiked with a known concentration/amount is a way to determine accuracy. Accuracy is expressed as a percent recovery (%R). Evaluation of the %R is based on statistical evaluation of past laboratory data or guidelines within the methods for organic and inorganic analyses. The formula used to calculate the %R is found in Section 15. External evaluation of accuracy is accomplished by analysis of Standard Reference Materials (SRM)<sup>1</sup>, certified reference materials, and interlaboratory performance data (See Section No. 13).

Completeness - Completeness is a measure of the quantity of valid data acquired from a measurement process compared to the amount that was expected to be acquired under the measurement conditions. Completeness is evaluated by the data user because the laboratory does not always have full knowledge of project-specific data quality objectives. The completeness of an analysis can be documented by including in the data deliverables sufficient information to allow the data user to assess the quality of the results. Additional information will be stored in the laboratories' archives, both hard copy and magnetic tape.

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<sup>1</sup> SRM refers to Standard Reference Materials certified and supplied by the National Institute of Standards and Technology (NIST).

Quality Assurance policies and procedures are established to provide information necessary to evaluate completeness.

Representativeness - Representativeness expresses the degree to which data accurately represent the media and conditions being measured. The representativeness of the data from the sampling site depends on the sampling procedure. Sample collection is the responsibility of the client, unless the client requests that the laboratory collect the sample. In the later case, MSAI has trained employees, certified by the State of Utah, through Rule R311-201 of the Utah Administrative Code. Written procedures containing acceptable sampling practices are followed. Samples are homogenized, if required, as part of the laboratory sample preparation.

Comparability - Comparability conveys the confidence with which one set of data can be compared to another. The analytical results can be compared to other laboratories by using traceable standards and standard methodology and consistent reporting units. The Laboratory Quality Assurance Program documents internal performance, and the interlaboratory studies document performance compared to other laboratories.

To ensure attainment of the quality assurance objectives, Company Policy and Procedure documents (CPP) and Standard Operating Procedures (SOP) are in place detailing the requirements for the correct performance of laboratory procedures.

All SOPs and QA CPPs are approved by the QA Department prior to implementation. The distribution of current policies and procedures and archiving of outdated ones are controlled through a master file. Table 5-1 provides an index of QA policies and procedures in place to support the Quality Assurance Objectives. These requirements are supplemented by the procedures in the laboratory and analytical SOPs.

Table 5-1

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<b>Quality Assurance Policies and Procedures</b>	
<b>Document #</b>	<b>Document Title</b>
QA-001	Sample Receipt and Log-In
QA-002	Sample Storage and Disposal
QA-003	Chain-of-Custody Documentation
QA-004	Analytical Methods
QA-005	Validation and Authorization of Analytical Methods
QA-006	Analytical Methods for Non-Routine Analyses
QA-007	Subcontracting to Other Laboratories
QA-008	Laboratory Notebooks
QA-009	Reagents, Chemicals, and Standards
QA-010	Instrument and Equipment Calibration
QA-011	Instrument and Equipment Maintenance
QA-012	Data Entry and Verification
QA-013	Data Storage and Security
QA-014	Quality Control Records
QA-015	Investigation and Corrective Action of Unacceptable Quality Control Data
QA-016	Personnel Training Records
QA-017	Quality Assurance Audits
QA-018	Proficiency Samples
QA-019	Electronic Data Integrity, Security, and Recovery
QA-020	Emergency Response for Refrigeration Systems
QA-021	Sample Collection
QA-022	Corrective Action

## Sampling Procedures

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In order for meaningful analytical data to be produced, the samples analyzed must be representative of the system from which they are drawn. It is the responsibility of the client to ensure that the samples are collected according to accepted or standard sampling methods. If the laboratory is requested to collect samples, MSAI has employees certified by the State of Utah, through Rule R311-201 of the Utah Administrative Code, to ensure proper representative sampling. A set of standard operating procedures are written to ensure that sampling is done according to established procedures. It is the responsibility of the client to identify the correct sampling site and specific location. When required, a project-specific sampling plan will be used as guidance for collecting samples.

The laboratory will provide appropriate sample containers, required preservatives, chain-of-custody forms, shipping containers, labels, and custody seals. The sample containers are purchased pre-cleaned from outside suppliers. Container traceability documentation is available upon request.

Each lot of preservative will be recorded in a notebook and checked for contaminants before use. The appropriate sample bottle will be preserved with the new preservative and filled with deionized water to represent a sample. It will be analyzed by the methods which require that preservative. Analysis results are maintained for each preservative lot number.

Trip blanks will be prepared by the laboratory, as specified by the client, and accompany sample containers at the

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project required frequency. Analyte-free water will also be provided for field blanks.

When requested, the laboratory will provide coolers with reusable refrigeration gel packs to be frozen for sample transport. Samples should be shipped to the laboratory in ice, or frozen gel packs. Upon arrival at the laboratory, samples are stored in a walk-in-cooler at  $4^{\circ}\text{C} \pm 2^{\circ}\text{C}$ .

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### Sample Custody

If the samples are collected by the laboratory, the date and time of collection are recorded in the sampler's logbook and on the field (or external) chain-of-custody form. Otherwise, the client is responsible for initiating sample custody in the field before shipment.

Samples are unpacked and inspected in the sample receipt area. At this time, the samples are examined for breakage and agreement with the associated client paperwork. The shipping container or cooler temperatures will be checked upon receipt and recorded. As the samples are unpacked, the sample label information will be compared with the chain-of-custody record and any discrepancies or missing information will be documented. If necessary, the cooler will be closed and placed in cold storage until instructions and resolution of any discrepancies are received from the client.

A member of the Sample Administration staff will act as sample custodian for the samples. To ensure accountability of our results, a unique identification number is assigned to each sample as soon as possible after receipt at the laboratory. When samples requiring preservation by either acid or base are received at the laboratory, the pH will be measured and documented, except samples designated for volatile analysis. Volatile analysis samples are checked for correct pH at the time of analysis. Samples requiring refrigeration will be stored in MSAI's walk-in cooler and other sample storage coolers maintained at  $4^{\circ}\text{C} \pm 2^{\circ}\text{C}$ . A computerized laboratory information system is used to track samples (by the MSAI sample # assignment) and is used to track custody of the sample from receipt until the time of its disposal. The laboratory building security system allows the entire facility to be designated as a secure area. A map of the laboratory building is attached in Section 8 (See Figure

8-1.) MSAI's routine procedure is to use internal sample tracking forms for tracking custody of samples within the laboratory. If requested, a hand-to-hand internal chain-of-custody will be provided as described in the attached CPP-QA-003. The laboratory chain of custody may begin with the preparation of bottles or the completion of the field chain of custody. The procedures for sample log-in, storage and disposal, and chain-of-custody documentation are detailed in the CPP-QA documents included in this section (QA-001, QA-002, and QA-003).

**Sample Containers, Preservatives, and Holding Times**

MSAI follows the requirements of SW-846 and 40 CFR 136, Table II for containers, preservatives, and holding times. See Tables 7-1 and 7-2. Sample bottles are prepared according to the requirements for the sample matrices and analyses to be performed, and the appropriate preservatives are added before transfer to the field. MSAI preserves samples (except volatiles) found to be improperly preserved when received and records the as-received pH on the chain of custody.

Holding times are determined from the time of sample collection unless project requirements specify otherwise. Contract Laboratory Program (CLP) sample holding times are determined from the verified time of sample receipt (VTSR).

Table 7-1

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Sample Containers, Preservatives, and Holding Times for Aqueous and Solid Samples					
Analysis	Matrix	Vol.(ml) or Wt. (g) Required	Container: P=Plastic G=Glass Q=Quartz	Preservation <sup>a</sup>	Holding Time <sup>b</sup> From Date/Time of Collection
Acidity	w/ww	250 ml	P or G	Cool, 4°C	14 days
Alkalinity	w/ww	500 ml	P or G	Cool, 4°C	14 days
Ammonia	w/ww	1000 ml	P or G	Cool, 4°C; H <sub>2</sub> SO <sub>4</sub> to pH < 2	28 days
BOD or Carbonaceous BOD	w/ww	1000 ml	P or G	Cool, 4°C;	48 hours
Boron	w/ww	1000 ml	P(PTFE) or Q	HNO <sub>3</sub> to pH < 2	6 months
	sw	25 g	P or Q	Cool, 4°C	6 months
Bromide	w/ww	50 ml	P or G	(None required)	28 days
COD	w/ww	100 ml	P or G	Cool, 4°C; H <sub>2</sub> SO <sub>4</sub> to pH < 2	28 days
Chloride	w/ww	500 ml	P or G	(None required)	28 days
	sw	50 g	P or G	(None required)	28 days
Chlorine, total residual	w/ww	250 ml	P or G (amber)	(None required)	< 24 hrs
Hexavalent Chromium	w/ww	200 ml	P or G	Cool, 4°C	24 hrs
	sw	100 g	P or G	Cool, 4°C	7 days <sup>a</sup>
Corrosivity	w/ww	50 ml	P or G	(None required)	< 24 hrs
	sw	50 g	P or G	(None required)	< 24 hrs
Cyanide (Total)	w/ww	1000 ml	P or G	Cool, 4°C; NaOH to pH>12	14 days <sup>f</sup>
	sw	100 g	G	Cool, 4°C	14 days <sup>f</sup>
Fluoride	w/ww	50 ml	P	(None required)	28 days
Hardness	w/ww	200 ml	P or G	HNO <sub>3</sub> to pH < 2	6 months
Ignitability	w/ww	50 ml	P or G	(None required)	(None)
	sw	50 g	P or G	(None required)	(None)
Kjeldahl Nitrogen	w/ww	1000 ml	P or G	Cool, 4°C; H <sub>2</sub> SO <sub>4</sub> to pH < 2	28 days
Metals (CVAA, FAA, GFAA, HAA, and ICP)	w/ww	1000 ml	P	Cool, 4°C; HNO <sub>3</sub> to pH<2	180 days <sup>a</sup>
	sw	100 g	G	Cool, 4°C	180 days <sup>a</sup>
Moisture	sw	50 g	P or G	Cool, 4°C	7 days

Table 7-1 (Continued)

Sample Containers, Preservatives, and Holding Times for Aqueous and Solid Samples					
Analysis	Matrix	Vol.(ml) or Wt. (g) Required	Container: P=Plastic G=Glass	Preservation <sup>a</sup>	Holding Time <sup>b</sup> From Date/Time of Collection
Nitrate or Nitrite (separate analytes)	w/ww	100 ml	P or G	Cool, 4°C	48 hrs
	sw	20 g	P or G	Cool, 4°C	48 hrs
Nitrate-nitrite	w	125 ml	P or G	Cool, 4°C; H <sub>2</sub> SO <sub>4</sub> to pH < 2	28 days
Nonhalogenated Volatile Organics (Includes TPH, Alcohols, and GC Fingerprints)	w/ww	2x1000 ml	G (amber)	Cool, 4°C	14 days
	sw	100 g	G	Cool, 4°C	14 days
Oil and Grease	w/ww	2x1000 ml	G (amber)	Cool, 4°C; H <sub>2</sub> SO <sub>4</sub> or HCl to pH < 2	28 days
	sw	50 g	G	Cool, 4°C	28 days
Organochloride and Organophosphate Pesticides, PCBs, and Herbicides	w/ww	2x1000 ml	G (amber)	Cool, 4°C; Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub>	7 days <sup>df</sup>
	sw	100 g	G	Cool, 4°C	14 days <sup>df</sup>
Orthophosphate	w/ww	125 ml	P or G	Cool, 4°C	48 hrs
Oxygen, dissolved	w/ww	300 ml	G	(None required)	<24 hrs
Paint Filter Liquid Test (Free Liquids)	liquid/ solid	125 g	G	(None required)	(None)
pH	w/ww	50 ml	P or G	Cool, 4°C	< 24 hrs
	sw	50 g	P or G	Cool, 4°C	< 24 hrs
Phenolics	w/ww	1000 ml	G (amber)	Cool, 4°C; H <sub>2</sub> SO <sub>4</sub> to pH<2	28 days
	sw	100 g	G	Cool, 4°C	28 days
Phenols by GC	w/ww	2x1000 ml	G (amber)	Cool, 4°C; Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub>	7 days <sup>d</sup>
	sw	100 g	G	Cool, 4°C	7 days <sup>d</sup>
Phosphorus, total	w/ww	500 ml	P or G	Cool, 4°C; H <sub>2</sub> SO <sub>4</sub> to pH < 2	28 days
	sw	20 g	G	Cool, 4°C	28 days
Polycyclic Aromatic Hydrocarbons (PAH)	w/ww	2x1000 ml	G (amber)	Cool, 4°C; Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub>	7 days <sup>d</sup>
	sw	100 g	G	Cool, 4°C	14 days <sup>d</sup>

Table 7-1 (Continued)

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Sample Containers, Preservatives, and Holding Times for Aqueous and Solid Samples					
Analysis	Matrix	Vol.(ml) or Wt. (g) Required	Container: P=Plastic G=Glass	Preservation <sup>a</sup>	Holding Time <sup>b</sup> From Date/Time of Collection
Reactivity	liquid/ solid	100 g	G	Cool, 4°C	14 days 7 days (sulfide)
Residue, total/filterable/ nonfilterable/volatile	w/ww	500 ml	P or G	Cool, 4°C	7 days
Residue, settleable	w/ww	1000 ml	P or G	Cool, 4°C	48 hrs
Semivolatiles (Acid, Base, Neutral Extractables)	w/ww	2x1000 ml	G (amber)	Cool, 4°C; Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub>	7 days <sup>d1</sup>
	sw	100 g	G	Cool, 4°C	14 days <sup>d1</sup>
Specific Conductance	w/ww	100 ml	P or G	Cool, 4°C	28 days
	sw	100 g	P or G	Cool, 4°C	28 days
Sulfate	w/ww	250 ml	P or G	Cool, 4°C	28 days
	sw	100 g	P or G	Cool, 4°C	28 days
Sulfide	w/ww	250 ml	G	Cool, 4°C; NaOH; ZnAC	7 days
	sw	100 g	G	Cool, 4°C	7 days
Total Organic Carbon (TOC)	w/ww	4 x 125 ml	G	Cool, 4°C; H <sub>2</sub> SO <sub>4</sub> to pH<2	28 days
	sw	20 g	G	Cool, 4°C	28 days
Total Organic Halogen (TOX)	w/ww	500 ml	G	Cool, 4°C; H <sub>2</sub> SO <sub>4</sub> to pH<2	14 days
	sw	50 g	G	Cool, 4°C	14 days
	oil	20 g	G	Cool, 4°C	(None)
Toxicity Characteristics Leaching Procedure (TCLP)	w/ww	3000 ml	G	Cool, 4°C	(Table 7-2)
	sw	200 g	G	Cool, 4°C	(Table 7-2)
	oil	3000 ml	G	Cool, 4°C	(Table 7-2)
Volatiles by GC (Includes BTEX, MTBE, Naphthalene, Aromatics, and Halocarbons)	w/ww	3x 40 ml	G	Cool, 4°C; HCl to pH<2	14 days
	sw	100 g	G	Cool, 4°C	14 days
Volatiles by GC/MS	w/ww	2x 40 ml	G	Cool, 4°C; HCl to pH<2	14 days <sup>f</sup>
	sw	100 g	G	Cool, 4°C	14 days <sup>f</sup>

Table 7-1 (Continued)

Sample Containers, Preservatives, and Holding Times for Aqueous and Solid Samples					
Analysis	Matrix	Vol.(ml) or Wt. (g) Required	Container: P=Plastic G=Glass	Preservation <sup>a</sup>	Holding Time <sup>b</sup> From Date/Time of Collection
Turbidity	w/ww	125 ml	P or G	Cool, 4°C	48 hrs

Footnotes: (Table 7-1)

- <sup>a</sup> pH Adjustment with acid/base is performed on water samples only.
- <sup>b</sup> Samples will be analyzed as soon as possible after collection. The times listed are the maximum times that samples will be held before analysis and still be considered valid.
- <sup>c</sup> Mercury must be analyzed within 28 days (26 days from VTSR for CLP).
- <sup>d</sup> Analysis must be within 40 days of extraction.
- <sup>e</sup> Analysis must be within 24 hours of extraction.
- <sup>f</sup> CLP Cyanide holding time is 12 days from VTSR.  
CLP Volatiles holding time is 10 days from VTSR.  
CLP Semivolatiles and Pesticides holding times are: 5 days for water extraction and 10 days for soil extraction from VTSR; analysis 40 days from extraction.

Table 7-2

	TCLP Holding Times	
	From field collection <u>to TCLP extraction</u>	From TCLP extraction <u>to complete analysis</u>
Volatiles	14 days	14 days
Semivolatiles	14 days	7/40 days <sup>*</sup>
Pesticides and Herbicides	14 days	7/40 days <sup>*</sup>
Mercury	28 days	28 days
All other metals	180 days	180 days

<sup>\*</sup> The first holding time is for sample preparation/the second holding time is for analysis

**QUALITY ASSURANCE  
COMPANY POLICY AND PROCEDURE  
CPF-QA-001**

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**Title:** Sample Receipt and Log-In

**References:**

40 CFR Part 136, Guidelines Establishing Test Procedures for the  
Analysis of Pollutants  
SOP-SA-101, Sample Receiving and Documentation  
SOP-RA-127, Receiving Radioactive Samples  
SOP-SA-102, Sample Entry

**Purpose:**

To establish requirements for sample receipt, sample inspection,  
and log-in that will ensure adequate laboratory sample  
management.

**Scope:**

This policy establishes the requirements for the receipt,  
inspection, and log-in of samples. It specifies that samples be  
assigned unique identification numbers.

**Background Information:**

It is important that samples received at the laboratory be  
logged-in properly to ensure that each is assigned a unique  
identification number. Unique identification numbers are used to  
prevent sample loss or mix-up and to provide accountability of  
analytical results. Sample temperature and preservation must be  
verified upon receipt to preserve the validity of the samples  
analyzed by the laboratory.

**Policy/Procedure:**

Sample receipt will be performed by Sample Administration. All  
client correspondence relating to the samples will be given to  
Sample Administration. Sample Administration will inspect and  
verify the condition of samples received.

1. Samples that meet MSAI's acceptance criteria will be  
received. SOP-SA-101 will specify the acceptance criteria  
and the procedure for receiving. Acceptance criteria will  
include the radioactivity criteria of SOP-RA-107, which will  
be in conformance with MSAI's radioactive material license.  
The chain of custody will be signed upon sample receipt.

2. Inspection will include measurement and recording of temperature within the shipping containers and coolers.
3. All sample shipments will be verified against the chain of custody. Discrepancies will be noted on the chain of custody and the project manager will be notified. The project manager will notify the client, if necessary.
4. The samples, except volatile organic samples, will be tested for pH to ensure proper preservation. Preservation criteria will be consistent with 40 CFR 136. If preservation criteria are not met, Sample Administration will document that fact and add the appropriate preservative. Clients will be notified for preservation problems that might adversely affect sample integrity.

Sample Administration will enter sample information into the Laboratory Information Management System (LIMS). The procedure will be detailed in SOP-SA-102.

1. The LIMS will assign a unique identification number to each sample. Sample Administration personnel will assign a refrigerator location for each group of samples and will enter this location in the LIMS.
2. Samples will be entered into the LIMS as soon as feasible. This will be done on the day of receipt, unless receipt is after normal receiving hours or additional sample information is needed. Shipments that cannot be immediately entered into the LIMS will be placed in refrigerated storage until they can be entered.
3. Sample Administration will communicate special conditions to analytical personnel and project managers. Special conditions might include rush sample requests, samples with short or soon-to-expire holding times, and non-standard analytical requirements.
4. Computer-generated labels will be affixed to each sample container. The label information will include the MSAI sample number, the storage location, the sample date, and the client ID #.
5. Once the samples are properly labeled, they will be stored in the assigned refrigerator location.

Sample administration will generate a sample group report that lists the samples with their assigned tests and includes other relevant sample information. This group report will be reviewed for accuracy and completeness by the project manager. When the report is determined to be accurate, it will be sent by facsimile

to the client and then filed in a folder created specifically for the sample group.

The sample group folder will be used to collect the following information: the chain of custody, LIMS reports (acknowledgments, analysis reports, revised analysis reports, QC summaries, and invoices), client correspondence, and telephone logs.

Samples requiring data package deliverables will be grouped into sample delivery groups (SDG) by Sample Administration personnel. An SDG will contain samples from only one client and will usually be matrix-specific. An SDG worksheet will be filled out with the SDG name, a list of included samples, and the samples designated to be spiked. The SDG worksheet will be circulated to the affected departments.

**QUALITY ASSURANCE  
COMPANY POLICY AND PROCEDURE  
CPP-QA-002**

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**Title:** Sample Storage and Disposal

**References:**

SOP-SA-103, Sample Maintenance  
CPP-QA-003, Chain of Custody Documentation  
CPP-QA-020, Emergency Response for Refrigeration Systems  
SOP-SA-105, Sample Disposal and Monitoring of Waste Containments

**Purpose:**

To establish requirements for sample storage, release to analysts, and disposal that will ensure sample integrity while in the custody of Mountain States Analytical, Inc.

**Scope:**

This establishes the requirements for storing samples, retrieving and returning samples for analysis, and discarding samples when they are no longer needed.

**Background Information:**

The integrity of MSAI's analytical data must be ensured by proper sample storage conditions. The objective of proper sample storage is to prevent sample deterioration prior to analysis. Sample Administration is responsible for assigning storage locations and monitoring the orderly storage of samples in locations from which they can easily be retrieved for analysis. Sample Administration is also responsible for making sure that samples are not discarded before the proper discard date and that the client has been contacted regarding the disposal of samples.

**Policy/Procedure:**

Sample Administration will determine the appropriate temperature and location (refrigerator or freezer) for sample storage for each group of samples as they are entered into the LIMS system. Sample groups will be assigned a specific storage location and will be stored in this location while in the custody of the laboratory. Separate designated refrigerators are used to store all samples for Volatile Organic Compound (VOC) analysis to avoid contamination.

Analysts will request and obtain samples from Sample Administration by filling out a sample request form. The sample request procedure and form will be described in SOP-SA-103.

Samples will be returned promptly to Sample Administration after the portion needed for analysis is removed. If the client has requested internal chain of custody documentation for its samples, the internal chain of custody section of CPP-QA-003 will be followed.

The temperature of each refrigerator or freezer used for storing samples will be checked daily and recorded in ink on log sheets posted on the storage units. Refrigerator temperatures will be maintained at  $4^{\circ}\text{C} \pm 2^{\circ}\text{C}$  and freezer temperatures at  $-15^{\circ}\text{C} \pm 5^{\circ}\text{C}$ . If the temperature of a unit is observed to be outside these operating parameters, corrective actions will be taken in accordance with CPP-QA-020.

All samples shall be returned to clients, stored for an extended period, or disposed of according to procedures in SOP-SA-105, which will conform to applicable federal and local regulations. Clients will be given the opportunity to select from among these options.

Sample Administration will obtain from the LIMS system a report of samples due for disposal to ensure that samples are not discarded prematurely.

**QUALITY ASSURANCE  
COMPANY POLICY AND PROCEDURE  
CPP-QA-003**

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**Title:** Chain of Custody Documentation

**References:**

SOP-SA-105, Sample Disposal and Monitoring of Waste Containments

**Purpose:**

To establish requirements for external and internal chain of custody documentation.

**Scope:**

This policy covers the preparation and use of internal chain of custody documentation and the treatment, by the laboratory, of external chain of custody documentation. Internal chain of custody procedures covered by this policy require a specific form and greater security than the requisition procedure used for normal samples.

**Background Information:**

In order to demonstrate the reliability of our analytical data, an accurate written record tracing the possession of a sample from the time of collection, to its receipt at the laboratory, its handling within the laboratory, to its disposal must be maintained. This documentation may be required by a regulatory agency or used as evidence in a legal case.

**Definition:**

A sample is in custody if it is:

1. In physical possession of an MSAI employee.
2. In view after being in physical possession.
3. Locked up so that no one can tamper with it.
4. In a secure area restricted to authorized personnel.

**Policy/Procedure:**

External chain of custody requirements will be observed for all samples received with a field chain of custody.

1. If requested by the client, an external chain of custody form will be initiated by the person packing the sample bottles for shipment to the client. If the bottles are delivered by an MSAI driver, the driver shall sign the form when relinquishing the bottles. Drivers must also sign chain of custody forms when picking up samples that require such documentation.
2. When samples arrive at the laboratory, Sample Administration will inspect the samples, receive them, and sign the external chain of custody form, if one is provided with the samples. If the sample was picked up by an MSAI driver, the driver must sign to relinquish custody of the sample to Sample Administration.
3. The completed external chain of custody forms will be filed in the group folder.
4. The original external chain of custody, a certified exact copy, or a carbonless copy will be returned to the client with the sample analysis reports.

Internal chain of custody documentation will be kept upon client request or for samples that are known to be involved in a legal dispute.

1. Sample Administration will enter the test code for "Internal Chain of Custody" in the LIMS, which will inform analysts of the need for chain of custody documentation.
2. Sample Administration will initiate an internal chain of custody form for each separate sample container at the time of log-in. The internal chain of custody forms will accompany the sample containers.
3. All changes of custody shall be documented on the form by both the relinquisher and the receiver. This includes exchanges between analysts within the same laboratory section.
4. If additional containers of the sample are created (such as an extract container for preparation for organic analysis), an additional form marked with the container type shall be created to accompany the new container.

After all analyses are completed, the internal chain of custody forms will be placed in the group folder to be forwarded to the client with the sample analysis reports.

Sample disposal usually takes place after the chain of custody forms are returned to the client. For that reason, the transfer

of samples from storage to disposal will be documented on a separate waste disposal report (See SOP-SA-105).

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## Facilities and Equipment

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### Facilities and Security

The laboratory's physical facilities are located in the Metro Business Park at 1645 and 1615 West 2200 South, Salt Lake City, Utah. The facility occupies approximately 13,000 square feet including laboratories, offices, a conference room, a data processing center, refrigerated and room-temperature storage areas, employee lunch room, and garage area. Mountain States Analytical is strategically located on a major freeway access and near the Salt Lake City International Airport.

The laboratory's air-handling systems have been specially designed and installed to protect sensitive instruments and prevent sample contamination. Positive pressure rooms house the gas chromatography, gas chromatography/mass spectrometry, and inductively coupled plasma spectrometry instruments. Separate negative pressure laboratories are used for general chemistry, metals digestions, and organic sample extraction. Separate refrigeration systems are used for volatile and nonvolatile sample storage. The main refrigerated storage area for samples is secured by an access and temperature alarm system. A separate locked storage refrigerator is used for samples requiring internal custody handling.

The laboratory is protected by a state-of-the-art security and alarm system designed to protect the integrity of both the physical facilities and our analytical data. The security system includes smoke detectors in all laboratories, door contacts on all outside doors, and passive infrared detectors along the hallways. A breach of any of these systems will trigger the alarm and notify on-site staff and the 24-hour surveillance company. The alarm system will also be activated if the temperature of the walk-in refrigerator used for sample storage falls outside EPA specifications.

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MSAI's security procedures ensure that only authorized laboratory personnel have access to client samples. All outside doors except the main entrances are kept locked, and the main entrances are monitored by a receptionist who registers visitors during business hours. Also, designated laboratory personnel must enter an access code to retrieve samples from or return samples to the walk-in refrigerator and data archival storage areas. In addition to providing security, this helps track custody of client samples through the laboratory and ensures restricted access to stored client data and documents.

The central Laboratory Information Management System (LIMS) runs on a Novell network consisting of a 486 PC Server with 1 GB of hard disk storage and 16 MB of RAM. Thirty-one PC workstations (486 or higher) are currently connected to the LIMS network. The multi-user system, written in the Clipper data base language, tracks all samples from receipt to final disposition and records results from laboratory instruments, generates analytical reports, invoices, management reports and electronic deliverables. The LIMS data base is used to facilitate the generation of data packages and quality control charts.

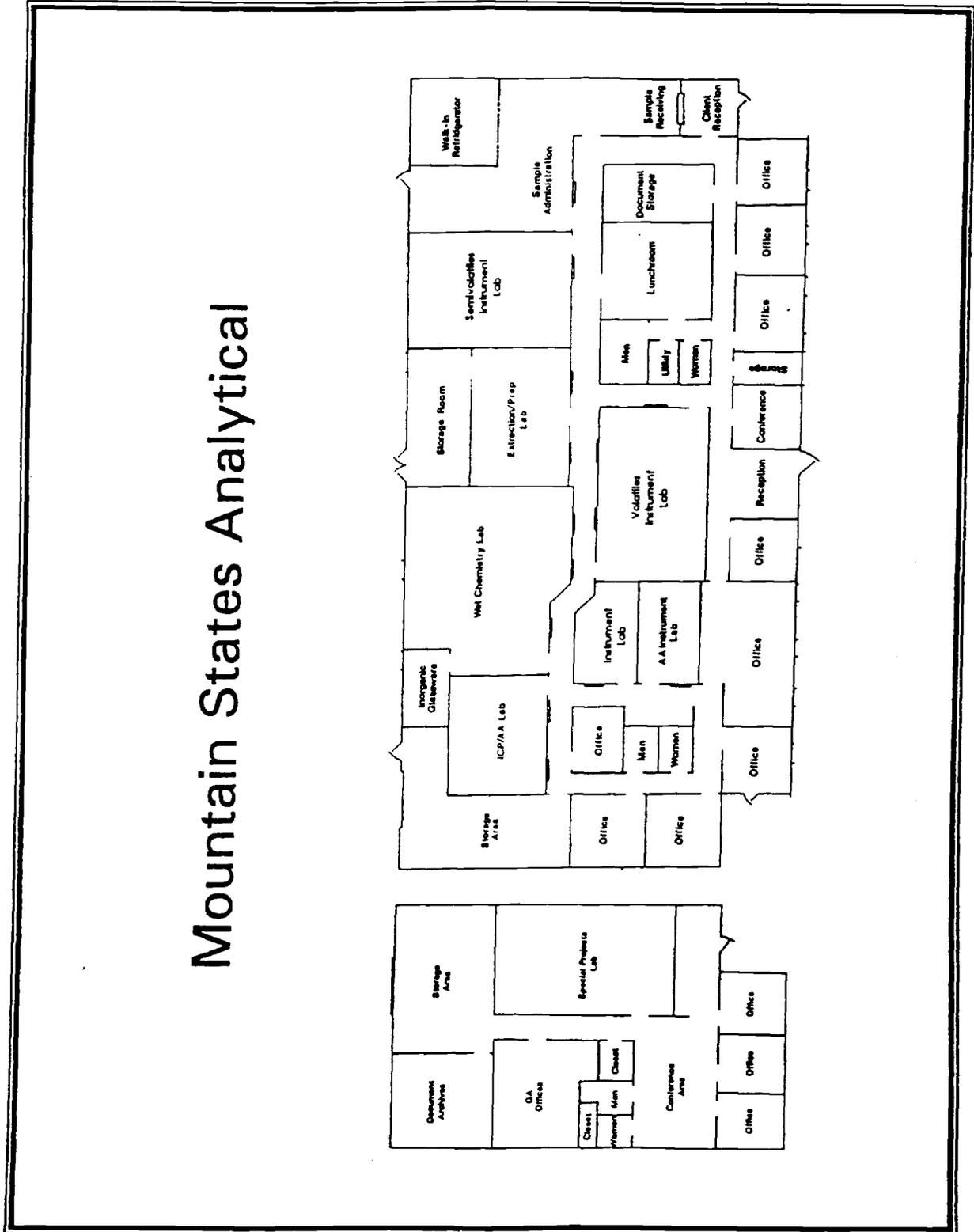
A new, graphical LIMS is being developed that utilizes the Oracle7 data base on a PC Server with 2 GB hard disk storage and 32 MB RAM. An upgrade to a Unix based Pentium Server is planned in the near future.

A Hewlett-Packard ChemServer has recently been installed to facilitate data collection, processing, control charting and data package generation for all Organic instrumentation in the laboratory. The hardware consists of an HP Model 735 Server running HPUX 9.05, VUE 3.0, Target 3.2 and Envision 3.2 from Thru-Put Systems. Three X\_Terminal stations and three Pentium PC workstations running Hummingbird emulation software are attached to the ChemServer.

Figure 8-1

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# Mountain States Analytical



289101

**Instruments and Equipment**

<b>Instrument</b>	<b>Units</b>	<b>Manufacturer/Model No.</b>
<b>Gas Chromatography</b>		
Gas Chromatograph with Autosampler: Includes electron capture detectors.	1	Hewlett-Packard Model 5890 GC Model 7673A AS
Gas Chromatograph with Autosampler: Includes electron capture detectors.	1	Hewlett-Packard Model 5890, Series II GC Model 7673A AS
Gas Chromatograph with Autosampler: Includes capillary capability with flame ionization detectors.	2	Hewlett-Packard Model 5890-II GC
Gas Chromatograph with Autosampler: Includes capillary capability and nitrogen/phosphorus detectors.	1	Hewlett-Packard Model 5890-II GC Model 7673A AS
Gas Chromatograph: Includes capillary capability with electro- conductivity and photoionization detectors.	1	Tracor Model 540
Gas Chromatograph: Purge & Trap with capillary capability with the following:	2	Hewlett-Packard Model 5890, Series II
1) tandem photoionization electroconductivity detector	1	OI Analytical, Model 4430/4420
2) tandem photoionization flame ionization detector	1	OI Analytical, Model 4430/4450
3) automatic Purge & Trap	2	Tekmar, Model LSC 2000
4) autosamplers for Purge & Trap	2	Archon, Model 5100A Tekmar, Model ALS 2016
ChemStation Data Processing System	5	Hewlett Packard 3365 Software on 486 or better computers
Chromatographic Integrator	1	Hewlett Packard Model 3393A

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Instrument	Units	Manufacturer/Model No.
<b>Gas Chromatography / Mass Spectrometry</b>		
Gas Chromatograph/Mass Spectrometer: Includes capillary and packed column injection ports with septum purge, quadrupole MSD with turbo pumps, capillary direct interfaces, and autosampler.	2	Hewlett-Packard Model 5970 MSD Model 5890 GC Model 7673A AS
Gas Chromatograph/Mass Spectrometer: Includes capillary and packed column injection ports with septum purge, MSD Quadrupole with turbo pumps, jet separator and capillary direct interfaces, and Purge & Trap interface. Equipped with:	2	Hewlett-Packard Model 5970/5890
(1) Automatic Purge & Trap	1	Tekmar, Model LSC 2000
(2) Automatic Purge & Trap	1	Tekmar, Model 3000
(3) Autosampler for Purge & Trap (16 Stations)	2	Tekmar, Model ALS 2016
(4) Automatic Sample Heater (16 Stations)	1	
GC/LCMS Data System: Includes Micro 24 CPU, 304 MB Disk Drive, 2 MB RAM, RTE Rev. F data handling software	2	Hewlett-Packard A-Series RTE, Rev. F
GC/LCMS Data System: Includes Micro 24 CPU, 150 MB Disk Drive, 2 MB RAM, RTE Rev. F data handling software	2	Hewlett-Packard A-Series RTE, Rev. F
<b>Supercritical Fluid Chromatography</b>		
Supercritical Fluid Chromatograph: with chemiluminescence detector, restrictor interface, and data system.	1	Lee Scientific, Model 600 SFC Thermedics Detection, Model 543
Supercritical Fluid Chromatograph: with mass spectrometric detector, restrictor interface, 10,000 psi pumping system, and data system	1	Lee Scientific, Model 600 SFC Finnigan INCOS 50 MS Data General Data System

289103

Instrument	Units	Manufacturer/Model No.
<b>Organics Data System:</b> UNIX File Server, TCP/IP, with operating system software  <b>Other hardware:</b> X Terminals PC-X Terminals	1   3 3	Hewlett-Packard Chem Server, UNIX, Model 735 (TCP/IP) with HPUX 9.05, VUE3.0, and Target 3.2 software H-P Envizex, 'a' Series Pentium based PC computers
<b>Ion Chromatography</b>		
Ion Chromatograph: Includes a conductivity detector and data system.	1	Dionex, Model DX500 Dionex, CD20 detector
<b>Infrared Spectrophotometer</b>		
Fourier Transform Infrared Spectrophotometer	1	Perkin Elmer, Model 283B
<b>Organic Sample Preparation Instruments and Equipment</b>		
Accelerated Solvent Extraction with programmable microprocessor controlled extraction capabilities. Includes 25 position sample and extract collection carousel	1	Dionex Model GP-40-1
Automated Soxhlet, 6 position, solvent extractor	1	Tecator, Soxtec 1043
Gel Permeation Chromatograph Equipped with a UV/vis Detector	1	Analytical Bio-Chemistry Laboratories GPC Model Auto Prep 1002-A Lee Scientific 501UV/vis Detector
Continuous liquid-liquid extraction system	10	Kontes
N-Evap nitrogen concentrator	1	Organomation, Model 115
<b>Atomic Absorption and Emission Spectrophotometry</b>		
Atomic Absorption Graphite Furnace Spectrophotometer: Includes direct injection furnace, multi-element Zeeman background correction, automatic sample dispenser, computer operating system, and color printer.	1	Varian SpectrAA 400Z IBM Computer Model PS/2 30286 Citizen Printer Model HSP-500

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Instrument	Units	Manufacturer/Model No.
<b>Atomic Absorption and Emission Spectrophotometry (Continued)</b>		
Atomic Absorption dedicated Graphite Furnace Spectrophotometer: Transverse furnace including AS-70 furnace autosampler, Zeeman background correction, and EDL dual lamp power supply	1	Perkin Elmer 4100ZL DEC 316SX computer Okidata printer
Atomic Absorption Spectrophotometer: Includes flame, cold vapor and hydride accessories with deuterium background correction, autosampler, computer and a printer	1	Thermo-Jarrel Ash Model 8000 AVA880 Hydride/Cold vapor generator AS150 Autosampler 486DX computer
Inductively Coupled Argon Plasma Atomic Emission Spectrometer: Simultaneous instrument includes 2 kW generator, crystal controlled at 27.12 MHz with autotuning, power stabilization, feedback loop, and direct coupling. Built-in peristaltic pump, cross flow nebulizer. 30 elements.	1	Thermo-Jarrel Ash ICAP 61E 486 computer printer
Atomic Absorption Spectrophotometer: Includes flame, hydride and cold vapor accessories.	1	Varian SpectrAA 20 VGA-76 vapor generation accessory Citizen Printer Model HP-500
<b>Radiochemistry Instrumentation</b>		
Alpha, Beta, Gamma Radiation Detector	2	Ludlum Model 3 Model 44-9 Probe
Alpha-Beta/Gamma Detector	1	Ludlum Model 2929 Model 43-10-1 Probe
<b>General Instrumentation and Equipment</b>		
TOC Analyzer: Equipped with purging and sealing unit	1	O. I. Corporation Model 700 Model 524
TOX Analyzer: Equipped with dual absorption modules	1	Mitsubishi Chemical Industries Model TOX-10
Ultraviolet Spectrophotometer	2	Milton Roy Company Spectronic 21DV

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<b>Instrument</b>	<b>Units</b>	<b>Manufacturer/Model No.</b>
<b>General Instrumentation and Equipment (Continued)</b>		
Turbidimeter	1	Hach Model 2100N
Ion Analyzer	2	Orion Model EA940
Conductivity/TDS	1	Orion Model 124
Conductivity Meter	1	Orion Model 160
Conductivity Meter	1	Yellow Springs Inst, Model 33
Closed-Cup Pensky-Martin Flashpoint Apparatus	1	Boekel Flashpoint Tester Model 152800
Closed-Cup Flashpoint Apparatus, Pensky-Martin	1	Kohler Instrument Co. Model 16200
Bomb Calorimeter	1	Parr Model 1341 EB
Midi Cyanide Distillation apparatus	1	Andrews Glass 110-10-R
Zero Headspace Extractor	2	Associated Design Model 3740
Zero Headspace Extractor	24	Analytical Testing & Consulting Services, Inc.
Toxicity Rotator (12 sample capacity), non-volatile	1	fn-house, SW-846 design
Toxicity Rotator (28 sample capacity), volatile	1	In-house, SW-846 design
Ultrasonic Probe Extraction System	2	Heat Systems Model XL2020 (1) Model 550 (1)
Ultrasonic Bath Extractor	1	Fisher Scientific Model B-2200 R-1
Centrifuge	2	Damon/IEC Division Model HN-SII
Top Loading Electronic Balance	1	Fisher Model XL300
Top Loading Electronic Balance	1	Denver Instrument Co. Model 400, XE Series
Top Loading Electronic Balance	1	Mettler Model PC4000
Top Loading Electronic Balance with filter chamber	1	Mettler Toledo, Model AB104
Top Loading Electronic Balance	1	Fisher Model XD-800

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<b>Instrument</b>	<b>Units</b>	<b>Manufacturer/Model No.</b>
<b>General Instrumentation and Equipment (Continued)</b>		
Top Loading Electronic Balance	1	Denver Instrument Co. Model XL-300
Electronic Balance	1	Fisher Model 200G
Electronic Balance	2	Mettler H31AR
BOD Incubator	2	Isotemp/Fisher Model 146
Oven, Drying	3	Isotemp/Fisher Series 200
Autoclave with dryer	1	Napco Model 8000 DSE
Muffle Furnace	1	Lindberg Model 58114
Pyro-Multi-Magnestir	1	Lab-Line Instrument Model 1268
Thermolyne Hot Plate	2	Fisher Type 2200
Water Bath	2	Precision Model 184
Water Bath	2	Precision Model 186
Lab Refrigerator (43 cubic feet)	4	Isotemp/Fisher Model 348G
Refrigerator (14 cubic feet)	1	Kenmore Model 106
Refrigerator/Freezer (4.8 cubic feet)	2	Marvel Industries, Model 61AF
Refrigerator/Freezer Flammable Materials (13.1 cubic feet)	2	Fisher, Precision Model 813
Refrigerator/Freezer (9 cubic feet)	1	Kelvinator
Freezer (17.5 cubic feet)	1	Fisher Isotemp Model 425F
Refrigerator/Freezer (4 cubic feet)	1	Goldstar, Model GR131OW
Walk-in Cooler: 3200 cubic feet. Galvanized steel with air defrost timer and room temperature control to $4\pm 2^{\circ}\text{C}$ .	1	Hussman
<b>Laboratory Information Management System Hardware (Main System)</b>		
Network 486 PC Server with 1 GB of hard disk storage and 16 MB of RAM, operating with Novell Netware	1	486 PC
486 (or higher) PC workstations	31	Various manufacturers

<u>Instrument</u>	<u>Units</u>	<u>Manufacturer/Model No.</u>
<b>Field Sampling Instrumentation and Equipment</b>		
Sigma Programmable Portable Sampler with integral flowmeter	1	Sigma Streamline 800SL Flowmeter #1378
Portable pH/Temperature Meter	1	Orion Model 230A
Gas Detector ("sniffer") with capability to detect O <sub>2</sub> , H <sub>2</sub> S, TOX, and LEL	1	Dynamation Combo 434
Core Soil Sampler	1	AMS
Soil Probe	1	AMS

The preceding list includes the major equipment and instruments that demonstrate specific capabilities. The laboratory is also equipped with flammable solvent and acid storage cabinets, approximately 40 linear feet of ventilated hood space, 120 square-foot canopy hood, several types of extraction/distillation devices including glassware and heating mantles, KD evaporative concentrators, miscellaneous glassware and chemicals, two tri-bed Culligan deionized water systems for delivery of Type II reagent water (ASTM D1193-77) for laboratory applications, and other equipment required for laboratory operations.

#### **Vehicle Fleet**

Sample pick-up service is offered to all clients within reasonable driving distance from the laboratory. Currently, services are available for Salt Lake City, Ogden, Provo/Orem, the surrounding vicinities of these cities, and southern Idaho. The laboratory also has a four-wheel drive truck for field operations.

Calibration Procedures and Frequency

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Procedures for initial calibration and continuing calibration verification are in place for all instruments within the laboratory. The calibrations generally involve checking instrument response to standards for each target analyte. The source and accuracy of standards used for this purpose are integral to obtaining the best quality data. Standards used at Mountain States Analytical, Inc. (MSAI) are purchased from commercial supply houses either as neat compounds or as solutions with certified concentrations. The accuracy and quality of these purchased standards are verified through documentation provided by these commercial sources. Most solutions and all neat materials require subsequent dilution to an appropriate working range. All dilutions performed are documented and the resulting solution is checked by obtaining the instrument response of the new solution and comparing with the response to the solution currently in use. Any discrepancies between the responses are investigated and resolved before the new solution is used. Each standard is assigned a code which allows traceability to the original components. The standard container is marked with the code, name of solution, concentration, date prepared, expiration date, and the initials of the preparer. Shelf-life and storage conditions for standards are included in the standard operating procedures for each analytical method. Old standards are replaced before their expiration date.

Each instrument is calibrated at the analytical method prescribed frequency using one or more concentrations of the standard solution. As analysis proceeds, the calibration is checked for any unacceptable change in instrument response. If the calibration check verifies the initial response, the analysis proceeds. If the calibration check indicates that

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a significant change in instrument response has occurred, then minor corrective maintenance and reverification are required prior to proceeding with the analysis. If minor corrective maintenance fails to remedy the calibration noncompliance, then a new calibration is initiated. Necessary maintenance and repair are performed prior to the recalibration.

Calibration records are usually kept in the form of raw data with the other instrument print-outs. In cases where no data system is used, calibration data are manually recorded in notebooks. Any maintenance or repair is also recorded in a notebook. The information recorded, either in the notebooks or on the instrument print-out, includes the date, instrument ID, employee name and identification number, and concentration or code number of the standard.

The frequency of calibration and calibration verification, number of calibration points used, and acceptance criteria for each of the instruments to be used, are listed on Table 9-1. In addition to checking the instrument response to target compounds, the GC/MS instruments are checked to ensure that standard mass spectral abundance criteria are met. Prior to each calibration, instruments being used for volatile compound analysis are tuned using bromofluorobenzene (BFB) and instruments being used for semivolatile analysis are tuned using decafluorotriphenylphosphine (DFTPP). The key ions and their abundance criteria are listed in Table 9-2.

289110

Table 9-1

Calibration Criteria					
Instrument • Method	Calibration			CCV	
	Fre- quency	# Calib. Points	Acceptance Criteria	Fre- quency	Acceptance Criteria
GC/MS Volatiles •524.2	After CCV fails	5	RF for SPCC's ≥0.300 except for bromoform ≥0.25; Max %RSD ≤ 20%	Every 8 hours	RF for SPCC's ≥0.300 except for bromoform ≥0.25; Max %D ≤ 30%
GC/MS Volatiles •624	After CCV fails	5	RF for SPCC's ≥0.300 except for bromoform ≥0.25; Max %RSD ≤ 35%	Every 24 hours	Check standard within limits
GC/MS Volatiles •8240/8260	After CCV fails	5	RF for SPCC's ≥0.300 except for bromoform ≥0.25; Max %RSD for CCC ≤ 30%	Every 12 hours	RF for SPCC's ≥0.300 except for bromoform ≥0.25; Max %D for CCC ≤ 25%
GC/MS Volatiles •CLP	After CCV fails	5	RF for SPCC's ≥0.300 except for bromoform ≥0.25; Max %RSD for CCC ≤ 30%	Every 12 hours	RF for SPCC's ≥0.300 except for bromoform ≥0.25; Max %D for CCC ≤ 25%

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Table 9-1 (Continued)

Calibration Criteria					
Instrument • Method	Calibration			CCV	
	Fre- quency	# Calib. Points	Acceptance Criteria	Fre- quency	Acceptance Criteria
GC/MS Semivolatiles •625	After CCV fails	3	RF for SPCC's ≥0.050; Max %RSD for CCC ≤ 35%	Every 24 hours	%D ≤ 20%
GC/MS Semivolatiles •8270	After CCV fails	5	RF for SPCC's ≥0.050; Max %RSD for CCC ≤ 30%	Every 12 hours	RF for SPCC's ≥ 0.050; Max %D for CCC ≤ 30%
GC/MS Semivolatiles •CLP	After CCV fails	5	RF for SPCC's ≥0.050; Max %RSD for CCC ≤ 30%	Every 12 hours	RF for SPCC's ≥ 0.050; Max %D for CCC ≤ 30%
GC VOA Halocarbons and Aromatics •502.2	After CCV fails	5	%RSD of ≤20%, otherwise use calibration curve	Every 12 hrs or every 10 samples	%D ≤15%
GC VOA Halocarbons and Aromatics •601/602	After CCV fails	3	%RSD of ≤20%, otherwise use calibration curve	Every 12 hrs or every 10 samples	%D ≤15%
GC VOA Halocarbons and Aromatics •8010/8020	After CCV fails	5	%RSD of ≤20%, otherwise use calibration curve	Every 12 hrs or every 10 samples	%D ≤15%

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Table 9-1 (Continued)

Calibration Criteria*					
Instrument • Method	Calibration			CCV	
	Fre- quency	# Calib. Points	Acceptance Criteria	Fre- quency	Acceptance Criteria
GC Pesticides •508	Each new run or after CCV fails	3 Minimum  5 Recom- ended	%RSD of $\leq 20\%$ , otherwise use calibration curve	Every 10 samples	%D $\leq 20\%$
GC Pesticides •608	Each new run or after CCV fails	3 Minimum	%RSD of $\leq 10$ , otherwise use calibration curve	Every 10 samples	%D $\leq 15\%$
GC Pesticides •8080	Each new run or after CCV fails	5	%RSD of $\leq 20\%$ , otherwise use calibration curve	Every 10 samples	%D $\leq 15\%$
GC Pesticides •CLP	Each new run or after CCV fails	3	%RSD of $\leq 20\%$ , otherwise use calibration curve	Every 10 samples	%D $\leq 25\%$
ICP •200.7	Each new run	2 <sup>1</sup>	ICV within $\pm 5\%$ of true value	Every 10 samples	CCV within $\pm 5\%$ of true value
ICP •6010	Each new run	2 <sup>1</sup>	ICV within $\pm 10\%$ of true value	Every 10 samples	CCV within $\pm 10\%$ of true value

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Table 9-1 (Continued)

Calibration Criteria*					
Instrument • Method	Calibration			CCV	
	Fre- quency	# Calib. Points	Acceptance Criteria	Fre- quency	Acceptance Criteria
ICP •CLP	Each new run	2 <sup>1</sup>	ICV within ±10% of true value	Every 10 samples	CCV within ±10% of true value
CVAA •245.1/245.5	Each new run	6 <sup>1</sup>	ICV within ±10% of true value	Every 10 samples	CCV within ±10% of true value
CVAA •7470/7471	Each new run	6 <sup>1</sup>	ICV within ±10% of true value	Every 10 samples	CCV within ±20% of true value
CVAA •CLP	Each new run	5 <sup>1</sup>	ICV within ±20% of true value	Every 10 samples	CCV within ±20% of true value
GFAA •200.9	Each new run	4 <sup>1</sup>	ICV within ±10% of true value	Every 10 samples	CCV within ±10% of true value
GFAA •200 Series	Each new run	4 <sup>1</sup>	ICV within ±10% of true value	Every 10 samples	CCV within ±10% of true value
GFAA •7000 Series	Each new run	4 <sup>1</sup>	ICV within ±10% of true value	Every 10 samples	CCV within ±20% of true value
GFAA •CLP	Each new run	4 <sup>1</sup>	ICV within ±10% of true value	Every 10 samples	CCV within ±10% of true value
FAA •200 Series	Each new run	4 <sup>1</sup>	ICV within ±10% of true value	Every 10 samples	CCV within ±10% of true value

289114

Table 9-1 (Continued)

Calibration Criteria*					
Instrument • Method	Calibration			CCV	
	Fre- quency	# Calib. Points	Acceptance Criteria	Fre- quency	Acceptance Criteria
FAA •7000 Series	Each new run	4 <sup>1</sup>	ICV within ±10% of true value	Every 10 samples	CCV within ±20% of true value
FAA •CLP	Each new run	4 <sup>1</sup>	ICV within ±10% of true value	Every 10 samples	CCV within ±10% of true value
HAA •206.3/270.3	Each new run	4 <sup>1</sup>	ICV within ±10% of true value	Every 10 samples	CCV within ±10% of true value
HAA •7061/7741	Each new run	4 <sup>1</sup>	ICV within ±10% of true value	Every 10 samples	CCV within ±20% of true value
Infrared Spectro- photometer •418.1	When CCV fails	5	Correlation coefficient ≥0.995	Every 10 samples	CCV within ±10% of true value
TOC Analyzer •415.1	Daily	2	ICV within ±10% of true value	Every 10 samples	CCV within ±10% of true value
TOC Analyzer •9060	Daily	2	ICV within ±10% of true value	Every 10 samples	CCV within ±10% of true value
TOX Analyzer •9020B	Each new run	1	ICV within ±10% of true value	Every 10 samples	CCV within ±15% of true value

289115

Table 9-1 (Continued)

Calibration Criteria*					
Instrument • Method	Calibration			CCV	
	Fre- quency	# Calib. Points	Acceptance Criteria	Fre- quency	Acceptance Criteria
Ion Chromatograph •300.0	When CCV fails	6	ICV within ±10% of true value	Every 20 samples	CCV within ±10% of true value
Balances	Daily	2 or 3	Within ±0.5%	N.A.	N.A.

Note 1      The number of calibration points for metal analyses includes a calibration blank.

\*Abbreviations to Table 9-1

- CCV:            Continuing Calibration Verification
- ICV:            Initial Calibration Verification
- SPCC's:        System Performance Check Compounds
- CCC:            Calibration Check Compounds
- RF:             Response Factor
- %RSD:        Percent Relative Standard Deviation
- %D:            Percent Difference
- C-cal:         Continuing Calibration
- ICP:            Inductively Coupled Plasma Spectrophotometer
- CVAA:         Cold Vapor Atomic Absorption Spectrophotometer
- GFAA:         Graphite Furnace Atomic Absorption Spectrophotometer
- FAA:            Flame Atomic Absorption Spectrophotometer
- HAA:            Hydride Atomic Absorption Spectrophotometer

Table 9-2

289116

Key Ions and Their Abundance Criteria	
Mass	Ion Abundance Criteria
<b>BFB Key Ion Abundance Criteria:</b>	
50	15% to 40% of mass 95 (CLP: 8% to 40%)
75	30% to 60% of mass 95 (CLP: 30% to 66%)
95	base peak, 100% relative abundance
96	5% to 9% of mass 95
173	less than 2% of mass 174
174	greater than 50% of mass 95 (CLP: 50% to 120%)
175	5% to 9% of mass 174 (CLP: 4% to 9%)
176	greater than 95% but less than 101% of mass 174 (CLP: >93% but <101%)
177	5% to 9% of mass 176
<b>DTFPP Key Ion Abundance Criteria:</b>	
51	30% to 60% of mass 198 (CLP: 30% to 80%)
68	less than 2% of mass 69
69	mass 69 relative abundance
70	less than 2% of mass 69
127	40% to 60% of mass 198 (CLP: 25% to 75%)
197	less than 1% of mass 198
198	base peak, 100% relative abundance
199	5% to 9% of mass 198
275	10% to 30% of mass 198
365	greater than 1% of mass 198 (CLP: >0.75%)
441	present but less than mass 443
442	greater than 40% of mass 198 (CLP: 40% to 110%)
443	17% to 23% of mass 442 (CLP: 15% to 24%)

CLP refers to specifications in the Statement of Work, OLM03.1

## Analytical Procedures

289117

The analytical procedures to be used for the preparation and analysis of water, sediment, and soil for organic and inorganic analytes are those described in USEPA methods publications (200 Series, 500 Series, and 600 Series), the USEPA SW-846, 3rd Edition, Update IIB, January 1995, CLP (SOW ILM04.0 and SOW OLM03.0), and *Standard Methods for the Examination of Water and Wastewater*. Copies of the standard references and the in-house analytical procedures are located in the laboratory and available for use by analysts. Copies of analytical methods are available upon request.

Tables 10-1 through 10-3 list the methods for which Mountain States Analytical, Inc. maintains certification from its resident state of Utah, as well as from several other states and accreditation programs. Table 10-4 lists Contract Laboratory Program (CLP) methods. Tables 10-5 through 10-20 list method detection limits (MDL) and limits of quantitation (LOQ), or contract required quantitation limits (CRQL) and contract required detection limits (CRDL) for CLP tests.

Table 10-1 Clean Water Act Methods 289118

METHOD*	DESCRIPTION
	<b>Metals Methods</b>
200.7	Aluminum, ICP, AES
202.1	Aluminum, AA, Direct Aspiration
200.7	Antimony, ICP, AES
204.1	Antimony, AA, Direct Aspiration
204.2	Antimony, AA, Furnace
200.7	Arsenic, ICP, AES
206.2	Arsenic, AA, Furnace
206.3	Arsenic, AA Hydride
200.7	Barium, ICP, AES
208.1	Barium, AA, Direct Aspiration
200.7	Beryllium, ICP, AES
210.1	Beryllium, AA, Direct Aspiration
210.2	Beryllium, AA, Furnace
200.7	Cadmium, ICP, AES
213.1	Cadmium, AA, Direct Aspiration
213.2	Cadmium, AA, Furnace
200.7	Chromium, ICP, AES
218.1	Chromium, AA, Direct Aspiration
218.2	Chromium, AA, Furnace
200.7	Cobalt, ICP, AES
219.1	Cobalt, AA, Direct Aspiration
219.2	Cobalt, AA, Furnace
200.7	Copper, ICP, AES
220.1	Copper, AA, Direct Aspiration
220.2	Copper, AA, Furnace
200.7	Iron, ICP, AES
236.1	Iron, AA, Direct Aspiration
200.7	Lead, ICP, AES
239.1	Lead, AA, Direct Aspiration
239.2	Lead, Furnace
200.7	Manganese, ICP, AES
243.1	Manganese, AA, Direct Aspiration
245.1	Mercury, Cold Vapor, Manual
200.7	Molybdenum, ICP, AES
246.1	Molybdenum, AA, Direct Aspiration
246.2	Molybdenum, AA, Furnace
200.7	Nickel, ICP, AES
249.1	Nickel, AA Direct Aspiration
249.2	Nickel, AA, Furnace
200.7	Selenium, ICP, AES

METHOD*	DESCRIPTION
270.2	Selenium, AA, Furnace
270.3	Selenium, AA, Hydride
200.7	Silver, ICP, AES
272.1	Silver, AA, Direct Aspiration
272.2	Silver, AA, Furnace
200.7	Thallium, ICP, AES
279.1	Thallium, AA, Direct Aspiration
279.2	Thallium, AA, Furnace
282.1	Tin, AA, Direct Aspiration
200.7	Vanadium, ICP, AES
286.1	Vanadium, AA, Direct Aspiration
286.2	Vanadium, AA, Furnace
200.7	Zinc, ICP, AES
289.1	Zinc, AA, Direct Aspiration
	<b>Mineral Methods</b>
305.1	Acidity, Titrimetric
310.1	Alkalinity, Titrimetric(pH 4.5)
200.7	Boron, ICP, AES
200.7	Calcium, ICP, AES
215.1	Calcium, AA, Direct Aspiration
325.3	Chloride, Titrimetr, Mercuric Nitrate
340.2	Fluoride, Potentiometric, Ion Selective Electrode with Bellack Distillation
130.2	Hardness, Total (mg/L as CaCO3) Titrimetric, EDTA
200.7	Magnesium, ICP, AES
242.1	Magnesium, AA, Direct Aspiration
150.1	pH, Electrometric
200.7	Potassium, ICP, AES
258.1	Potassium, AA, Direct Aspiration
200.7	Sodium, ICP, AES
273.1	Sodium, AA, Direct Aspiration
120.1	Specific Conductance
376.1	Sulfide, Titrimetric, Iodine
	<b>Nutrient Methods</b>
350.2	Ammonia, Titrimetric, Potentiometric, Distillation Procedure

28949

METHOD <sup>a</sup>	DESCRIPTION
	<b>Nutrient Methods (Continued)</b>
353.3	Nitrate/Nitrite, Colorimetric, Manual Cadmium Reduction
354.1	Nitrite, Spectrophotometric
365.3	Orthophosphate
365.3	Phosphorus, All Forms, Colorimetric, Ascorbic Acid, Two Reagents
375.4	Sulfate, Turbidimetric
351.3	Total Kjeldahl Nitrogen (TKN)
	<b>Residue Methods</b>
160.1	Residue Filterable (TDS)
160.2	Residue Nonfilterable (TSS)
160.5	Residue Settleable Matter, Volumetric
160.3	Residue Total, Gravimetric, Dried at 103 - 105 °C
160.4	Residue Volatile, Gravimetric, Ignition at 550 °C
	<b>Demand Methods</b>
405.1	BOD (5 day, 20 °C)
SM 5210B <sup>b</sup>	Carbonaceous BOD
410.4	COD, Colorimetric, Automated; Manual
360.1	Dissolved Oxygen, Membrane Electrode
415.1	TOC, Combustion or Oxidation

METHOD <sup>a</sup>	DESCRIPTION
	<b>Organic Methods</b>
601	Purgeable Halocarbons, GC/ELCD(ECD)
602	Purgeable Aromatic, GC/PID
604	Phenols, GC/FID(ECD after Derivatization)
608	Organochlor Pesticides, GC/ECD
608	PCBs, GC/ECD
624	Purgeables, P&T/GC/MS
625	Base/Neutrals & Acids, GC/MS
	<b>Miscellaneous Methods</b>
330.4	Chlorine, Total Residual
110.2	Color, Colorimetric, Platinum-Cobalt
335.2	Cyanide, Titrimetric, Spectrophotometric
335.1	Cyanide, Amenable to Chlorination
413.1	Oil and Grease, Gravimetric, Separatory Funnel Extraction, Total Recoverable
420.1	Phenols, Spectrophotometric, Manual 4-AAP Total Recoverable with Distillation
180.1	Turbidity, Nephelometric

These footnotes apply to Table 10-1 and Table 10-2.

<sup>a</sup> All methods are EPA methods, except where noted.

<sup>b</sup> "SM" represents *Standard Methods for the Examination of Water and Wastewater*.

Table 10-2

Drinking Water Methods

289120

METHOD*	DESCRIPTION
	<b>Metals Methods</b>
200.7	Aluminum, ICP
200.9	Antimony, GFAA
200.7A	Arsenic, ICP
206.2	Arsenic, GFAA
206.3	Arsenic, AA, Hydride
200.7	Barium, ICP
208.1	Barium, AA, Direct Aspiration
200.7	Beryllium, ICP
200.9	Beryllium, GFAA
200.7	Cadmium, ICP
213.2	Cadmium, GFAA
200.7	Chromium, ICP
218.2	Chromium, GFAA
200.7	Copper, ICP
200.9	Copper, GFAA
200.7	Iron, ICP
236.1	Iron, AA, Direct Aspiration
200.9	Lead, GFAA
200.7	Manganese, ICP
243.1	Manganese, AA, Direct Aspiration
245.1	Mercury, AA Cold Vapor
200.7	Nickel, ICP
200.9	Nickel, GFAA
270.2	Selenium, GFAA
200.7	Silver, ICP
200.9	Silver, GFAA
200.9	Thallium, GFAA
200.7	Zinc, ICP
289.1	Zinc, AA, Direct Aspiration
	<b>Minerals Methods</b>
310.1	Alkalinity-Titrimetric (pH 4.5)
200.7	Calcium, ICP
215.1	Calcium, AA, Direct Aspiration
215.2	Calcium, Titrimetric, EDTA
300.0	Chloride, IC
120.1	Conductivity, Spec. Conductance
300.0A	Orthophosphate, IC
365.3	Orthophosphate, Colorimetric, ascorbic acid, 2 reagent

METHOD*	DESCRIPTION
	<b>Minerals Methods (Cont.)</b>
200.7	Sodium, ICP
273.1	Sodium, AA, Direct Aspiration
	<b>Nutrient Methods</b>
300.0	Fluoride, IC
340.2	Fluoride, Potentiometric, Ion Selective Electrode
300.0A	Nitrate, IC
353.3	Nitrate, colorimetr, manl, Cd-red.
300.0A	Nitrate/Nitrite, IC
353.3	Nitrate/Nitrite, Colorimetric, manual cadmium reduction
300.0A	Nitrite, IC
354.1	Nitrite, Spectrophotometric
375.4	Sulfate, Turbidimetric
	<b>Organic Methods</b>
502.2	Total THMs, GC/ELCD/PID
502.2	VOCs, GC/ELCD/PID
504	EDB/DBCP, GC/ECD
507	Nitr/Phos Pesticides, GC/NPD
508	Chlorinated Pesticides, GC/ECD
508	PCBs, GC/ECD
508A	PCBs (screen), perchlorination
515.1	Chlorophenoxy Herb., GC/ECD
524.2	Total THMs, GC/MS
524.2	VOCs, GC/MS
	<b>Miscellaneous Methods</b>
110.2	Color, Colorimetric, Platinum-Cobalt
	Corrosivity/Langlier Index
335.2	Cyanide, Total, Titrimetr., Spectr.
150.1	pH, Electrometric
160.1	Total Dissolved Solids (TDS)
180.1	Turbidity, Nephelometric
SM 214A <sup>b</sup>	Turbidity, Nephelometric
SM 4500-Cl-F <sup>b</sup>	Chlorine, Residual

Table 10-3 RCRA (SW-846) Methods

289121

METHOD	DESCRIPTION
	<b>Metals Methods</b>
6010A	Aluminum, ICP
7020	Aluminum, AA, Direct Aspiration
6010A	Antimony, ICP
7040	Antimony, AA, Direct Aspiration
7041	Antimony, AA, Furnace Technique
6010A	Arsenic, ICP
7060	Arsenic, AA, Furnace Technique
7061A	Arsenic, Hydride
6010A	Barium, ICP
7080	Barium, AA, Direct Aspiration
7081	Barium, AA, Furnace Technique
6010A	Beryllium, ICP
7090	Beryllium, AA, Direct Aspiration
7091	Beryllium, AA, Furnace Technique
6010A	Cadmium, ICP
7130	Cadmium, AA, Direct Aspiration
7131	Cadmium, AA, Furnace Technique
6010A	Chromium, ICP
7190	Chromium, AA, Direct Aspiration
7191	Chromium, AA, Furnace Technique
7196A	Chromium, Hexavalent
6010A	Cobalt, ICP
7200	Cobalt, AA, Direct Aspiration
7201	Cobalt, AA, Furnace Technique
6010A	Copper, ICP
7210	Copper, AA, Direct Aspiration
7211	Copper, AA, Furnace Technique
6010A	Iron, ICP
7380	Iron, AA, Direct Aspiration
6010A	Lead, ICP
7420	Lead, AA, Direct Aspiration
7421	Lead, AA, Furnace Technique
6010A	Lithium, ICP
6010A	Manganese, ICP
7460	Manganese, AA, Direct Aspiration
7470	Mercury, Manual Cold-Vapor, Technique
7471	Mercury, Manual Cold-Vapor Technique
6010A	Molybdenum, ICP

METHOD	DESCRIPTION
7480	Molybdenum, AA, Direct Aspiration
7481	Molybdenum, AA, Furnace Technique
6010A	Nickel, ICP
7520	Nickel, AA, Direct Aspiration
6010A	Selenium, ICP
7740	Selenium, AA, Furnace Technique
7741	Selenium, AA, Gaseous Hydride
6010A	Silver, ICP
7760A	Silver, AA, Direct Aspiration
7761	Silver, AA, Furnace Technique
7780	Strontium, AA, Direct Aspiration
6010A	Thallium, ICP
7840	Thallium, AA, Direct Aspiration
7841	Thallium, AA, Furnace Technique
7870	Tin, AA, Direct Aspiration
6010A	Vanadium, ICP
7910	Vanadium, AA Direct Aspiration
7911	Vanadium, AA, Furnace Technique
6010A	Zinc, ICP
7950	Zinc, AA, Direct Aspiration
	<b>Minerals</b>
6010	Boron, ICP
6010A	Calcium, ICP
7140	Calcium, AA, Direct Aspiration
6010A	Magnesium, ICP
7450	Magnesium, AA, Direct Aspiration
6010A	Phosphorus, ICP
6010A	Potassium, ICP
7610	Potassium, AA, Direct Aspiration
6010A	Sodium, ICP
7770	Sodium, AA, Direct Aspiration
	<b>Organic Methods</b>
8020	Aromatic Volatile Organics
8150A	Chlorinated Herbicides
8010A	Halogenated Volatile Organics
8011	EDB & DBCP
8015A	Nonhalogen Volatile Organics
8080	Organochlorine Pesticides

METHOD	DESCRIPTION
	<b>Organic Methods (Continued)</b>
8080	PCB
8040A	Phenols, GC
8141	Organophosphorus Pesticides, Capillary Column
8270A	Semivolatiles, GC/MS
8240A	Volatiles, GC/MS
8260	Volatiles, GC/MS, Capillary Column
8031	Volatiles, Halogenated, GC/ELCD/PID
	<b>Miscellaneous Methods</b>
9081	Cation Exchange of Soils
9252	Chloride (Titrimetric, Mercuric Nitrate)
9010A	Cyanide Total/Amenable

METHOD	DESCRIPTION
1010	Ignitability
9200	Nitrate
9070	Oil & Grease, Gravimetric, Separatory Funnel Extraction
9095	Paint Filter Liquid Test
9040	pH, Electrometric Measurement
9045C	pH, Soil and Waste
9065	Phenolics, Spectrophotometric, Manual 4-AAP (Distillation)
7.3	Reactivity, Cyanide (Sect. 7.3.3)
7.3	Reactivity, Sulfide (Sect. 7.3.4)
9050	Specific Conductance
9038	Sulfates (Turbidimetric)
9030A	Sulfides
1311	TCLP, for Metals, Volatiles, & Semivolatiles
9060	Total Organic Carbon
9020A	Total Organic Halides

Table 10-4 EPA Contract Laboratory Program (CLP) Methods

289123

METHOD	DESCRIPTION
	<i>Inorganics Methods (ILM04.0)</i>
200.7 CLP-M	Aluminum, ICP
204.2 CLP-M	Antimony, AA, Furnace Technique
200.7 CLP-M	Arsenic, ICP
206.2 CLP-M	Arsenic, AA, Furnace Technique
200.7 CLP-M	Barium, ICP
200.7 CLP-M	Beryllium, ICP
200.7 CLP-M	Cadmium, ICP
213.2 CLP-M	Cadmium, AA, Furnace Technique
200.7 CLP-M	Calcium, ICP
200.7 CLP-M	Chromium, ICP
218.2 CLP-M	Chromium, AA, Furnace Technique
200.7 CLP-M	Cobalt, ICP
200.7 CLP-M	Copper, ICP
200.7 CLP-M	Iron, ICP
200.7 CLP-M	Lead, ICP
239.2 CLP-M	Lead, AA, Furnace Technique
200.7 CLP-M	Magnesium, ICP
200.7 CLP-M	Manganese, ICP
245.1 CLP-M	Mercury, Manual Cold-Vapor, Technique, Water
245.5 CLP-M	Mercury, Manual Cold-Vapor, Technique, Soil/Sediment
200.7 CLP-M	Nickel, ICP
200.7 CLP-M	Selenium, ICP
270.2 CLP-M	Selenium, AA, Furnace Technique
200.7 CLP-M	Silver, ICP
200.7 CLP-M	Sodium, ICP
200.7 CLP-M	Thallium, ICP
279.2 CLP-M	Thallium, AA, Furnace Technique
200.7 CLP-M	Vanadium, ICP
200.7 CLP-M	Zinc, ICP
335.2 CLP-M	Cyanide, Total, Water
335.2 CLP-M	Cyanide, Total, Soil/Sediment

METHOD	DESCRIPTION
	<i>Organics Methods (OLM03.1)</i>
VOA	Volatiles, GC/MS
SVOA	Semivolatiles, GC/MS
PEST/ARO	Pesticides/Aroclors, GC

Table 10-5

289124

Volatile Priority Pollutant Compound List (GC/MS)				
Compound	LOQ		MDL	
	water (ug/l)	soil (ug/kg)	water (ug/l)	soil (ug/kg)
Chloromethane	10	10	1	1
Bromomethane	10	10	1	1
Vinyl chloride	10	10	1	1
Chloroethane	10	10	6	1
Acrolein	100	100	5	5
Acrylonitrile	50	50	5	5
Methylene chloride	5	5	2	1
Trichlorofluoromethane	5	5	1	1
1,1-Dichloroethene	5	5	1	1
1,1-Dichloroethane	5	5	1	1
trans-1,2-Dichloroethene	5	5	1	1
Chloroform	5	5	1	1
1,2-Dichloroethane	5	5	1	1
1,1,1-Trichloroethane	5	5	1	1
Carbon tetrachloride	5	5	1	1
Bromodichloromethane	5	5	1	1
1,1,2,2-Tetrachloroethane	5	5	1	1
1,2-Dichloropropane	5	5	1	1
trans-1,3-Dichloropropene	5	5	1	1
Trichloroethene	5	5	1	1
Dibromochloromethane	5	5	1	1
1,1,2-Trichloroethane	5	5	1	1
Benzene	5	5	1	1
cis-1,3-Dichloropropene	5	5	1	1
2-Chloroethylvinyl ether	20	20	8	1
Bromoform	5	5	1	1
Tetrachloroethene	5	5	1	1

Table 10-5 (Continued)

289125

Volatile Priority Pollutant Compound List (GC/MS)				
Compound	LOQ		MDL	
	water (ug/l)	soil (ug/kg)	water (ug/l)	soil (ug/kg)
Toluene	5	5	1	1
Chlorobenzene	5	5	1	1
Ethylbenzene	5	5	1	1
Xylene (total)	5	5	2	1
Xylene (ortho)	5	5	1	1

\*Specific quantitation limits are highly matrix dependant. The quantitation limits listed herein are provided for guidance and may not always be achievable.

Quantitation limits listed for soil/sediment are based on wet weight.  
Quantitation limits calculated on a dry weight basis will be higher.

LOQ is defined as "Limit of Quantitation."  
MDL is defined as "Method Detection Limit."

289126

Table 10-6

Appendix IX Volatile Compounds				
Compound	LOQ		MDL	
	water (ug/l)	soil (ug/kg)	water (ug/l)	soil (ug/kg)
Chloromethane	10	10	3	3
Bromomethane	10	10	3	3
Vinyl chloride	10	10	3	3
Dichlorodifluoromethane	5	5	1	1
Chloroethane	10	10	4	4
Methyl iodide	5	5	1	1
Acrolein	100	100	1	1
Acrylonitrile	50	50	1	1
Acetonitrile	150	150	1	1
Methylene chloride	5	5	4	4
Acetone	20	20	6	6
Trichlorofluoromethane	5	5	1	1
Carbon disulfide	5	5	3	3
Propionitrile	100	100	1	1
1,1-Dichloroethene	5	5	2	1
Allyl chloride	5	5	1	1
1,1-Dichloroethane	5	5	2	2
trans-1,2-Dichloroethene	5	5	2	2
Chloroform	5	5	2	2
1,2-Dichloroethane	5	5	2	2
Methacrylonitrile	10	10	1	1
2-Butanone	20	20	9	9
Dibromomethane	5	5	1	1
1,1,1-Trichloroethane	5	5	3	3
1,4-Dioxane	500	500	1	1
Carbon tetrachloride	5	5	2	2
Isobutyl alcohol	300	300	1	1

Table 10-6 (Continued)

289127

Appendix IX Volatile Compounds*				
Compound	LOQ		MDL	
	water (ug/l)	soil (ug/kg)	water (ug/l)	soil (ug/kg)
Vinyl acetate	10	10	2	1
Bromodichloromethane	5	5	1	1
2-Chloro-1,3-butadiene	5	5	1	1
1,2-Dichloropropane	5	5	1	1
trans-1,3-Dichloropropene	5	5	1	1
Trichloroethene	5	5	1	1
Dibromochloromethane	5	5	1	1
1,1,2-Trichloroethane	5	5	1	1
1,2-Dibromoethane	5	5	1	1
Benzene	5	5	1	1
cis-1,3-Dichloropropene	5	5	1	1
Methyl methacrylate	5	5	1	1
1,1,1,2-Tetrachloroethane	5	5	1	1
Bromoform	5	5	1	1
trans-1,4-Dichloro-2-butene	10	10	1	1
1,2,3-Trichloropropane	5	5	1	1
2-Hexanone	10	10	2	1
4-Methyl-2-pentanone	10	10	1	1
Tetrachloroethene	5	5	1	1
1,1,2,2-Tetrachloroethane	5	5	1	1
Toluene	5	5	1	1
Ethyl methacrylate	5	5	1	1
Chlorobenzene	5	5	1	1
Pentachloroethane	10	10	1	1
Ethylbenzene	5	5	1	1
1,2-Dibromo-3-chloropropane	10	10	1	1

289128

Table 10-6 (Continued)

Appendix IX Volatile Compounds*				
Compound	LOQ		MDL	
	water (ug/l)	soil (ug/kg)	water (ug/l)	soil (ug/kg)
Styrene	5	5	1	1
Xylenes (total)	5	5	5	5
Xylenes (ortho)	5	5	2	2

\*Specific quantitation limits are highly matrix dependant. The quantitation limits listed herein are provided for guidance and may not always be achievable.

Quantitation limits listed for soil/sediment are based on wet weight.  
Quantitation limits calculated on a dry weight basis will be higher.

LOQ is defined as "Limit of Quantitation."  
MDL is defined as "Method Detection Limit."

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Table 10-7

Volatiles Compound List for Toxicity Characteristic Leaching Procedure (TCLP) Quantitation and Regulatory Limits			
Compound	Hazardous Waste Identification Number	Quantitation Limit (mg/l)	Regulatory Limit (mg/l)
Benzene	D018	0.05	0.5
Carbon tetrachloride	D019	0.05	0.5
Chlorobenzene	D021	0.05	100.0
Chloroform	D022	0.05	6.0
1,2-Dichloroethane	D028	0.05	0.5
1,1-Dichloroethene	D029	0.05	0.7
2-Butanone (MEK)	D035	0.2	200.0
Tetrachloroethene	D039	0.05	0.7
Trichloroethene	D040	0.05	0.5
Vinyl chloride	D043	0.1	0.2

\*Specific quantitation limits are highly matrix dependant. The quantitation limits listed herein are provided for guidance and may not always be achievable.

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Table 10-8

Volatiles Target Compound List (TCL) and Contract Required Quantitation Limits (CRQL)				
Compound	CAS Number	Quantitation Limits		
		water (ug/l)	low soil (ug/kg)	med soil (ug/kg)
Chloromethane	74-87-3	10	10	1200
Bromomethane	74-83-9	10	10	1200
Vinyl chloride	75-01-4	10	10	1200
Chloroethane	75-00-3	10	10	1200
Methylene chloride	75-09-2	10	10	1200
Acetone	67-64-1	10	10	1200
Carbon disulfide	75-15-0	10	10	1200
1,1-Dichloroethene	75-35-4	10	10	1200
1,1-Dichloroethane	75-34-3	10	10	1200
1,2-Dichloroethene (total)	540-59-0	10	10	1200
Chloroform	67-66-3	10	10	1200
1,2-Dichloroethane	107-06-02	10	10	1200
2-Butanone	78-93-3	10	10	1200
1,1,1-Trichloroethane	71-55-6	10	10	1200
Carbon tetrachloride	56-23-5	10	10	1200
Bromodichloromethane	75-27-4	10	10	1200
1,2-Dichloropropane	78-87-5	10	10	1200
cis-1,3-Dichloropropene	10061-01-5	10	10	1200
Trichloroethene	79-01-6	10	10	1200
Dibromochloromethane	124-48-1	10	10	1200
1,1,2-Trichloroethane	79-00-5	10	10	1200
Benzene	71-43-2	10	10	1200
trans-1,3-Dichloropropene	10061-02-6	10	10	1200
Bromoform	75-25-2	10	10	1200
4-Methyl-2-pentanone	108-10-1	10	10	1200

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**Table 10-8 (Continued)**

<b>Volatiles Target Compound List (TCL) and Contract Required Quantitation Limits (CRQL)</b>				
<b>Compound</b>	<b>CAS Number</b>	<b>Quantitation Limits</b>		
		<b>water (ug/l)</b>	<b>low soil (ug/kg)</b>	<b>med soil (ug/kg)</b>
2-Hexanone	591-78-6	10	10	1200
Tetrachloroethene	127-18-4	10	10	1200
1,1,2,2-Tetrachloroethane	79-34-5	10	10	1200
Toluene	108-88-3	10	10	1200
Chlorobenzene	108-90-7	10	10	1200
Ethylbenzene	100-41-4	10	10	1200
Styrene	100-42-5	10	10	1200
Xylenes (total)	1330-20-7	10	10	1200

\*Specific quantitation limits are highly matrix dependant. The quantitation limits listed herein are provided for guidance and may not always be achievable.

Quantitation limits listed for soil/sediment are based on wet weight.  
Quantitation limits calculated on a dry weight basis will be higher.

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Table 10-9

Semivolatile Priority Pollutant Compound List				
Compound	LOQ		MDL	
	water (ug/l)	soil (ug/kg)	water (ug/l)	soil (ug/kg)
2-Chlorophenol	10	330	1	33
Phenol	10	330	1	33
2-Nitrophenol	10	330	1	33
2,4-Dimethylphenol	10	330	1	33
2,4-Dichlorophenol	10	330	1	33
4-Chloro-3-methylphenol	20	1300	1	33
2,4,6-Trichlorophenol	10	330	1	33
2,4-Dinitrophenol	50	3300	9	297
4-Nitrophenol	50	3300	3	99
2-Methyl-4,6-dinitrophenol	50	3300	1	33
Pentachlorophenol	50	3300	1	33
N-Nitrosodimethylamine	10	330	1	33
bis(2-Chloroethyl)ether	10	330	1	33
1,3-Dichlorobenzene	10	330	1	33
1,4-Dichlorobenzene	10	330	1	33
1,2-Dichlorobenzene	10	330	1	33
bis(2-Chloroisopropyl)ether	10	330	1	33
Hexachloroethane	10	330	1	33
N-Nitrosodi-n-propylamine	10	330	1	33
Nitrobenzene	10	330	1	33
Isophorone	10	330	1	33
bis(2-Chloroethoxy)methane	10	330	1	33
1,2,4-Trichlorobenzene	10	330	1	33
Naphthalene	10	330	1	33
Hexachlorobutadiene	10	330	1	33
Hexachlorocyclopentadiene	10	330	4	132
2-Chloronaphthalene	10	330	1	33

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Table 10-9 (Continued)

Semivolatile Priority Pollutant Compound List				
Compound	LOQ		MDL	
	water (ug/l)	soil (ug/kg)	water (ug/l)	soil (ug/kg)
Acenaphthylene	10	330	1	33
Dimethylphthalate	10	330	1	33
2,6-Dinitrotoluene	10	330	1	33
Acenaphthene	10	330	1	33
2,4-Dinitrotoluene	10	330	1	33
Fluorene	10	330	1	33
4-Chlorophenyl phenylether	10	330	1	33
Diethylphthalate	10	330	1	33
1,2-Diphenylhydrazine	10	330	1	33
N-Nitrosodiphenylamine	10	330	1	33
4-Bromophenyl phenylether	10	330	1	33
Hexachlorobenzene	10	330	1	33
Phenanthrene	10	330	1	33
Anthracene	10	330	1	33
Di-n-butylphthalate	10	330	1	33
Fluoranthene	10	330	1	33
Pyrene	10	330	1	33
Benzidine	50	3300	1	33
Butylbenzylphthalate	10	330	1	33
Benz(a)anthracene	10	330	1	33
Chrysene	10	330	1	33
3,3'-Dichlorobenzidine	20	1300	1	33
bis(2-Ethylhexyl)phthalate	10	330	1	33
Di-n-octylphthalate	10	330	1	33
Benzo(b)fluoranthene	10	330	1	33
Benzo(K)fluoranthene	10	330	1	33

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Table 10-9 (Continued)

Semivolatile Priority Pollutant Compound List				
Compound	LOQ		MDL	
	water (ug/l)	soil (ug/kg)	water (ug/l)	soil (ug/kg)
Benzo(a)pyrene	10	330	1	33
Ideno(1,2,3-cd)pyrene	10	330	1	33
Dibenz(a,h)anthracene	10	330	1	33
Benzo(g,h,i)perylene	10	330	1	33

\*Specific quantitation limits are highly matrix dependant. The quantitation limits listed herein are provided for guidance and may not always be achievable.

Quantitation limits listed for soil/sediment are based on wet weight.  
Quantitation limits calculated on a dry weight basis will be higher.

LOQ is defined as "Limit of Quantitation."  
MDL is defined as "Method Detection Limit."  
ND is defined as "Not Determined."

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Table 10-10

Appendix IX Semivolatile Compounds				
Compound	LOQ		MDL	
	water (ug/l)	soil (ug/kg)	water (ug/l)	soil (ug/kg)
Acenaphthene	10	1000	1	100
Acenaphthylene	10	1000	1	100
Acetophenone	10	1000	1	100
2-Acetylaminofluorene	10	1000	1	100
4-Aminobiphenyl	10	1000	1	100
Aniline	10	1000	1	100
Anthracene	10	1000	1	100
Benz(a)anthracene	10	1000	1	100
Benzo(b)fluoranthene	10	1000	2	200
Benzo(K)fluoranthene	10	1000	2	200
Benzo(ghi)perylene	10	1000	1	100
Benzo(a)pyrene	10	1000	1	100
Benzyl alcohol	20	2000	1	100
bis(2-Chloroethoxy)methane	10	1000	1	100
bis(2-Chloroethyl)ether	10	1000	1	100
bis(2-Chloro-1-methylethyl) ether	10	1000	1	100
bis(2-Ethylhexyl)phthalate	10	1000	4	100
4-Bromophenyl phenylether	10	1000	1	100
Butylbenzylphthalate	10	1000	2	200
4-Chloroaniline	20	2000	1	100
Chlorobenzilate	10	1000	1	100
4-Chloro-3-methylphenol	10	1000	1	100
2-Chloronaphthalene	10	1000	1	100
2-Chlorophenol	10	1000	1	100
4-Chlorophenyl phenylether	10	1000	1	100
Chrysene	10	1000	1	100

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Table 10-10 (Continued)

Appendix IX Semivolatile Compounds <sup>1</sup>				
Compound	LOQ		MDL	
	water (ug/l)	soil (ug/kg)	water (ug/l)	soil (ug/kg)
2-Methylphenol	10	1000	1	100
3-Methylphenol	10	1000	1	100
4-Methylphenol	10	1000	1	100
Diallate	10	1000	1	100
Dibenzofuran	10	1000	1	100
Di-n-butylphthalate	10	1000	7	700
Dibenz(a,h)anthracene	10	1000	1	100
1,2-Dichlorobenzene	10	1000	2	200
1,3-Dichlorobenzene	10	1000	1	100
1,4-Dichlorobenzene	10	1000	1	100
3,3'-Dichlorobenzidine	20	2000	1	100
2,4-Dichlorophenol	10	1000	1	100
2,6-Dichlorophenol	10	1000	1	100
Diethylphthalate	10	1000	2	200
Dimethoate <sup>1</sup>	50	5000	1	100
p-(Dimethylamino)azobenzene	10	1000	1	100
7,12-Dimethylbenz(a)anthracene <sup>1</sup>	10	1000	1	100
3,3'-Dimethylbenzidine	10	1000	1	100
a,a-Dimethyl-1-phenethylamine	20	2000	1	100
2,4-Dimethylphenol	10	1000	2	200
Dimethylphthalate	10	1000	3	300
1,3-Dinitrobenzene	10	1000	1	100
2-Methyl-4,6-dinitro-o-cresol	50	5000	1	100
2,4-Dinitrophenol	50	5000	2	200
2,4-Dinitrotoluene	10	1000	1	100
2,6-Dinitrotoluene	10	1000	1	100

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Table 10-10 (Continued)

Appendix IX Semivolatile Compounds				
Compound	LOQ		MDL	
	water (ug/l)	soil (ug/kg)	water (ug/l)	soil (ug/kg)
Di-n-octylphthalate	10	1000	3	300
Diphenylamine	10	1000	1	100
Ethyl methanesulfonate	10	1000	1	100
Fluoranthene	10	1000	2	200
Fluorene	10	1000	1	100
Hexachlorobenzene	10	1000	1	100
Hexachloro-1,3-butadiene	10	1000	1	100
Hexachlorocyclopentadiene	10	1000	1	100
Hexachloroethane	10	1000	2	200
Hexachloropropene <sup>1</sup>	10	1000	1	100
Indeno(1,2,3-cd)pyrene	10	1000	1	100
Isodrin	10	1000	1	100
Isophorone	10	1000	1	100
Isosafrole	10	1000	1	100
Methapyrilene	50	5000	1	100
3-Methylchloranthene	10	1000	1	100
Methyl methanesulfonate	10	1000	1	100
2-Methylnaphthalene	10	1000	1	100
Naphthalene	10	1000	1	100
1,4-Naphthoquinone <sup>1</sup>	50	5000	1	100
1-Naphthylamine	10	1000	1	100
2-Naphthylamine	20	2000	1	100
2-Nitroaniline	50	5000	1	100
3-Nitroaniline	50	5000	1	100
4-Nitroaniline	20	2000	1	100
Nitrobenzene	10	1000	1	100

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Table 10-10 (Continued)

Appendix IX Semivolatile Compounds <sup>*</sup>				
Compound	LOQ		MDL	
	water (ug/l)	soil (ug/kg)	water (ug/l)	soil (ug/kg)
2-Nitrophenol	10	1000	1	100
4-Nitrophenol	50	5000	1	100
4-Nitroquinoline 1-oxide <sup>1</sup>	50	5000	1	100
N-Nitrosodi-n-butylamine	10	1000	1	100
N-Nitrosodiethylamine	10	1000	1	100
N-Nitrosodimethylamine	10	1000	1	100
N-Nitrosodiphenylamine	10	1000	1	100
N-Nitrosodi-n-propylamine	10	1000	1	100
N-Nitrosomethylethylamine	10	1000	1	100
N-Nitrosomorpholine	20	2000	1	100
N-Nitrosopiperidine	10	1000	1	100
N-Nitrosopyrrolidine	10	1000	1	100
5-Nitro-o-toluidine	10	1000	1	100
Pentachlorobenzene	10	1000	1	100
Pentachloronitrobenzene	10	1000	1	100
Pentachlorophenol	50	1700	2	100
Phenacetin	10	1000	1	100
Phenanthrene	10	1000	1	100
Phenol	10	1000	1	100
p-Phenylenediamine <sup>1</sup>	100	10000	1	100
2-Picoline	10	1000	1	100
Pronamide	10	1000	1	100
Pyrene	10	1000	1	100
Pyridine	10	1000	1	100
Safrole	10	1000	1	100
1,2,4,5-Tetrachlorobenzene	10	1000	1	100

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Table 10-10 (Continued)

Appendix IX Semivolatile Compounds*				
Compound	LOQ		MDL	
	water (ug/l)	soil (ug/kg)	water (ug/l)	soil (ug/kg)
2,3,4,6-Tetrachlorophenol	10	1000	1	100
Tetraethyldithiopyrophosphate	10	1000	1	100
Thionazin	20	1000	1	100
o-Toluidine	10	1000	1	100
1,2,4-Trichlorobenzene	10	1000	1	100
2,4,5-Trichlorophenol	50	1700	1	100
2,4,6-Trichlorophenol	10	1000	1	100
0,0,0-Triethylphosphorothioate	10	1000	1	100
sym-Trinitrobenzene	50	5000	1	100

\*Specific quantitation limits are highly matrix dependant. The quantitation limits listed herein are provided for guidance and may not always be achievable.

Quantitation limits listed for soil/sediment are based on wet weight.  
Quantitation limits calculated on a dry weight basis will be higher.

LOQ is defined as "Limit of Quantitation."  
MDL is defined as "Method Detection Limit."

<sup>1</sup>Since this is either a highly reactive compound or because uncontaminated neat material is unavailable, only semiquantitative data is reported.

Table 10-11

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Semivolatiles Compound List for Toxicity Characteristic Leaching Procedure (TCLP) and Quantitation and Regulatory Limits			
Compound	Hazardous Waste Identification Number	Quantitation Limit (mg/l)	Regulatory Limit (mg/l)
o-Cresol	D023	0.04	200.0 <sup>**</sup>
m-Cresol	D024	0.04	200.0 <sup>**</sup>
p-Cresol	D025	0.04	200.0 <sup>**</sup>
1,4-Dichlorobenzene	D027	0.04	7.50
2,4-Dinitrotoluene	D030	0.04	0.13
Hexachlorobenzene	D032	0.04	0.13
Hexachlorobutadiene	D033	0.04	0.5
Hexachloroethane	D034	0.04	3.0
Nitrobenzene	D036	0.04	2.0
Pentachlorophenol	D037	0.2	100.0
Pyridine	D038	0.04	5.0
2,4,5-Trichlorophenol	D041	0.04	400.0
2,4,6-Trichlorophenol	D042	0.04	2.0

\*Specific quantitation limits are highly matrix dependant. The quantitation limits listed herein are provided for guidance and may not always be achievable.

\*\*If o-, m-, and p-cresol concentrations cannot be differentiated, the total cresol concentration is used.

289101

Table 10-12

Semivolatiles Target Compound List (TCL) and Contract Required Quantitation Limits (CRQL)				
Compound	CAS Number	Quantitation Limits		
		water (ug/l)	low soil (ug/kg)	med soil (ug/kg)
Phenol	108-95-2	10	330	10000
bis-(2-Chloroethyl)ether	111-44-4	10	330	10000
2-Chlorophenol	95-57-8	10	330	10000
1,3-Dichlorobenzene	541-73-1	10	330	10000
1,4-Dichlorobenzene	106-46-7	10	330	10000
1,2-Dichlorobenzene	95-50-1	10	330	10000
2-Methylphenol	95-48-7	10	330	10000
2,2'-oxybis(1-Chloropropane)	108-60-1	10	330	10000
4-Methylphenol	106-44-5	10	330	10000
N-Nitroso-di-n-propylamine	621-64-7	10	330	10000
Hexachloroethane	67-72-1	10	330	10000
Nitrobenzene	98-95-3	10	330	10000
Isophorone	78-59-1	10	330	10000
2-Nitrophenol	88-75-5	10	330	10000
2,4-Dimethylphenol	105-67-9	10	330	10000
bis(2-Chloroethoxy)methane	111-91-1	10	330	10000
2,4-Dichlorophenol	120-83-2	10	330	10000
1,2,4-Trichlorobenzene	120-82-1	10	330	10000
Naphthalene	91-20-3	10	330	10000
4-Chloroaniline	106-47-8	10	330	10000
Hexachlorobutadiene	87-68-3	10	330	10000
4-Chloro-3-methylphenol	59-50-7	10	330	10000
2-Methylnaphthalene	91-57-6	10	330	10000
Hexachlorocyclopentadiene	77-47-4	10	330	10000
2,4,6-Trichlorophenol	88-06-2	10	330	10000
2,4,5-Trichlorophenol	95-95-4	25	830	25000

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Table 10-12 (Continued)

Semivolatiles Target Compound List (TCL) and Contract Required Quantitation Limits (CRQL)*				
Compound	CAS Number	Quantitation Limits		
		water (ug/l)	low soil (ug/kg)	med soil (ug/kg)
2-Chloronaphthalene	91-58-7	10	330	10000
2-Nitroaniline	88-74-4	25	830	25000
Dimethylphthalate	131-11-3	10	330	10000
Acenaphthylene	208-96-8	10	330	10000
2,6-Dinitrotoluene	606-20-2	10	330	10000
3-Nitroaniline	99-09-2	25	830	25000
Acenaphthene	83-32-9	10	330	10000
2,4-Dinitrophenol	51-28-5	25	830	25000
4-Nitrophenol	100-02-7	25	830	25000
Dibenzofuran	132-64-9	10	330	10000
2,4-Dinitrotoluene	121-14-2	10	330	10000
Diethylphthalate	84-66-2	10	330	10000
4-Chlorophenyl-phenyl ether	7005-72-3	10	330	10000
Fluorene	86-73-7	10	330	10000
4-Nitroaniline	100-01-6	25	830	25000
4,6-Dinitro-2-methylphenol	534-52-1	25	830	25000
N-nitrosodiphenylamine	86-30-6	10	330	10000
4-Bromophenyl-phenylether	101-55-3	10	330	10000
Hexachlorobenzene	118-74-1	10	330	10000
Pentachlorophenol	87-86-5	25	830	25000
Phenanthrene	85-01-8	10	330	10000
Anthracene	120-12-7	10	330	10000
Carbazole	86-74-8	10	330	10000
Di-n-butylphthalate	84-74-2	10	330	10000
Fluoranthene	206-44-0	10	330	10000
Pyrene	129-00-0	10	330	10000

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Table 10-12 (Continued)

Semivolatiles Target Compound List (TCL) and Contract Required Quantitation Limits (CRQL)*				
Compound	CAS Number	Quantitation Limits		
		water (ug/l)	low soil (ug/kg)	med soil (ug/kg)
Butylbenzylphthalate	85-68-7	10	330	10000
3,3'-Dichlorobenzidine	91-94-1	10	330	10000
Benzo(a)anthracene	56-55-1	10	330	10000
Chrysene	218-01-9	10	330	10000
bis(2-Ethylhexyl)phthalate	117-81-7	10	330	10000
Di-n-octylphthalate	117-84-0	10	330	10000
Benzo(b)fluoranthene	205-99-2	10	330	10000
Benzo(k)fluoranthene	207-08-9	10	330	10000
Benzo(a)pyrene	50-32-8	10	330	10000
Indeno(1,2,3-cd)pyrene	193-39-5	10	330	10000
Dibenzo(a,h)anthracene	53-70-3	10	330	10000
Benzo(g,h,i)perylene	191-24-2	10	330	10000

\*Specific quantitation limits are highly matrix dependant. The quantitation limits listed herein are provided for guidance and may not always be achievable.

Quantitation limits listed for soil/sediment are based on wet weight.  
Quantitation limits calculated on a dry weight basis will be higher.

Table 10-13

**Volatiles by GC  
Volatile Organics List**

Compound	LOQ		MDL	
	water (ug/l)	soil (ug/kg)	water (ug/l)	soil (ug/kg)
Chloromethane	2	2	0.4	0.4
Bromomethane	2	2	0.4	0.4
Dichlorodifluoromethane	1	1	0.2	0.2
Vinyl chloride	2	2	0.4	0.4
Chloroethane	2	2	0.4	0.4
Methylene chloride	1	1	0.2	0.2
Trichlorofluoromethane	2	2	0.4	0.4
1,1-Dichloroethene	1	1	0.2	0.2
1,1-Dichloroethane	1	1	0.2	0.2
1,2-Dichloroethene ( <i>cis/trans</i> )	1	1	0.2	0.2
Chloroform	1	1	0.2	0.2
1,2-Dichloroethane	1	1	0.2	0.2
1,1,1-Trichloroethane	1	1	0.2	0.2
Carbontetrachloride	1	1	0.2	0.2
Bromodichloromethane	1	1	0.2	0.2
1,2-Dichloropropane	1	1	0.2	0.2
<i>trans</i> -1,3-Dichloropropene	1	1	0.2	0.2
Trichloroethene	1	1	0.2	0.2
Dibromochloromethane	1	1	0.2	0.2
1,1,2-Trichloroethane	1	1	0.2	0.2
<i>cis</i> -1,3-Dichloropropene	1	1	0.2	0.2
2-Chloroethylvinyl-ether	2	2	0.4	0.4
Bromoform	2	2	0.4	0.4
1,1,2,2-Tetrachloroethane	2	2	0.4	0.4
Tetrachloroethene	1	1	0.2	0.2
Chlorobenzene	1	1	0.2	0.2

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Table 10-13 (Continued)

Volatiles by GC Volatile Organics List				
Compound	LOQ		MDL	
	water (ug/l)	soil (ug/kg)	water (ug/l)	soil (ug/kg)
Benzene	1	1	0.2	0.2
Toluene	1	1	0.2	0.2
Ethylbenzene	1	1	0.2	0.2
o-Dichlorobenzene	1	1	0.2	0.2
m-Dichlorobenzene	1	1	0.2	0.2
p-Dichlorobenzene	1	1	0.2	0.2

\*Specific quantitation limits are highly matrix dependant. The quantitation limits listed herein are provided for guidance and may not always be achievable.

Quantitation limits listed for soil/sediment are based on wet weight.  
Quantitation limits calculated on a dry weight basis will be higher.

LOQ is defined as "Limit of Quantitation."  
MDL is defined as "Method Detection Limit."

289146

Table 10-14

Pesticide/PCB Priority Pollutant Compound List and Appendix IX Organochlorides*				
Compound	LOQ		MDL	
	water (ug/l)	soil (ug/kg)	water (ug/l)	soil (ug/kg)
alpha-BHC	0.05	5	0.005	1
beta-BHC	0.05	5	0.005	1
gamma-BHC (Lindane)	0.05	5	0.005	1
delta-BHC	0.05	5	0.005	1
Heptachlor	0.05	5	0.005	1
Aldrin	0.05	5	0.005	1
Heptachlor epoxide	0.05	5	0.005	1
4,4-DDE	0.05	5	0.005	1
4,4-DDD	0.05	5	0.005	1
4,4-DDT	0.05	5	0.005	1
Dieldrin	0.05	5	0.005	1
Endrin	0.05	5	0.005	1
Chlordane	1.0	100	0.1	20
Toxaphene	1.0	100	0.1	20
Endosulfan I	0.05	5	0.005	1
Endosulfan II	0.05	5	0.005	1
Endosulfan sulfate	0.05	5	0.005	1
Endrin aldehyde	0.05	5	0.005	1
PCB-1016	1	100	0.2	20
PCB-1221	1	100	0.2	20
PCB-1232	1	100	0.2	20
PCB-1242	1	100	0.2	20
PCB-1248	1	100	0.2	20
PCB-1254	1	100	0.2	20
PCB-1260	1	100	0.2	20

Table 10-14 (Continued)

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Pesticide/PCB Priority Pollutant Compound List and Appendix IX Organochlorides*				
Compound	LOQ		MDL	
	water (ug/l)	soil (ug/kg)	water (ug/l)	soil (ug/kg)
Methoxychlor**	0.05	5	0.005	1

\*Specific quantitation limits are highly matrix dependant. The quantitation limits listed herein are provided for guidance and may not always be achievable.

Quantitation limits listed for soil/sediment are based on wet weight.  
Quantitation limits calculated on a dry weight basis will be higher.

LOQ is defined as "Limit of Quantitation."

MDL is defined as "Method Detection Limit."

\*\*This compound used for Appendix IX Organochlorines only.

289148

Table 10-15

<b>Pesticides Compound List for Toxicity Characteristic Leaching Procedure (TCLP) and Quantitation and Regulatory Limits</b>			
<b>Compound</b>	<b>Hazardous Waste Identification Number</b>	<b>Quantitation Limit (mg/l)</b>	<b>Regulatory Limit (mg/l)</b>
Chlordane	D020	0.03	0.03
Endrin	D012	0.02	0.02
Heptachlor	D031	0.008	0.008
Lindane	D013	0.4	0.4
Methoxychlor	D014	10.0	10.0
Toxaphene	D015	0.5	0.5

\*Specific quantitation limits are highly matrix dependant. The quantitation limits listed herein are provided for guidance and may not always be achievable.

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Table 10-16

Pesticides/Aroclors Target Compound List (TCL) and Contract Required Quantitation Limits (CRQL)			
Compound	CAS Number	Quantitation Limits	
		water (ug/l)	low soil (ug/kg)
alpha-BHC	319-84-6	0.05	1.7
beta-BHC	319-85-7	0.05	1.7
delta-BHC	319-86-8	0.05	1.7
gamma-BHC (Lindane)	58-89-9	0.05	1.7
Heptachlor	76-44-8	0.05	1.7
Aldrin	309-00-2	0.05	1.7
Heptachlor epoxide	111024-57-3	0.05	1.7
Endosulfan I	959-98-8	0.05	1.7
Dieldrin	60-57-1	0.10	3.3
4,4'-DDE	72-55-9	0.10	3.3
Endrin	72-20-8	0.10	3.3
Endosulfan II	33213-65-9	0.10	3.3
4,4'-DDD	72-54-8	0.10	3.3
Endosulfan sulfate	1031-07-8	0.10	3.3
4,4'-DDT	50-29-3	0.10	3.3
Methoxychlor	72-43-5	0.50	17.0
Endrin ketone	53494-70-5	0.10	3.3
Endrin aldehyde	7421-93-4	0.10	3.3
alpha-Chlordane	5103-71-9	0.05	1.7
gamma-Chlordane	5103-74-2	0.05	1.7
Toxaphene	8001-35-2	5.0	170.0
Aroclor-1016	12674-11-2	1.0	33.0
Aroclor-1221	11104-28-2	2.0	67.0
Aroclor-1232	11141-16-5	1.0	33.0
Aroclor-1242	53469-21-9	1.0	33.0
Aroclor-1248	12672-29-6	1.0	33.0

**Table 10-16 (Continued)**

<b>Pesticides/Aroclors Target Compound List (TCL) and Contract Required Quantitation Limits (CRQL)*</b>			
<b>Compound</b>	<b>CAS Number</b>	<b>Quantitation Limits</b>	
		<b>water (ug/l)</b>	<b>low soil (ug/kg)</b>
Aroclor-1254	11097-69-1	1.0	33.0
Aroclor-1260	11096-82-5	1.0	33.0

\*Specific quantitation limits are highly matrix dependant. The quantitation limits listed herein are provided for guidance and may not always be achievable.

Quantitation limits listed for soil/sediment are based on wet weight.  
 Quantitation limits calculated on a dry weight basis will be higher.

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Table 10-17

Appendix IX Organophosphates				
Compound	LOQ		MDL	
	water (ug/l)	soil (ug/kg)	water (ug/l)	soil (ug/kg)
Disulfoton	5	50	0.2	10
Methyl parathion	5	50	0.2	10
Ethyl parathion	5	50	0.2	10
Famphur	5	50	0.2	10
Phorate	5	50	0.2	10

\*Specific quantitation limits are highly matrix dependant. The quantitation limits listed herein are provided for guidance and may not always be achievable.

Quantitation limits listed for soil/sediment are based on wet weight.  
Quantitation limits calculated on a dry weight basis will be higher.

LOQ is defined as "Limit of Quantitation."  
MDL is defined as "Method Detection Limit."

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Table 10-18

Appendix IX Herbicide Compounds*				
Compound	LOQ		MDL	
	water (ug/l)	soil (ug/kg)	water (ug/l)	soil (ug/kg)
2,4-D	0.5	10	0.1	4
Dinoseb	1.0	20	0.2	10
2,4,5-TP	0.5	10	0.1	4
2,4,5-T	0.5	10	0.1	4

\*Specific quantitation limits are highly matrix dependant. The quantitation limits listed herein are provided for guidance and may not always be achievable.

Quantitation limits listed for soil/sediment are based on wet weight.  
Quantitation limits calculated on a dry weight basis will be higher.

LOQ is defined as "Limit of Quantitation."  
MDL is defined as "Method Detection Limit."

Table 10-19

Herbicides Compound List for Toxicity Characteristic Leaching Procedure (TCLP) and Quantitation and Regulatory Limits			
Compound	Hazardous Waste Identification Number	Quantitation Limit (mg/l)	Regulatory Limit (mg/l)
2,4-D	D016	10.0	10.0
2,4,5-TP	D017	1.0	1.0

\*Specific quantitation limits are highly matrix dependant. The quantitation limits listed herein are provided for guidance and may not always be achievable.

Table 10-20

289153

Inorganic Metals Limits of Quantitation (LOQ)								
Analyte	ICP		GFAA		FAA		CVAA/HAA	
	ug/l	mg/kg	ug/l	mg/kg	ug/l	mg/kg	ug/l	mg/kg
Aluminum	150	15			500	50		
Antimony	500	50	18	2	300	30		
Arsenic	150	15	13	1.3			20	2.5
Barium	15	2			200	20		
Beryllium	2	0.2	2	0.2	20	2		
Boron	160	16						
Cadmium	15	1.5	2	0.2	25	3		
Calcium	500	50			50	5		
Chromium	15	2	0.7	0.07	50	5		
Cobalt	10	1	2	0.2	100	10		
Copper	25	3	9	0.9	50	5		
Iron	500	50			600	60		
Lead	150	15	5	0.5	250	25		
Lithium	15	2			10	1		
Magnesium	250	25			50	5		
Manganese	15	2	1	0.1	250	25		
Mercury							0.5	0.3
Molybdenum	80	8	4	0.4	100	10		
Nickel	60	6	4	0.4	150	15		
Phosphorous	500	50						
Potassium	900	90			50	5		
Selenium	400	40	20	2			15	2
Silica	1000				4000	400		
Silver	25	3	3	0.3	40	4		
Sodium	1800	180			100	10		
Strontium	15	2	0.5	0.05	80	8		

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Table 10-20 (Continued)

Inorganic Metals Limits of Quantitation (LOQ)*								
Analyte	ICP		GFAA		FAA		CVAA/HAA	
	ug/l	mg/kg	ug/l	mg/kg	ug/l	mg/kg	ug/l	mg/kg
Thallium	500	50	3	0.3	100	10		
Tin					100	10		
Titanium	10	1						
Vanadium	10	1	5	0.5	180	18		
Zinc	300	30			100	10		

\*Specific quantitation limits are highly matrix dependant. The quantitation limits listed herein are provided for guidance and may not always be achievable.

Quantitation limits listed for soil/sediment are based on wet weight.  
Quantitation limits calculated on a dry weight basis will be higher.

289155

Table 10-21

Inorganic Metals Method Detection Limits (MDL)								
Analyte	ICP		GFAA		FAA		CVAA/HAA	
	ug/l	mg/kg	ug/l	mg/kg	ug/l	mg/kg	ug/l	mg/kg
Aluminum	30	3			100	10		
Antimony	100	10	3.5	0.4	50	5		
Arsenic	30	3	2.6	0.3			4	0.25
Barium	3	0.3			40	4		
Beryllium	0.3	0.03	0.3	0.03	4	0.4		
Boron	35	3.5						
Cadmium	3	0.3	0.3	0.03	5	0.5		
Calcium	100	10			10	1		
Chromium	5	0.5	0.7	0.07	10	1		
Cobalt	2	0.2	0.5	0.05	20	2		
Copper	5	0.5	2	0.2	10	1		
Iron	100	10			120	12		
Lead	35	3.5	1	0.1	50	5		
Lithium	3	0.3			6	0.6		
Magnesium	50	5			10	1		
Manganese	3	0.3	0.2	0.02	50	5		
Mercury							0.1	0.1
Molybdenum	20	2	0.7	0.07	20	2		
Nickel	15	1.5	0.8	0.08	30	3		
Phosphorous	100	10						
Potassium	200	20			10	1		
Selenium	75	7.5	1	0.1			3	0.13
Silica					400	40		
Silver	5	0.5	0.5	0.05	8	0.8		
Sodium	350	35			20	2		
Strontium	3	0.3	0.1	0.01	20	2		

289156

Table 10-21 (Continued)

Inorganic Metals Method Detection Limits (MDL)*								
Analyte	ICP		GFAA		FAA		CVAA/HAA	
	ug/l	mg/kg	ug/l	mg/kg	ug/l	mg/kg	ug/l	mg/kg
Thallium	100	10	0.6	0.06	20	2		
Tin					20	2		
Titanium	2	0.2						
Vanadium	2	0.2	1	0.1	30	3		
Zinc	60	6			20	2		

\*Method detection limits are determined annually. The actual values will vary a small amount from one determination to the next.

Table 10-22

<b>Metals Analyte List for Toxicity Characteristic Leaching Procedure (TCLP) and Quantitation and Regulatory Limits</b>			
<b>Compound</b>	<b>Hazardous Waste Identification Number</b>	<b>Quantitation Limit (mg/l)</b>	<b>Regulatory Limit (mg/l)</b>
Arsenic	D004	0.15	5.0
Barium	D005	1.0	100.0
Cadmium	D006	0.02	1.0
Chromium	D007	0.02	5.0
Lead	D008	0.2	5.0
Mercury	D009	0.0007	0.2
Selenium	D010	0.4	1.0
Silver	D011	0.02	5.0

\*Specific quantitation limits are highly matrix dependant. The quantitation limits listed herein are provided for guidance and may not always be achievable.

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Table 10-23

Inorganic Target Analyte List (TAL) and Contract Required Detection Limits (CRDL)*					
Analyte	CAS Number	Contract Required Detection Limit (ug/l)	Instrument Detection Limit (ug/l)		
			ICP	GFAA	CVAA
Aluminum	7429-90-5	200	26.1		
Antimony	7440-36-0	60		2.1	
Arsenic	7440-38-2	10 <sup>~</sup>	19.2	1.1	
Barium	7440-39-3	200	1.3		
Beryllium	7440-41-7	5	0.3		
Cadmium	7440-43-9	5	3.4	0.1	
Calcium	7440-70-2	5000	8.5		
Chromium	7440-47-3	10	5.2	0.4	
Cobalt	7440-48-4	50	3.1		
Copper	7440-50-8	25	4.7		
Iron	7439-89-6	100	52		
Lead	7439-92-1	3 <sup>~</sup>	20.2	1.3	
Magnesium	7439-95-4	5000	16.5		
Manganese	7439-96-5	15	0.9		
Mercury	7439-97-6	0.2			0.1
Nickel	7440-02-0	40	11.8		
Potassium	7440-09-7	5000	81.6		
Selenium	7782-49-2	5 <sup>~</sup>	58.3	1.0	
Silver	7440-22-4	10	5.1		
Sodium	7440-23-5	5000	59.0		
Thallium	7440-28-0	10 <sup>~</sup>	74.2	1.1	
Vanadium	7440-62-2	50	2.4		
Zinc	7440-66-6	20	2.7		

\*Specific detection limits are highly matrix dependant. The detection limits listed herein are provided for guidance and may not always be achievable.

<sup>~</sup>Graphite fumace required.

Table 10-24

Inorganic General Chemistry Limits of Quantitation and Method Detection Limits				
Analyte	Limit of Quantitation		Method Detection Limit	
	water	soil	water	soil
Acidity	3 mg/L	30 mg/kg	0.5 mg/L	5 mg/kg
Alkalinity	2 mg/L	15 mg/kg	0.4 mg/L	3 mg/kg
Ammonia	2 mg/L	1000 mg/kg	0.4 mg/L	200 mg/kg
BOD	1.8 mg/L		0.6 mg/L	
Carbonaceous BOD	1.8 mg/L		0.6 mg/L	
Cation Exchange of Soils		0.1 meq/100 g		NIA
Chloride	2 mg/L	20 mg/kg	0.4 mg/L	4 mg/kg
Chlorine	0.05 mg/L	0.5 mg/kg	NIA	NIA
COD	50 mg/L		10 mg/L	
Corrosivity/Langlier Index	0.01 units		NIA	
Cyanide	0.005 mg/L	0.13 mg/kg	0.001 mg/L	0.05 mg/kg
Dissolved Oxygen	0.1 mg/L		0.01 mg/L	
Fluoride	0.1 mg/L	40 mg/kg	0.02 mg/L	8 mg/kg
Hardness, Total	5 mg/L	50 mg/kg	1 mg/L	10 mg/kg
Hexavalent Chromium	0.007 mg/L	0.05 mg/kg	0.002 mg/L	0.02 mg/kg
Ion Chromatograph:				
Bromide	0.5 mg/L	5 mg/kg	0.04 mg/L	0.4 mg/kg
Chloride	0.2 mg/L	2 mg/kg	0.03 mg/L	0.3 mg/kg
Fluoride	0.1 mg/L	1 mg/kg	0.01 mg/L	0.1 mg/kg
Nitrate	0.1 mg/L	1 mg/kg	0.003 mg/L	0.03 mg/kg
Nitrate/Nitrite	0.1 mg/L	1 mg/kg	0.300 mg/L	3.0 mg/kg
Nitrite	0.1 mg/L	1 mg/kg	0.02 mg/L	0.2 mg/kg
o-Phosphate	0.5 mg/L	5 mg/kg	0.02 mg/L	0.2 mg/kg
Sulfate	0.5 mg/L	5 mg/kg	0.03 mg/L	0.3 mg/kg

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Table 10-24 (Continued)

Inorganic General Chemistry Limits of Quantitation and Method Detection Limits				
Analyte	Limit of Quantitation		Method Detection Limit	
	water	soil	water	soil
Ignitability	50°F	50°F	50°F	50°F
Nitrate	0.25 mg/L	2.5 mg/kg	0.05 mg/L	0.5 mg/kg
Nitrate/Nitrite	0.25 mg/L	2.5 mg/kg	0.05 mg/L	0.5 mg/kg
Nitrite	0.01 mg/L	0.1 mg/kg	0.002 mg/L	0.02 mg/kg
Oil & Grease	5 mg/L	50 mg/kg	1 mg/L	10 mg/kg
o-Phosphate	0.02 mg/L	2 mg/kg	0.002 mg/L	0.5 mg/kg
Paint Filter Liquid Test	0%	0%	0%	0%
pH	0.01	0.01	0.01	0.01
Phenolics	0.05 mg/L	25 mg/kg	0.01 mg/L	5 mg/kg
Phosphorus, Total	0.08 mg/L	2 mg/kg	0.02 mg/L	0.5 mg/kg
Reactivity:	CN <sup>-</sup>	250 mg/kg	250 mg/kg	50 mg/kg
	S <sup>2-</sup>	410 mg/kg	410 mg/kg	136 mg/kg
Residue, Filterable (TDS)	24 mg/L		8 mg/L	
Residue, Nonfilterable (TSS)	10 mg/L		3.3 mg/L	
Residue, Settleable, Volumetric	0.2 mg/L		NIA	
Residue, Total	24 mg/L		8 mg/L	
Residue, Volatile	0.1 mg/L		0.1 mg/L	
Specific Conductance	1 umhos/cm	10 umhos/cm	0.17 umhos/cm	1.7 umhos/cm
Specific Gravity/ Bulk Density	0.01	0.6 lb/ft <sup>3</sup>	0.01	0.6 lb/ft <sup>3</sup>
Sulfate	2 mg/L	20 mg/kg	0.4 mg/L	4 mg/kg
Sulfide	5 mg/L	25 mg/kg	1 mg/L	5 mg/kg

Table 10-24 (Continued)

289161

Inorganic General Chemistry Limits of Quantitation and Method Detection Limits*				
Analyte	Limit of Quantitation		Method Detection Limit	
	water	soil	water	soil
Total Kjeldahl Nitrogen	2 mg/L	100 mg/kg	0.5 mg/L	25 mg/kg
Total Organic Carbon	2 mg/L	100 mg/kg	0.3 mg/L	15 mg/kg
Total Organic Halides	100 mg/L	100 mg/kg	22 mg/L	22 mg/kg
Turbidity	1 NTU		0.01 NTU	

\*Specific quantitation limits are highly matrix dependant. The quantitation limits listed herein are provided for guidance and may not always be achievable.

Quantitation limits listed for soil/sediment are based on wet weight.  
Quantitation limits calculated on a dry weight basis will be higher.

NIA is defined as "No Information Available."

Table 10-25

CLP Cyanide and Contract Required Detection Limit (CRDL)		
Analyte	CAS Number	Contract Required Detection Limit (ug/l)
Cyanide	N0009100	10

Data Reduction, Verification, and Reporting

288162

Raw analytical data generated in the laboratories are collected on printouts from the instruments and associated data system, or manually in bound notebooks. Analysts review data as it is generated to determine that the instruments are performing within specifications. This review includes calibration checks, surrogate recoveries, blank checks, retention time reproducibility, and other QC checks described in Section No. 12. If any problems are noted during the analytical run, corrective action is taken and documented.

Each analytical run is reviewed by an analyst for completeness and accuracy prior to interpretation and data reduction. The following calculations are used to reduce raw data to reportable results.

The calculation used by the Laboratory Information Management Systems (LIMS) to determine the reporting concentration is:

$$\text{Conc.} = \frac{Q \times DF \times V_f}{I} \times U$$

Where Q = the concentration determined by the analytical procedure (typically mg/L or  $\mu\text{g/L}$ )  
DF = dilution factor (if needed)  
 $V_f$  = final extract volume (ml)  
I = initial sample volume (ml) or weight (g)  
U = unit conversion factor, such as  $\mu\text{g}$  to mg (if needed)

Dry weight results are calculated by LIMS according to:

$$\text{Dry weight result} = \frac{(\text{As received}) \times 100\%}{100\% - (\% \text{ Moisture})}$$

The calculation used by the organics data system to determine concentration in extract for GC/MS semivolatiles or in the sample itself for GC/MS volatiles is:

$$Q \text{ (ug/l)} = \frac{A_x \times I_s}{A_{I_s} \times RRF \times V_i}$$

(Multiply this equation by 1000 if extract was injected.)

Where Q = concentration determined by the data system  
A<sub>x</sub> = peak area  
A<sub>I<sub>s</sub></sub> = internal standard peak area  
I<sub>s</sub> = amount of internal standard injected (ng)  
RRF = relative response factor  
V<sub>i</sub> = volume of extract injected (ul) or  
volume sample purged (ml)

For GC analyses, an average response factor calibration procedure is used. The equations that the data system uses for calculating analyte concentrations are shown below:

$$Q \text{ (ug/l)} = A_x \times RF_{avg}$$

with average response factor (Rf<sub>avg</sub>) calculated as:

$$RF_{avg} = \frac{\sum_{i=1}^n \left( \frac{C_{std}}{A_{std}} \right)_i}{n}$$

Where Q = concentration determined by the data system  
A<sub>x</sub> = analyte peak height or peak area  
A<sub>std</sub> = analyte peak height or peak area in the  
ith calibration level (of n levels)  
C<sub>std</sub> = analyte concentration in the ith  
calibration level (of n levels)  
n = number of calibration levels

289164

The results for inorganic metals analyses are reported in units of micrograms per liter ( $\mu\text{g/L}$ ) or milligrams per liter ( $\text{mg/L}$ ) for aqueous samples and in milligrams per kilogram ( $\text{mg/kg}$ ) for solids. The instrument data systems determine results directly from a calibration curve relating absorbance or emission intensity to standard concentration in  $\mu\text{g/L}$  or  $\text{mg/L}$ .

Moisture content of solids is calculated as percent moisture:

$$\% \text{ Moisture} = \frac{(C_i + S - C_f) \times 100\%}{S}$$

Where  $C_i$  = container's initial weight (g) without sample  
 $S$  = sample weight (g) added to the container  
 $C_f$  = container's final weight (g) after drying time

General chemistry results are calculated by many different equations specifically suited to each type of analysis. Exact equations are given in the methods and SOPs. Some general categories are: titration, concentration determined from a calibration curve, gravimetry, and direct reading from a meter.

The generalized titration calculation is:

$$\text{Conc. (mg/l, mg/kg)} = \frac{(T - T_b) \times N \times F}{I}$$

Where  $T$  = volume of titrant (ml)  
 $T_b$  = volume of titrant for the blank (ml)  
 $N$  = normality of titrant  
 $I$  = initial sample volume (ml) or weight (g)  
 $F$  = conversion factor for formula weights and units

Examples of titrimetric methods are acidity, alkalinity, ammonia, calcium (EDTA), chloride, hardness, and sulfides.

289165

Determinations using calibration curves are calculated by comparing sample readings from an instrument with those of a calibration curve correlating instrument readings for standards with the standard concentrations. The result is calculated as:

$$\text{Conc. (mg/l, mg/kg)} = \frac{Q \times F}{I}$$

Where Q = concentration determined from calibration data  
F = factor to correct for dilution and effects of preparation steps, such as distillation  
I = initial sample volume (ml) or weight (g)

Some examples of this type of calculation are colorimetric methods (such as cyanide, nitrate, nitrite, total phosphorus, orthophosphate, and phenolics), turbidimetric analyses (such as sulfate and turbidity), total organic carbon, and so forth.

The generalized gravimetric calculation is of the form:

$$\text{Conc. (mg/l, mg/kg)} = \frac{(C_f - C_i) \times F}{I}$$

Where  $C_f$  = container's final weight (g) with residue  
 $C_i$  = container's initial weight (g) without sample  
I = initial sample volume (ml) or weight (g)  
F = factor to correct for dilution and units

Gravimetric analyses include oil and grease and residues (filterable, nonfilterable, settleable, total, and volatile).

Direct readings are reported without calculations, however instrument calibration is a prerequisite. The following are examples:

pH is directly read from a pH meter in standard units.

Specific Conductance is read from a conductivity meter in umhos/cm.

Paint Filter Liquid Test (Free Liquids) is a direct observation test and requires no calculations.

Results are usually reported in mg/l or ug/l for water samples and in mg/kg or ug/kg for solid samples. Soil samples are reported on an as received or on a dry weight basis, depending on the requirements of the client's project. The results are reported by the LIMS on MSAI Analysis Report Forms.

The principle criteria used to determine data quality will be the acceptance criteria described in Sections No. 9 and 12 and protocols specified in laboratory SOPs. Following review, interpretation, and data reduction by the analyst, the data are transferred to the LIMS either by direct data transfer from the analytical data system or manually. This system stores client information, sample results, and QC results. A security system is in place to control access of the LIMS by laboratory personnel and to provide an audit trail for information changes. The data are again reviewed by the Group Leader or another analyst, whose function is to provide an independent assessment, then verified on LIMS. The person performing the peer review step reviews all data, including quality control information, prior to verifying the data. Any errors identified during the review process are corrected to ensure generation of quality data. If data package deliverables have been requested, the laboratory will complete the appropriate forms (CLP-like data package forms) summarizing sample results and the quality control information, and assemble

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copies of all raw data (instrument printouts, spectra, chromatograms, laboratory notebooks, etc.) Each "fraction" of the data package is technically reviewed by the Group Leader or an experienced analyst in the analytical group producing that portion of the data. This information from the various analytical groups is combined into one package in the client requested format. This package is reviewed by the Quality Assurance Department for conformance with SOPs and to ensure that all QC goals have been met. Any analytical problems are discussed in the case narrative, which is also included with the data package deliverables.

The review of the data by the Quality Assurance Department includes spot checking raw data versus the final report, checking that all pertinent raw data are included and refers to the samples analyzed, review of all QC results for conformance with the method, and review of the case narrative for description of any unusual occurrences during analysis. This review is performed using techniques similar to the validation used by the Sample Management Office for the USEPA's Contract Laboratory Program. The review performed by the laboratory differs from "validation" because it does not address useability of the data, which usually requires some knowledge of the site. The laboratory will make every attempt to meet the requirements of this LQAP, thus reducing the need to assess useability of the data.

The LIMS are programmed to accept and track the results of quality control samples including blanks, spike recoveries, duplicates, controls, and reference materials. These computerized systems are programmed with the acceptance criteria for each type of QC sample and display explanation codes if the data are not within specifications. The LIMS produce control charts to aid in data review. These are available for review by analysts, Group Leaders, and the Quality Assurance Department to assess the severity of observed problems and data trends. If

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needed, reports are produced by the analytical groups for the purpose of documenting any corrective actions taken. The flow of data from the time the samples enter the laboratory until the data are reported are summarized in Table 11-1.

Any data recorded manually will be collected in bound notebooks. All entries will be in ink, with no erasures or white-out being permitted. Any changes in data will be made using a single line to avoid obliteration of the original entry and will be dated and signed. Any data resulting from instrument printouts will be dated and will contain the signature and/or identification of the analyst responsible for its generation. After copies of the data are incorporated into the data package deliverables, the originals will be stored in locked archives at the laboratory for a period of ten years.

Project files will be created per client/project and will contain chain-of-custody records, analysis requirements, and laboratory acknowledgements which document samples received, laboratory sample number assignment, and analysis requested. Raw data are filed per batch number assignment and laboratory sample number which correlates to the sample receipt documents. When the project is complete, all documentation is archived in a limited access area and retained for ten years.

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Table 11-1

Sample and Data Routing at Mountain States Analytical, Inc.		
	Action	Personnel Involved
1	Sample received at MSAI	Sample Administration Staff
2	Sample is entered onto LIMS (lab ID number assigned, analyses scheduled, chain of custody started, storage location assigned)	Sample Administration Staff
3	Sample stored in assigned location (refrigerator, freezer, etc.)	Sample Administration Staff
4	Acknowledgement sent to client	Sample Administration Staff
5	Sample removed from storage for analysis and returned to the assigned storage location.	Sample Administration Staff
6	Sample obtained for analysis; necessary aliquot taken and sample returned to Sample Administration for storage	Technical Staff
7	Analysis is performed according to selected analytical method; raw data recorded, reviewed, and transferred to computer by analyst or technician*	Technical Staff
8	Computer performs calculations as programmed according to methods	Data Processing
9	Another analyst or supervisor verifies raw data	Technical Staff
10	Data package deliverables** are assembled	Data Package Staff
11	Data packages are reviewed	Quality Assurance Dept.
12	Data packages and analytical reports are reviewed against client requirements prior to mailing	Client Manager
13	Data packages and analytical reports are sent to the client; copies of all relevant documentation are stored in the archives.	Document Control Staff

\* Analyses requiring the analyst's interpretation may involve manual data reduction prior to entry onto the computer.

\*\* Analysis reports not requiring a data package are printed directly from LIMS and are reviewed at step 12 before mailing.

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## Internal Quality Control Checks

The particular types and frequencies of quality control checks analyzed with each sample are defined in each methods. General quality control check guidance is given in USEPA SW-846, the CLP organic and inorganic statements of work, and EPA quality assurance manuals. The quality control checks (QC checks) routinely performed during sample analysis include surrogates, matrix spikes, duplicates, blanks, internal standards, and laboratory control samples. In addition to these checks, some inorganic analyses employ post digestion spikes, analytical spikes, serial dilutions, and interference check samples. The tables in this section list the types and frequency of the quality control checks performed, along with the acceptance criteria and corrective action to take if a QC check falls outside of its acceptance limit. Calibration checks with their corresponding criteria and frequencies are given in Section No. 9. Limits of Quantitation (LOQs) can be found in Section No. 10. The formulas for calculating these quality control checks are found in Section No. 15.

Surrogates (SURR) (used for organic analysis only) - Each sample, matrix spike, matrix spike duplicate, and blank are spiked with surrogate compounds prior to purging and extraction in order to monitor preparation and analysis. Surrogates are used to evaluate analytical efficiency by measuring the percent recovery.

Matrix Spikes (MS) - A matrix (soil or water) is spiked at the laboratory with known quantities of specific compounds and subjected to the entire analytical procedure in order to indicate the appropriateness of the method for the matrix by measuring the percent recovery.

Duplicates (DUP, MSD) (duplicate and matrix spike duplicate) - A second aliquot of a matrix/sample is taken at the start of sample

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preparation and analyzed at the same time as the original sample in order to determine the precision of the method. Recovery of the original or matrix spike compared to the duplicate (or matrix spike duplicate) is expressed as a Relative Percent Difference (RPD).

Blanks (BLK) (method and preparation) - Blanks are an analytical control consisting of a volume of deionized, distilled laboratory water for water samples, or a purified solid matrix for soil/sediment samples. Metals use a digested reagent blank with soils. Blanks are treated with the same reagents, internal standards, and surrogate standards, and carried through the entire analytical procedure. The blank is used to define the level of laboratory background contamination. Field, trip, and storage blanks are used to define the level of background contamination from the corresponding phase of sample handling.

Internal Standards (IS) (used for GC/MS analysis) - Internal standards are compounds added to every standard, blank, matrix spike, matrix spike duplicate, and sample at a known concentration, prior to analysis. Comparison of the peak areas of the internal standards are used for internal standard quantitation as well as to determine when changes in the instrument response will adversely affect quantification of target compounds.

Laboratory Control Samples (LCS) - Aqueous and solid control samples of known composition are analyzed using the same sample preparation, reagents, and analytical methods employed for the sample. For inorganics, LCS percent recovery must fall within established control limits. For organics, an LCS is run when MS/MSD recovery falls outside established limits. The organic LCS percent recovery must fall within acceptance limits based on statistical evaluation of past laboratory data.

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Post Digestion Spike (PDS) (used for inorganics only) - If the matrix spike falls outside of its control limits, the digested parent sample is spiked with known quantities of the analytes which failed, and analyzed in order to verify the matrix spike result or any suspected interferences.

Analytical Spike (A) (used for GFAA analysis only) - Graphite furnace analyses are required to spike each sample, blank, and laboratory control sample with a known quantity of the analyte of interest after their digestion. The percent recovery determines the outcome of the data (See Figure 12-1).

Serial Dilutions (L) (used for inorganics ICP only) - If the analyte concentration is sufficiently high ( $\geq 50 \times$  the Instrument Detection Limit) an analysis of a 5 fold dilution must agree within 10% of the original determination. If the dilution analysis is not within 10%, a chemical or physical interference effect should be suspected.

Interference Check Sample (ICS) (used for inorganics ICP only) - To verify interelement and background correction factors a solution containing both interfering and analyte elements of known concentration are analyzed at the beginning and end of each analysis run or a minimum of twice per 8 hours.

The results of all quality control samples are entered into the computer along with sample results. The computer is programmed to compare the individual values with the acceptance limits. If the results are not within the acceptance criteria, appropriate corrective action is taken. For some analytical tests, control limits are generated by spreadsheet, and the comparison of results to control limits is done manually. Control Charts are plotted via computer showing mean and standard deviation and indicating trends or method bias. They may be accessed by laboratory personnel.

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Quality control data are kept for spikes, duplicates, laboratory control samples, surrogates, calibration verifications, and blanks. Control limit definition and the procedures used to calculate them are found in Section No. 15. A new LIMS in development at MSAI will identify adverse trends as out-of-control conditions, so that appropriate corrective action may be taken.

Acceptance criteria for spikes, duplicates, laboratory control samples, and surrogates will be defined as the more restrictive of the limits given in the method or statistically determined control limits. This definition will be in effect after April 1, 1996. Exceptions are made for acceptance limits defined by a statement of work, such as for CLP.

Table 12-1

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GC/MS Volatile Organic Compounds Quality Control* (524.2)			
QC Check	Acceptance Limits	Frequency	Corrective Action
<b>SURR:</b> Bromofluorobenzene 1,2-Dichlorobenzene-d4	Smaller of statistical or method limits	Each sample, MS, MSD, BLK, and LCS	Reanalyze sample. If reanalysis confirms original, document on report and case narrative
<b>MS:</b> Spike all compounds of interest	Smaller of statistical or method limits	Once per group of $\leq 20$ samples per matrix/level	Run LCS for compounds that failed
<b>MSD:</b> Spike all compounds of interest	Smaller of statistical or method limits	Once per group of $\leq 20$ samples per matrix/level	Evaluated by analyst in relationship to other QC results
<b>BLK:</b>	$\leq \text{LOQ}^1$	Once for each 8 hour time period	Reanalyze blank and associated samples
<b>IS:</b> Fluorobenzene	-50% to +100% of internal standard area of 8-hour STD  Retention time change $\leq 30$ seconds	Each sample, MS, MSD, BLK, and LCS	Reanalyze sample. If reanalysis confirms original, document on report and case narrative
<b>LCS:</b> Spike all compounds of interest	Smaller of statistical or method limits	Once per group of $\leq 20$ samples per matrix/level when MS/MSD fail	Reanalyze LCS and associated samples for compounds that failed

\*Accuracy is subject to change over time.

<sup>1</sup>A BLK acceptance limit of  $\leq 25$  times LOQ (Methylene chloride and acetone) and  $\leq 50$  LOQ (2-butanone) is allowed.

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Table 12-2

GC/MS Volatile Organic Compounds Quality Control* (624)				
QC Check	Acceptance Limits		Frequency	Corrective Action
	water	soil		
<b>SURR:</b> Toluene-d8 Bromofluorobenzene Dibromofluoromethane	Smaller of statistical or method limits		Each sample, MS, MSD, BLK, and LCS	Reanalyze sample. If reanalysis confirms original, document on report and case narrative
<b>MS:</b> Spike all compounds of interest	Smaller of statistical or method limits		Once per group of $\leq 20$ samples per matrix/level	Run LCS for compounds that failed
<b>MSD:</b> Spike all compounds of interest	Smaller of statistical or method limits		Once per group of $\leq 20$ samples per matrix/level	Evaluated by analyst in relationship to other QC results
<b>BLK:</b>	$\leq \text{LOQ}^1$		Once for each 12 hour time period	Reanalyze blank and associated samples
<b>IS:</b> Bromochloromethane 1,4-Difluorobenzene Chlorobenzene-d5 1,4-Dichlorobenzene-d4	-50% to +100% of internal standard area of 12-hour STD  Retention time change $\leq 30$ seconds		Each sample, MS, MSD, BLK, and LCS	Reanalyze sample. If reanalysis confirms original, document on report and case narrative
<b>LCS:</b> Spike all compounds of interest	Smaller of statistical or method limits		Once per group of $\leq 20$ samples per matrix/level when MS/MSD fail	Reanalyze LCS and associated samples for compounds that failed

\*Accuracy is subject to change over time.

<sup>1</sup>A BLK acceptance limit of  $\leq 25$  times LOQ (Methylene chloride and acetone) and  $\leq 50$  LOQ (2-butanone) is allowed.

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Table 12-3

GC/MS Volatile Organic Compound Quality Control (SW-846)				
QC Check	Acceptance Limits		Frequency	Corrective Action
	water	soil		
<b>SURR:</b> Toluene-d8 Bromofluorobenzene Dibromofluoromethane	Smaller of statistical or method limits		Each sample, MS, MSD, BLK, and LCS	Reanalyze sample. If reanalysis confirms original, document on report and case narrative
<b>MS:</b> Spike all compounds of interest	Smaller of statistical or method limits		Once per group of $\leq 20$ samples per matrix/level	Run LCS for compounds that failed
<b>MSD:</b> Spike all compounds of interest	Smaller of statistical or method limits		Once per group of $\leq 20$ samples per matrix/level	Evaluated by analyst in relationship to other QC results
<b>BLK:</b>	$\leq \text{LOQ}^1$		Once for each 12 hour time period	Reanalyze blank and associated samples
<b>IS:</b> Bromochloromethane 1,4-Difluorobenzene Chlorobenzene-d5 1,4-Dichlorobenzene-d4	-50% to +100% of internal standard area of 12-hour STD  Retention time change $\leq 30$ seconds		Each sample, MS, MSD, BLK, and LCS	Reanalyze sample. If reanalysis confirms original, document on report and case narrative
<b>LCS:</b> Spike all compounds of interest	Smaller of statistical or method limits		Once per group of $\leq 20$ samples per matrix/level when MS/MSD fail	Reanalyze LCS and associated samples for compounds that failed

\*Accuracy is subject to change over time.

<sup>1</sup>A BLK acceptance limit of  $\leq 25$  times LOQ (Methylene chloride and acetone) and  $\leq 50$  LOQ (2-butanone) is allowed.

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Table 12-4

GC/MS Volatile Organic Compound Quality Control (CLP)				
QC Check	Acceptance Limits		Frequency	Corrective Action
	water	soil		
<b>SURR:</b> Toluene-d8 Bromofluorobenzene 1,2-Dichloroethane-d4	Recov. 88-110% 86-115% 76-114%	Recov. 84-138% 59-113% 70-121%	Each sample, MS, MSD, BLK, and LCS	Reanalyze sample. If reanalysis confirms original, document on report and case narrative
<b>MS:</b> 1,1-Dichloroethene Trichloroethene Benzene Toluene Chlorobenzene	Recov. 61-145% 71-120% 76-127% 76-125% 75-130%	Recov. 59-172% 62-137% 66-142% 59-139% 60-133%	Once per group of $\leq 20$ samples per matrix/level	Evaluated by analyst in relationship to other QC results
<b>MSD:</b> 1,1-Dichloroethene Trichloroethene Benzene Toluene Chlorobenzene	RPD 14 14 11 13 13	RPD 22 24 21 21 21	Once per group of $\leq 20$ samples per matrix/level	Evaluated by analyst in relationship to other QC results
<b>BLK:</b>	$\leq$ CRQL <sup>1</sup>		Once for each 12 hour time period	Reanalyze blank and associated samples
<b>IS:</b> Bromochloromethane 1,4-Difluorobenzene Chlorobenzene-d5	-50% to +100% of internal standard area of 12-hour STD  Retention time change <30 seconds		Each sample, MS, MSD, BLK, and LCS	Reanalyze sample. If reanalysis confirms original, document on report and case narrative

\*Accuracy is subject to change over time.

<sup>1</sup>Methylene chloride has a BLK acceptance limit of  $\leq 2.5$  times its CRQL. Acetone and 2-butanone have a BLK acceptance limit of  $\leq 5$  times their respective CRQLs.

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Table 12-5

GC/MS Semivolatile Organic Compounds Quality Control (625)				
QC Check	Acceptance Limits		Frequency	Corrective Action
	water	soil		
<b>SURR:</b> Nitrobenzene-d5 2-Fluorobiphenyl Terphenyl-d14 Phenol-d6 2-Fluorophenol 2,4,6-Tribromophenol	Smaller of statistical or method limits		Each sample, MS, MSD, BLK, and LCS	Repeat analysis if more than one SURR out per fraction or any recovery <10%. If reanalysis confirms original, document on report and case narrative
<b>MS:</b> Spike all compounds of interest	Smaller of statistical or method limits		Once per group of ≤20 samples per matrix/level	Run LCS for compounds that failed
<b>MSD:</b> Spike all compounds of interest	Smaller of statistical or method limits		Once per group of ≤20 samples per matrix/level	Evaluated by analyst in relationship to other QC results
<b>BLK:</b>	≤LOQ <sup>1</sup>		Once per group of ≤20 samples per matrix/level	Re-extract and reanalyze blank and associated samples
<b>IS:</b> 1,4-Dichlorobenzene-d4 Naphthalene-d8 Acenaphthene-d10 Phenanthrene-d10 Chrysene-d12 Perylene-d12	-50% to +100% of internal standard area of 12-hour STD  Retention time change ≤30 seconds		Each sample, MS, MSD, BLK, and LCS	Reanalyze sample. If reanalysis confirms original, document on report and case narrative
<b>LCS:</b> Spike all compounds of interest	Smaller of statistical or method limits		Once per group of ≤20 samples per matrix/level when MS/MSD fail	Re-extract and reanalyze LCS and associated samples for compounds that failed

Accuracy is subject to change over time.

<sup>1</sup>Phthalate esters & benzaldehyde have a BLK acceptance limit of ≤ 5 x LOQ.

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Table 12-6

GC/MS Semivolatile Organic Compounds Quality Control (SW-846)				
QC Check	Acceptance Limits		Frequency	Corrective Action
	water	soil		
<b>SURR:</b> Nitrobenzene-d5 2-Fluorobiphenyl Terphenyl-d14 Phenol-d6 2-Fluorophenol 2,4,6-Tribromophenol	Smaller of statistical or method limits		Each sample, MS, MSD, BLK, and LCS	Repeat analysis if more than one SURR out per fraction or any recovery <10%. If reanalysis confirms original, document on report and case narrative
<b>MS:</b> Spike all compounds of interest	Smaller of statistical or method limits		Once per group of ≤20 samples per matrix/level	Run LCS for compounds that failed
<b>MSD:</b> Spike all compounds of interest	Smaller of statistical or method limits		Once per group of ≤20 samples per matrix/level	Evaluated by analyst in relationship to other QC results
<b>BLK:</b>	≤LOQ <sup>1</sup>		Once per group of ≤20 samples per matrix/level	Re-extract and reanalyze blank and associated samples
<b>IS:</b> 1,4-Dichlorobenzene-d4 Naphthalene-d8 Acenaphthene-d10 Phenanthrene-d10 Chrysene-d12 Perylene-d12	-50% to +100% of internal standard area of 12-hour STD  Retention time change ≤30 seconds		Each sample, MS, MSD, BLK, and LCS	Reanalyze sample. If reanalysis confirms original, document on report and case narrative
<b>LCS:</b> Spike all compounds of interest	Smaller of statistical or method limits		Once per group of ≤20 samples per matrix/level when MS/MSD fail	Re-extract and reanalyze LCS and associated samples for compounds that failed

Accuracy is subject to change over time.

<sup>1</sup>Phthalate esters and benzaldehyde have a BLK accept.limit of ≤ 5 x LOQ.

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Table 12-7

GC/MS Semivolatile Organic Compounds Quality Control <sup>1</sup> (CLP)				
QC Check	Acceptance Limits		Frequency	Corrective Action
	water	soil		
<b>SURR:</b> Nitrobenzene-d5 2-Fluorobiphenyl Terphenyl-d14 Phenol-d5 2-Fluorophenol 2,4,6-Tribromophenol	%Recov. 35-114 43-116 33-141 10-110 21-110 10-123	%Recov. 23-120 30-115 18-137 24-113 25-121 19-122	Each sample, MS, MSD, BLK, and LCS	Repeat analysis if more than one SURR out per fraction or any recovery <10%. If reanalysis confirms original, document on report and case narrative
<b>MS:</b> Phenol 2-Chlorophenol 1,4-Dichlorobenzene N-Nitroso-di-n-prop. 1,2,4-Trichlorobenz. 4-Chloro-3-methylphe. Acenaphthene 4-Nitrophenol 2,4-Dinitrotoluene Pentachlorophenol Pyrene	%Recov. 12-110 27-123 36-97 41-116 39-98 23-97 46-118 10-80 24-96 9-103 26-127	%Recov. 26-90 25-102 28-104 41-126 38-107 26-103 31-137 11-114 28-89 17-109 35-142	Once per group of ≤20 samples per matrix/level	Evaluated by analyst in relationship to other QC results
<b>MSD:</b> Phenol 2-Chlorophenol 1,4-Dichlorobenzene N-Nitroso-di-n-prop. 1,2,4-Trichlorobenz. 4-Chloro-3-methylphe. Acenaphthene 4-Nitrophenol 2,4-Dinitrotoluene Pentachlorophenol Pyrene	RPD 42 40 28 38 28 42 31 50 38 50 31	RPD 35 50 27 38 23 33 19 50 47 47 36	Once per group of ≤20 samples per matrix/level	Evaluated by analyst in relationship to other QC results
<b>BLK:</b>	≤CRQL <sup>1</sup>		Once per group of ≤20 samples per matrix/level	Re-extract and reanalyze blank and associated samples

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Table 12-7 (continued)

GC/MS Semivolatile Organic Compounds Quality Control (CLP)				
QC Check	Acceptance Limits		Frequency	Corrective Action
	water	soil		
<b>IS:</b> 1,4-Dichlorobenz.-d4 Naphthalene-d8 Acenaphthene-d10 Phenanthrene-d10 Chrysene-d12 Perylene-d12	-50% to +100% of internal standard area of 12-hour STD  Retention time change ≤30 seconds		Each sample, MS, MSD, BLK, and LCS	Reanalyze sample. If reanalysis confirms original, document on report and case narrative

Accuracy is subject to change over time.

<sup>1</sup>Phthalate esters have a BLK acceptance limit of ≤ 5 x CRQL.

Table 12-8

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Volatile Organic Compounds by GC Quality Control (502.2)			
QC Check	Acceptance Limits	Frequency	Corrective Action
<b>SURR:</b> Halocarbons: Chlorocyclohexane (ELCD) Aromatics: Fluorobenzene (PID)	Smaller of statistical or method limits	Each sample, MS, MSD, BLK, and LCS	Results would not be reported unless matrix related problems are evident
<b>MS:</b>	Smaller of statistical or method limits	Once per group of ≤20 samples	Run LCS for compounds that failed
<b>MSD:</b>	Smaller of statistical or method limits	Once per group of ≤20 samples	Evaluated by analyst in relationship to other QC results
<b>BLK:</b>	≤LOQ	Once per group of ≤20 samples	Reanalyze blank and associated samples
<b>LCS:</b>	Smaller of statistical or method limits	Once per group of ≤20 samples when MS/MSD fail	Reanalyze LCS and associated samples for compounds that failed

\*Accuracy is subject to change over time.

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Table 12-9

Volatile Organic Compounds by GC Quality Control* (601/602)				
QC Check	Acceptance Limits		Frequency	Corrective Action
	water	soil		
<b>SURR:</b> Halocarbons: Chlorocyclohexane (ELCD) Aromatics: Fluorobenzene (PID)	Smaller of statistical or method limits		Each sample, MS, MSD, BLK, and LCS	Results would not be reported unless matrix related problems are evident
<b>MS:</b>	Smaller of statistical or method limits		Once per group of $\leq 20$ samples per matrix/level	Run LCS for compounds that failed
<b>MSD:</b>	Smaller of statistical or method limits		Once per group of $\leq 20$ samples per matrix/level	Evaluated by analyst in relationship to other QC results
<b>BLK:</b>	$\leq$ LOQ		Once per $\leq 20$ samples per matrix	Reanalyze blank and associated samples
<b>LCS:</b>	Smaller of statistical or method limits		Once per group of $\leq 20$ samples per matrix/level when MS/MSD fail	Reanalyze LCS and associated samples for compounds that failed

\*Accuracy is subject to change over time.

Table 12-10

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Volatile Organic Compounds by GC Quality Control (SW-846)				
QC Check	Acceptance Limits		Frequency	Corrective Action
	water	soil		
<b>SURR:</b> Halocarbons: Chlorocyclohexane (ELCD) Aromatics: Fluorobenzene (PID)	Smaller of statistical or method limits		Each sample, MS, MSD, BLK, and LCS	Results would not be reported unless matrix related problems are evident
<b>MS:</b>	Smaller of statistical or method limits		Once per group of ≤20 samples per matrix/level	Run LCS for compounds that failed
<b>MSD:</b>	Smaller of statistical or method limits		Once per group of ≤20 samples per matrix/level	Evaluated by analyst in relationship to other QC results
<b>BLK:</b>	≤LOQ		Once per <20 samples per matrix	Reanalyze blank and associated samples
<b>LCS:</b>	Smaller of statistical or method limits		Once per group of ≤20 samples per matrix/level when MS/MSD fail	Reanalyze LCS and associated samples for compounds that failed

\*Accuracy is subject to change over time.

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Table 12-11

Pesticides, PCBs, and Herbicides Quality Control (500 Series)			
QC Check	Acceptance Limits	Frequency	Corrective Action
<b>SURR:</b> Organochloride pesticides: Decachlorobiphenyl Organophosphate pesticides: 2-Nitro-m-xylene Herbicides: 2,4-Dichlorophenyl-acetic acid	Smaller of statistical or method limits	Each sample, MS, MSD, BLK, and LCS during the extraction phase	At least one SURR must pass unless matrix related problems are evident, in which case, document on report and case narrative
<b>MS:</b> Organochloride pesticides: Spike all compounds of interest except PCBs, chlordane, and toxaphene Organophosphate pesticides: Spike for Phorate, Disulfoton, Famphur, Methyl parathion, Ethyl parathion Herbicides: Spike all compounds of interest	Smaller of statistical or method limits	Once per group of $\leq 20$ samples per matrix/level	Run LCS for compounds that failed
<b>MSD:</b> (Same information as the MS)	Smaller of statistical or method limits	Once per group of $\leq 20$ samples per matrix/level	Evaluated by analyst in relationship to other QC results

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Table 12-11 (Continued)

<b>Pesticides, PCBs, and Herbicides Quality Control (500 Series)</b>			
<b>QC Check</b>	<b>Acceptance Limits</b>	<b>Frequency</b>	<b>Corrective Action</b>
<b>BLK:</b>	$\leq$ LOQ	Once per group of $\leq$ 20 samples per matrix/level	Inject a hexane or solvent blank first to ensure the system is clean. Reinject blank. If acceptable, reinject associated samples. If unacceptable, reextract group
<b>LCS:</b> (Same information as the MS)	Smaller of statistical or method limits	Once per group of $\leq$ 20 samples per matrix/level when MS/MSD fail	Reextract and reanalyze LCS and associated samples for compounds that failed

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Table 12-12

Pesticides, PCBs, and Herbicides Quality Control (600 Series)				
QC Check	Acceptance Limits		Frequency	Corrective Action
	water	soil		
<b>SURR:</b> Organochloride pesticides: Decachlorobiphenyl Tetrachloro-m-xylene Organophosphate pesticides: 2-Nitro-m-xylene Herbicides: 2,4-Dichlorophenyl-acetic acid	Smaller of statistical or method limits		Each sample, MS, MSD, BLK, and LCS during the extraction phase	At least one SURR must pass unless matrix related problems are evident, in which case, document on report and case narrative
<b>MS:</b> Organochloride pesticides: Spike all compounds of interest except PCBs, chlordane, and toxaphene Organophosphate pesticides: Spike for Phorate, Disulfoton, Famphur, Methyl parathion, Ethyl parathion Herbicides: Spike all compounds of interest	Smaller of statistical or method limits		Once per group of $\leq 20$ samples per matrix/level	Run LCS for compounds that failed
<b>MSD:</b> (Same information as the MS)	Smaller of statistical or method limits		Once per group of $\leq 20$ samples per matrix/level	Evaluated by analyst in relationship to other QC results

Table 12-12 (Continued)

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Pesticides, PCBs, and Herbicides Quality Control (600 Series)				
QC Check	Acceptance Limits		Frequency	Corrective Action
	water	soil		
BLK:	≤LOQ		Once per group of ≤20 samples per matrix/level	Inject a hexane or solvent blank first to ensure the system is clean. Reinject blank. If acceptable, reinject associated samples. If unacceptable, reextract group
LCS: (Same information as the MS)	Smaller of statistical or method limits		Once per group of ≤20 samples per matrix/level when MS/MSD fail	Reextract and reanalyze LCS and associated samples for compounds that failed

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Table 12-13

Pesticides, PCBs, and Herbicides Quality Control (SW-846)				
QC Check	Acceptance Limits		Frequency	Corrective Action
	water	soil		
<b>SURR:</b> Organochloride pesticides: Decachlorobiphenyl Tetrachloro-m-xylene Organophosphate pesticides: 2-Nitro-m-xylene Herbicides: 2,4-Dichlorophenyl-acetic acid	Smaller of statistical or method limits		Each sample, MS, MSD, BLK, and LCS during the extraction phase	At least one SURR must pass unless matrix related problems are evident, in which case, document on report and case narrative
<b>MS:</b> Organochloride pesticides: Spike all compounds of interest except PCBs, chlordane, and toxaphene Organophosphate pesticides: Spike for Phorate, Disulfoton, Famphur, Methyl parathion, Ethyl parathion Herbicides: Spike all compounds of interest	Smaller of statistical or method limits		Once per group of $\leq 20$ samples per matrix/level	Run LCS for compound that failed
<b>MSD:</b> (Same information as the MS)	Smaller of statistical or method limits		Once per group of $\leq 20$ samples per matrix/level	Evaluated by analyst in relationship to other QC results

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Table 12-13 (Continued)

Pesticides, PCBs, and Herbicides Quality Control (SW-846)				
QC Check	Acceptance Limits		Frequency	Corrective Action
	water	soil		
BLK:	≤LOQ		Once per group of ≤20 samples per matrix/level	Inject a hexane or solvent blank first to ensure the system is clean. Reinject blank. If acceptable, reinject associated samples. If unacceptable, reextract group
LCS: (Same information as the MS)	Smaller of statistical or method limits		Once per group of ≤20 samples per matrix/level when MS/MSD fail	Reextract and reanalyze LCS and associated samples for compounds that failed

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Table 12-14

Pesticides, PCBs, and Herbicides Quality Control (CLP)				
QC Check	Acceptance Limits		Frequency	Corrective Action
	water	soil		
<b>SURR:</b>  Decachlorobiphenyl Tetrachloro-m-xylene	%Recov. 30-150% 30-150%	%Recov. 30-150% 30-150%	Each sample, MS, MSD, and BLK during the extraction phase	At least one SURR must pass unless matrix related problems are evident, in which case, document on report and case narrative
<b>MS:</b>  Lindane Heptachlor Aldrin Dieldrin Endrin 4,4'-DDT	%Recov. 56-123 40-131 40-120 52-126 56-121 38-127	%Recov. 46-127 35-130 34-132 31-134 42-139 23-134	Once per group of ≤20 samples per matrix/level	Evaluated by analyst in relationship to other QC results
<b>MSD:</b>  Lindane Heptachlor Aldrin Dieldrin Endrin 4,4'-DDT	RPD 15 20 22 18 21 27	RPD 50 31 43 38 45 50	Once per group of ≤20 samples per matrix/level	Evaluated by analyst in relationship to other QC results
<b>BLK:</b>	≤CRQL		Once per group of ≤20 samples per matrix/level	Inject a hexane or solvent blank first to ensure the system is clean. Reinject blank. If acceptable, reinject associated samples. If unacceptable, reextract group

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Table 12-15

<b>Inorganics Quality Control (200 Series)</b>			
<b>QC Check</b>	<b>Acceptance Limits (water and soil)</b>	<b>Frequency</b>	<b>Corrective Action</b>
<b>MS:</b> Spike all analytes of interest	Smaller of statistical or method limits	Once per batch*	Confirm matrix effects with a post digestion spike (PDS) or by method of standard additions (MSA)
<b>DUP:</b>	Smaller of statistical or method limits	Once per batch*	Flag the data
<b>BLK:</b> Calibration blanks: Initial Calibration Blank (ICB) Continuing Calibration Blank (CCB)	$\leq$ LOQ ICP: statistical control limits	Each wavelength; after every calibration verification	Repeat and average results. If avg fails, correct problem, recalibrate, and rerun from last acceptable CCB
<b>BLK:</b> Preparation blanks (PB)	$\leq$ MDL or $\leq$ 5% of sample concentration or $\leq$ 5% of regulatory limit.	10% or minimum of once per batch*	Reanalyze. If still out, then redigest and reanalyze BLK and associated samples for analytes that failed
<b>LCS:</b> Spike all compounds of interest	Smaller of statistical or method limits	Once per batch*	Redigest and reanalyze LCS and associated samples for analytes that failed
<b>QCS (Quality Control Sample):</b> (ICP only)	$\pm$ 5% of certified value	Once per week, if analyses are done	Prepare new calibration solution

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Table 12-15 (Continued)

Inorganics Quality Control (200 Series)			
QC Check	Acceptance Limits (water and soil)	Frequency	Corrective Action
PDS: (Not used for GFAA)	Not Applicable	As needed (e.g., when MS fails)	Evaluated by analyst in relationship to other QC results
Analytical Spike (A): (GFAA only)	85-115%	Once per batch*	Use method of standard addition (MSA)
Serial Dilution (L): (ICP only)	Within $\pm 10\%$ of the original determination	Once per batch*	Flag the data
ICS: (ICP only)	Within $\pm 20\%$ of true value for the analytes	Each wavelength; after cal. verification at beginning and end of every run; at least twice every 8 hrs	Recalibrate and rerun samples from last good ICS

\*Batch refers to samples prepared together as a group. Batch size is typically  $\leq 20$  samples, but requirements may vary by method. Batches are grouped according to matrix, concentration level, and analytical method.

Table 12-16

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Inorganics Quality Control (SW-846)			
QC Check	Acceptance Limits (water and soil)	Frequency	Corrective Action
<b>MS:</b> Spike all analytes of interest	Smaller of statistical or method limits	Once per batch*	Confirm matrix effects with a post digestion spike (PDS) or by method of standard additions (MSA)
<b>MSD:</b> Spike all analytes of interest	Smaller of statistical or method limits	Once per batch*	Evaluated by analyst in relationship to other QC results
<b>DUP:</b>	Smaller of statistical or method limits	Once per batch*	Flag the data
<b>BLK:</b> Calibration blanks:  Initial Calibration Blank (ICB)  Continuing Calibration Blank (CCB)	Statistical limits (mean $\pm$ 3s)	Each wavelength; after each calibration verification	Repeat twice and average. If avg of 3 analyses fails, correct any problem, recalibrate, and reanalyze samples after last acceptable CCB.
<b>BLK:</b> Preparation blanks (PB)	$\leq$ MDL or $\leq$ 5% of sample concentration or $\leq$ 5% of regulatory limit	10% or once per batch*	Reanalyze. If still out, redigest and reanalyze BLK and associated samples for analytes that failed
<b>LCS:</b> Spike all compounds of interest	Smaller of statistical or method limits	Once per batch*	Redigest and reanalyze LCS and associated samples for analytes that failed

Table 12-16 (Continued)

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<b>Inorganics Quality Control (SW-846)</b>			
<b>QC Check</b>	<b>Acceptance Limits (water and soil)</b>	<b>Frequency</b>	<b>Corrective Action</b>
<b>PDS:</b> (not performed for GFAA)	75-125%	When MS/MSD fail	Evaluated by analyst in relationship to other QC results
<b>Analytical spike (A):</b> (GFAA only)	85-115%	Once per batch*	Analyze by method of standard addition (MSA)
<b>Serial Dilution (L):</b> (ICP only)	Within $\pm 10\%$ of the original determination	Once per batch*	Flag the data
<b>ICS:</b> (ICP only)	Within $\pm 20\%$ of true value for the analytes	Each wavelength; after calibration verification at beginning and end of every run; at least twice every 8 hrs	Recalibrate and rerun samples from last good ICS

\*HAA analyses have a frequency of once per group of  $\leq 10$  samples per matrix/level.

Table 12-17

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<b>Inorganics Quality Control (CLP)</b>			
<b>QC Check</b>	<b>Acceptance Limits (water and soil)</b>	<b>Frequency</b>	<b>Corrective Action</b>
<b>MS:</b> (Spike all compounds per CLP Inorganic SOW Exhibit E, Table 3)	75-125% except where sample concentration is $\geq 4$ times the spike concentration	Once per SDG <sup>*</sup> of $\leq 20$ samples per matrix, level and method	Analyze a post digestion spike (PDS) on parent sample and flag the data
<b>DUP:</b>	Sample results $< 5 \times$ CRDL must be within a CRDL of each other. Others $\leq 20\%$ RPD	Once per SDG <sup>*</sup> of $\leq 20$ samples per matrix, level and method <sup>*</sup>	Flag the data
<b>BLK:</b> Calibration blanks:	$\leq$ CRDL	Each wavelength; after init. calibration verification	Correct problem and recalibrate
Initial Calibration Blank (ICB)			
Continuing Calibration Blank (CCB)	$\leq$ CRDL	Each wavelength; after each continuing calibration verification	Correct problem, recalibrate or reslope, and reanalyze samples following last acceptable CCB
<b>BLK:</b> Preparation blanks (PB)	$\leq$ CRDL or $>$ CRDL when lowest concentration in samples is $> 10$ times PB concentration	Once per SDG <sup>*</sup> of $\leq 20$ samples per matrix, level and method	Redigest and reanalyze BLK and associated samples for analytes that failed
<b>LCS:</b> Spike all compounds of interest	80-120% for water  Certified limits for soil	Once per SDG <sup>*</sup> of $\leq 20$ samples per matrix/level and method <sup>*</sup>	Redigest and reanalyze LCS and associated samples for analytes that failed

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**Table 12-17 (Continued)**

<b>Inorganics Quality Control (CLP)</b>			
<b>QC Check</b>	<b>Acceptance Limits (water and soil)</b>	<b>Frequency</b>	<b>Corrective Action</b>
<b>PDS:</b> (Spike at 2X CRDL or 2X indigenous conc.) (not done for GFAA)	Not applicable	When MS/MSD fail	Not applicable
<b>Analytical Spike (A):</b> (Spike at 2X CRDL) (GFAA only)	85-115%	Each sample, DUP, PB, and LCS	See Figure 12-1
<b>Serial dilution (L):</b>  (ICP only)	Within $\pm 10\%$ of the original determination	Once per SDG* of $\leq 20$ samples per matrix/level	Flag the data
<b>ICS:</b> (Includes: ICSA - no limits ICSAB - evaluated)  (ICP only)	Within $\pm 20\%$ of true value for the analytes	Each wavelength; after calibration verification at beginning and end of every run, or twice every 8 hrs	Recalibrate and rerun samples from last good ICS

\*Sample Delivery Group

Figure 12-1

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**Graphite Furnace Atomic Absorption Analysis Scheme**

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Table 12-18

<b>Anions by Ion Chromatography</b>			
<b>QC Check</b>	<b>Acceptance Limits<sup>*</sup></b>	<b>Frequency</b>	<b>Corrective Action</b>
<b>MS:</b> Spike all analytes of interest	Statistical limits or 80-120%	Once per 10 samples	Evaluated by analyst in relationship to other QC results
<b>MSD:</b> Spike all analytes of interest	Statistical limits or 80-120% Recovery/ ≤20% RPD	Once per 10 samples	Evaluated by analyst in relationship to other QC results
<b>BLK:</b>	≤LOQ	Before each analysis run	Reanalyze blank, and correct any problem.
<b>LCS:</b> Spike all analytes of interest	Statistical limits or 80-120%	Before each analysis run	Reanalyze LCS, and correct any problem.

\*Limits of 80%-120% recovery for the MS, MSD, and LCS will be used until sufficient data points are collected to calculate statistical limits. Likewise, the RPD limit will be 20% for the MSD until statistical limits are determined.

Table 12-19

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General Chemistry Quality Control <sup>1</sup>				
Parameter	BLK Limit <sup>1</sup>	MS/MSD Limits <sup>2†</sup>	DUP/MSD RPD Limits <sup>3†</sup>	LCS Limits <sup>1</sup>
Ammonia	≤LOQ	75-125%	≤20%	90-110%
BOD	≤LOQ	75-125%	≤20%	80-120%
Chloride	≤LOQ	75-125%	≤20%	90-110%
Chlorine	≤LOQ	75-125%	≤20%	90-110%
COD	≤LOQ	75-125%	≤20%	90-110%
Corrosivity	NA	NA	≤20%	90-110%
Cyanide <sup>4</sup>	≤LOQ	75-125%	≤20%	85-115%
Fluoride	≤LOQ	75-125%	≤20%	90-110%
Hardness	≤LOQ	75-125%	≤20%	90-110%
Ignitability	NA	NA	≤20%	90-110%
Nitrate/Nitrite	≤LOQ	75-125%	≤20%	90-110%
Oil and Grease	≤LOQ	75-125%	≤20%	90-110%
pH	NA	NA	≤20%	90-110%
Phenolics	≤LOQ	75-125%	≤20%	90-110%
Phosphorus, Total & Orthophosphate	≤LOQ	75-125%	≤20%	90-110%
Residues	≤LOQ	75-125%	≤20%	90-110%
Specific Conductance	≤LOQ	NA	≤20%	90-110%
Sulfate	≤LOQ	75-125%	≤20%	90-110%
Sulfide	≤LOQ	75-125%	≤20%	90-110%
Total Kjeldahl N	≤LOQ	75-125%	≤20%	90-110%
TOC water solid	≤LOQ	75-125%	≤20%	90-110%
	≤LOQ	75-125%	≤35%	90-110%
TOX	≤LOQ	75-125%	≤20%	85-115%
Turbidity	≤LOQ	75-125%	≤20%	30-110%

See "Notes" on the following page

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**Table 12-19 (Continued)**

**NOTES:**

**Frequency:** Each QC check is performed with 10% frequency

**Corrective Action:** If either the LCS or BLK is outside the acceptance criteria<sup>1</sup>, the QC and associated samples will be prepared again and reanalyzed. If either the MS or DUP is outside the criteria, the data are flagged.

**NA** is defined as "Not Applicable."

<sup>1</sup>Acceptance limits for MS/MSD, DUP/MSD, and LCS are the more restrictive of statistical control limits and the fixed limits shown in the table.

<sup>1</sup>Blanks that are greater than the LOQ are acceptable if the associated sample concentrations are greater than 10 times the blank concentration.

<sup>2</sup>Spikes recoveries are considered insignificant if the sample concentration exceeds 4 times the spike concentration used.

<sup>3</sup>Samples that are less than 5 times the LOQ must be within an LOQ of each other. Otherwise the  $\leq 20\%$  RPD limit applies.

<sup>4</sup>Cyanide by CLP methods will comply with the quality control specifications of ILM04.0, or the most current inorganic CLP Statement of Work.

**Performance and Systems Audits**

**289202**

Members of the Quality Assurance Department routinely conduct system audits of each department at Mountain States Analytical, Inc. (MSAI). The audits include reviews of methodology, reagent preparation, equipment calibration and maintenance, quality control results, and training of personnel. The results of the audits and corrective actions, when necessary, are communicated to laboratory personnel and management by means of a written report. Refer to Section No. 16 for corrective action procedures and to Section No. 17 for quality assurance reports to management. Audits by outside organizations including clients, regulatory agencies, and the USEPA are permitted by arrangement with the Quality Assurance Director.

Performance audits consist of both single-blind and double-blind proficiency evaluation samples. Performance audits initiated as single-blind samples are known to analysts, but the target analyte concentrations remain unknown until the results are evaluated. Double-blind samples containing known amounts of target analytes are prepared by the Quality Assurance Department and by commercial suppliers and submitted to the laboratories under fictitious client names. Quarterly performance audits include samples prepared by the Quality Assurance Department and samples from commercial suppliers. MSAI also participates in a number of single-blind interlaboratory performance evaluation programs. Inorganics, pesticide/herbicides, trihalomethanes, volatile organic compounds, semivolatile organic compounds, traditional general chemistry analyses, and geotechnical analyses are analyzed by MSAI for studies conducted by the USEPA, USDOE, and other government and private sector performance evaluation programs.

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The following list identifies performance evaluation programs in which MSAI routinely participates.

- ▶ USEPA Water Supply (WS) Performance Evaluation Program
- ▶ USEPA Water Pollution (WP) Performance Evaluation Program
- ▶ USEPA Discharge Monitoring Report-Quality Assurance (DMR-QA)
- ▶ NIOSH Environmental Lead Proficiency Analytical Testing (ELPAT)
- ▶ USDOE Mixed Analyte Performance Evaluation Program (MAPEP)
- ▶ AASHTO Material Reference Laboratory, at the National Institute of Standards and Technology (NIST), Soil Proficiency Sample Program

**Preventive Maintenance**

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In order to ensure timely production of data, Mountain States Analytical, Inc. (MSAI) schedules routine preventive maintenance of instruments based on manufacturer's recommendations. A company policy and procedure document included in this section, CPP-QA-011, specifies equipment maintenance requirements. Maintenance of the laboratory instruments is the responsibility of the technical group using the equipment. A schedule of routinely performed instrument maintenance tasks is found in Table 14-1. All preventive maintenance, as well as corrective maintenance, is recorded in instrument logs kept near the instrument.

Critical spare parts are kept in supply at the laboratory by the technical group using the equipment. Most items not kept in stock at the laboratory are available through overnight delivery from the manufacturer. In addition, MSAI maintains multiple instruments for critical laboratory operations. An instrument and equipment inventory may be found in Section 8. Because MSAI has redundant capacity, the problems of instrument downtime are minimized.

QUALITY ASSURANCE  
COMPANY POLICY AND PROCEDURE  
CPP-QA-011

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**Title:** Instrument and Equipment Maintenance

**References:**

CPP-QA-008, Laboratory Notebooks

CPP-QA-010, Instrument and Equipment Calibration

**Purpose:**

To establish the requirement for a system of regular preventive maintenance for all instruments and equipment.

**Scope:**

This policy assigns responsibility for ensuring preventive maintenance is done and defines the documentation required during the maintenance of equipment.

**Background Information:**

Instruments and other laboratory equipment occasionally require maintenance, either for preventive reasons or to correct malfunctions. Since the condition of equipment can affect the accuracy and precision of analyses, it is important to keep records of the type of maintenance performed and the date on which it was done.

**Definition:**

For this document, equipment means any device used in an analysis, such that a malfunction can result in an error in the test results. All laboratory instruments fall into this class, as well as peripheral devices such as ovens, refrigerators, and freezers.

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**Policy/Procedure:**

Each piece of equipment must have a written preventive maintenance schedule if preventive maintenance is recommended by the manufacturer. However, preventive maintenance schedules are recommended regardless of manufacturers' recommendation.

Preventive maintenance includes cleaning, oiling, and routine part replacement. It is the responsibility of the Department Manager or Group Leader to ensure that preventive maintenance is scheduled and performed on the equipment and instruments in that department or group. The responsibility for the actual maintenance may be delegated to a qualified analyst.

An equipment notebook will be established for each piece of equipment. Necessary reference information will be recorded in the notebook.

1. The notebook will be issued and numbered in conformance with CPP-QA-008. The cover or first few pages of the book will list the name of the equipment, the manufacturer, the model number, and the serial number.
2. Following the equipment identification, the next few pages will contain the routine preventive maintenance schedules and procedures or a reference to the standard operating procedure (SOP) that contains this information. Acceptance criteria for any checks used to assess proper operation will be included. Appropriate actions to take when acceptance criteria are not met must be available, either in the notebook or the SOP.
3. For major equipment with a service agreement, the contract number, service engineer, and technical service telephone number will be listed. If needed, the calibration data described in CPP-QA-010 may be kept in the same notebook.

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All maintenance done on the equipment, no matter how minor, will be recorded in the equipment notebook. This includes both preventive and corrective maintenance. In nonroutine repairs for corrective purposes, the notebook will document the nature of the failure, how and when the defect was discovered, what tests were affected, and what remedial action was taken (if any). All records will be kept in ink and will be signed by the staff member who either did the maintenance or supervised the work of an outside technician from a service firm.

The maintenance record notebook will be kept near the equipment and will be readily available to all personnel responsible for maintenance work.

Any equipment taken out of service because it needs corrective maintenance should be tagged or labeled to prevent use.

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Table 14-1

Preventive Maintenance Schedule		
Instrument	Preventive Maintenance	Frequency
GC/MS	Change septum Check fans Check cool flow Clean source Change oil in vacuum pump Change oil in turbo pump	Weekly Monthly Monthly Bimonthly Semiannually Semiannually
GC Volatiles	Check propanol level Check all flows Conductivity Det. Maint. Clean cell Change reaction tube Change Teflon line Change resin Replace trap Column Maintenance Change PID Lamp	Semiweekly Prior to calib. As needed  As needed As needed As needed
GC	Septum change Column maintenance Clean detector Vacuum filters Leak check ECD's	Every 100 injections As needed As needed Semiannually Semiannually
IC	Change guard column Rinse O-ring and piston Change end-of-line filter Change low pressure in-line filter Clean separation column Change piston seal	Semiannually Weekly As needed As needed  As needed Semiannually
Cold Vapor AA, Flame AA, and Hydride AA	Rinse burner head, chamber and trap Clean nebulizer Inspect tubing and O-rings Replace lamp	Weekly (minimum)  Weekly Monthly As needed
GFAA	Rinse workhead assembly Clean windows Replace probe tubing Check rinse bottle & drain	Weekly Weekly As needed Daily

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Table 14-1 (Continued)

Preventive Maintenance Schedule		
Instrument	Preventive Maintenance	Frequency
ICP	Clean torch Clean nebulizer & spray chamber Replace pump winding Lubricate autosampler Check mirror Checking tubing to torch Check fan filters, clean if needed Check cool flow, clean if needed Check water filter, replace if needed	Every other day Every other day After 4 runs After 4 runs After 4 runs After 4 runs Biweekly Biweekly Quarterly
Infrared Spectrometer (FTIR)	Check on-demand diagnostics Check wavenumber with polystyrene film Change desiccant	Monthly Monthly Biannually
Total Organic Carbon Analyzer	Check IR zero Check for leaks Check acid pump calib. Check persulfate pump calibration Inspect 6-port rotary valve Inspect sample pump head Wash molecular sieve Check sample loop calibration Clean gas permeation tube Inspect digestion vessel o-rings Check activated carbon scrubber Dust back and clean circuit boards Check IR cell	Weekly Weekly Bimonthly Bimonthly Monthly Monthly Quarterly Monthly Quarterly 6 Months 6 Months 6 Months 6 Months Annually

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Table 14-1 (Continued)

Preventive Maintenance Schedule		
Instrument	Preventive Maintenance	Frequency
Total Organic Halogen Analyzer	Polish counter electrode Polish sensor electrode Clean loaders and pistons Replace agar bridge	Daily Biweekly As needed Monthly

NOTES:

"As needed" maintenance is done in response to frequently monitored indicators, such as visible signs of wear. It is done before operating conditions reach corrective action limits.

Any of these items may be performed more frequently if response during operation indicates this is necessary.

Other instruments and equipment not listed are maintained according to the manufacturer's recommendations.

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## Routine Procedures Used to Assess Data Quality

This section describes the procedures and calculations used by the laboratory to assess the data quality parameters; specifically, precision, accuracy, completeness, representativeness, and comparability. These parameters are defined in Section No. 5. In addition, the procedures used to determine method detection limits and the limits of quantitation are included in this section. These limits are used in the assessment of data quality by defining the lower bounds of confidence for precision and accuracy criteria. Control limits for precision and accuracy are calculated statistically using data collected from quality control (QC) sample results.

Precision - Precision refers to the repeatability of a sample result when a second aliquot of the same sample is analyzed. The degree of agreement between duplicates is expressed as the Relative Percent Difference (RPD). The RPD is calculated according to the following equation:

$$RPD = \frac{|D_2 - D_1|}{[(D_1 + D_2) / 2]} \times 100\%$$

Where:  $D_1$  = First sample value  
 $D_2$  = Second sample value (Duplicate)

Duplicates, and/or duplicate spikes, are analyzed for at least 5% of the samples (each batch or SDG,  $\leq 20$  samples.) Acceptance criteria are based on statistical evaluation of past laboratory data or on method specifications. (See Section No. 12.) Quality control sample results are entered into the computer and compared with acceptance limits. Quality control data in the computer system are used to create control charts and to calculate a

historical mean and standard deviation. Control charts provide a graphical means of monitoring precision and bias over time.

Accuracy - Accuracy is a measure of the agreement between the amount of an analyte measured by the test method and the amount actually present. Accuracy is usually expressed as a percent recovery (%R) of surrogates, matrix spikes, and laboratory control samples. Recoveries are calculated according to the following equations:

$$\text{Surrogate Recovery} = \frac{Qd}{Qa} \times 100\%$$

Where: Qd = quantity determined by analysis  
Qa = quantity added to sample

$$\text{Matrix Spike Recovery} = \frac{SSR - SR}{SA} \times 100\%$$

Where: SSR = Spiked Sample Result  
SR = Sample Result  
SA = Spike added

$$\text{Laboratory Control Sample Recovery} = \frac{LCS \text{ Found}}{LCS \text{ True}} \times 100\%$$

Surrogate standards are added to each sample analyzed for organics. Spikes and Laboratory Control Samples are analyzed for at least 5% of the samples (each batch or SDG, ≤20 samples). Refer to Section No. 12 for acceptance criteria for accuracy. For many analyses, the computer is programmed to compare the

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individual values with the acceptance limits and inform the analyst if the results meet specification. Where no computer screening of recovery values is available, the comparison is done manually by a qualified analyst. If the results are not within the acceptance criteria, corrective action suitable to the situation will be taken and documented as explained in Section No. 16. This may include, but is not limited to, checking calculations and instrument performance, reanalysis of the associated samples, examining other QC analyzed with the same batch of samples, and qualifying results with documentation of any QC problems in the case narrative.

Commercial quality control materials are run at least quarterly to ensure accuracy of the analytical procedure. Accuracy information determined from reference materials is valuable because variables specific to sample matrix are eliminated.

The data for surrogates, spikes, control materials and reference materials are evaluated for mean and standard deviation in order to determine statistical control limits.

Completeness - Completeness is the percentage determined from the amount of valid data acquired from a measurement system compared to the number of valid measurements that are necessary to meet the project data quality objectives.

$$\% \text{ Completeness} = \frac{\text{Number of valid measurements}}{n} \times 100\%$$

Where: n = the total number of measurements necessary to achieve a specified level of confidence in decision making

The laboratory will use computerized work scheduling and sample tracking to ensure that all required measurements are made, including the associated quality controls. As required, the laboratory will include in the data deliverables sufficient

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information to allow the data user to assess the quality and validity of the results. This information will include, but is not limited to, summaries of QC data and sample results, chromatograms, spectra, and instrument tune and calibration data. Additional information will be stored in the laboratory's archives, both hard copy and magnetic tape.

Representativeness - The end user determines representativeness by comparison of the measurement results to results of comparable samples for the population being studied. The laboratory contributes to achievement of representativeness objectives by homogenization of samples prior to analysis if required. If sampling is performed by the laboratory, every effort will be made to obtain the most representative samples (refer to Section No. 6).

Comparability - Routine participation in interlaboratory performance evaluations is used to determine that results obtained by Mountain States Analytical, Inc. are comparable to those of other laboratories for the same analytes and matrices. (Refer to Section No. 13 for a list of performance evaluations.) Internal and accreditation audits monitor the consistency with which written standard operating procedures and analytical methods are followed and conform with accepted standard methods.

Method Detection Limit (MDL) - It is important to ascertain the MDL that can be achieved by a given method, particularly when the method is commonly used to determine trace levels of analytes. The Environmental Protection Agency has established a method for determining MDLs in 40 CFR 136, Appendix B.

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MDL is defined as follows for all measurements:

$$MDL = t_{(n-1, 1-\alpha=0.99)} \times S$$

Where:  $s$  = standard deviation of the replicate analyses (see the definition later in this section)  
 $t_{(n-1, 1-\alpha=0.99)}$  = students' t-value for a one-sided 99% confidence level and a standard deviation estimate with  $n-1$  degrees of freedom  
 $n$  = number of replicate analyses  
 $\alpha$  = area under the t-distribution curve, such that  $(1-\alpha) \times 100\%$  is equal to the confidence level

The MDL is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero. It is determined from analysis of a sample in a given matrix containing the analyte at an appropriate concentration.

Limit of Quantitation (LOQ) - LOQ can be established when the MDL is known. The LOQ is defined as the lowest concentration to which quantitative results may be achieved, under routine laboratory conditions, with a specified degree of accuracy and precision. The EPA and other organizations recommend setting the quantitation limit at a multiple of the MDL. MSAI typically uses a factor between 3 and 10 times the MDL, with due consideration for the particular analyte and matrix.

Data used in the determination of MDLs and LOQs for each method and sample matrix type are kept on file. MDLs are determined on

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an annual basis, or more frequently if instrument or method changes occur.

#### Quality Control Limits

Control limits are calculated for quality control samples used to measure precision and accuracy, such as matrix spikes, duplicates, matrix spike duplicates, laboratory control samples, and surrogates. Control limits are determined from the mean and standard deviation of the most recent set of relevant QC results (at least 20 data points) for the analytical method. Mean and standard deviation are calculated as follows:

$$\text{Mean} = \bar{X} = \frac{\sum_{i=1}^n X_i}{n}$$

and

$$\text{Standard Deviation} = s = \sqrt{\frac{\sum_{i=1}^n (X_i - \bar{X})^2}{n - 1}}$$

Where: X = result of a single measurement  
n = the number of measurements used for calculation

Control limits are defined as the mean  $\pm$  3s (or three times the standard deviation). Warning limits are defined as the mean  $\pm$  2s. Where practical, control limits will be determined as mean  $\pm$  2s and the warning limits as mean  $\pm$  s. The 3s control limits are approximately equal to the 99% confidence limits, and the 2s limits are approximately equal to the 95% confidence limits.

A measurement system is considered to be out of control when at least one of the following conditions occurs:

- one result is outside the control limits
- three consecutive results are outside the warning limits
- eight consecutive results are on the same side of the mean
- six consecutive results progressively increase or decrease
- an obvious cyclic pattern is observed

After April 1, 1996, acceptance limits for matrix spikes, duplicates, matrix spike duplicates, laboratory control samples, and surrogates will be the more restrictive of method-specified limits and control limits. Exception will be made for acceptance limits defined by a statement of work, such as for CLP.

## Corrective Action

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Whenever any of the data generated falls outside the established acceptance criteria outlined for instrument tune and calibration (Section No. 9) and Internal QC (Section No. 12), the cause of this irregularity must be investigated, corrected, and documented. The documentation will be used to prevent a recurrence of the problem and to inform management of the situation.

When results are not within acceptance criteria, the appropriate corrective action will be initiated. This may include, but is not limited to, checking calculation and instrument performance, reanalysis of the associated samples, examining other QC analyzed with the same batch of samples, and qualifying results with a comment stating the observed deviation.

Analysts are responsible for recognizing when results exceed acceptance criteria and for taking corrective actions. Specific corrective actions are given in the methods and SOPs, and they are summarized in Section 12 of this document. All QC data must be entered onto the computerized LIMS or QC spreadsheets promptly after their generation so that reports and charts can be generated. In addition, analysts can enter comments to explain any QC result that is outside acceptance limits. Any data outside the acceptance criteria are reviewed by the group leader or coordinator. If the appropriate corrective actions are not taken, the group leader notifies the analyst and ensures that the situation is corrected.

The Quality Assurance Department will review QC data as part of routine data package review. If there are any problems with frequent outliers or any failure to take corrective actions, a formal corrective action request will be issued to the leader of the applicable technical group. A written response from the

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technical group will outline the investigation and steps taken to correct the problem. Similarly, the Quality Assurance Department will issue corrective action requests when proficiency audit results are unacceptable. The technical groups will investigate the causes, form a corrective action plan, and reply within a specified time.

The Quality Assurance Department is also responsible for conducting periodic audits that ensure compliance with laboratory SOPs and assist in identifying and correcting any deficiencies. These audits entail observation as procedures are carried out or a review of records to demonstrate traceability and compliance with all documented record keeping procedures. The QA Department will then issue a written report that summarizes the audit. The technical groups must respond in writing to the audit report within 30 days of report receipt. The response will address any corrective actions that need to be taken along with an expected completion date. Audit results and the corresponding response are communicated to laboratory personnel and management. Follow-up audits verify that proper corrective action has been taken for the identified discrepancy.

A Quality Improvement Team (QIT) comprised of managers, technical group leaders, and client service representatives meets regularly to discuss and resolve laboratory-wide quality issues. All MSAI personnel can submit quality concerns to the QIT for review. Client concerns are often resolved through the QIT. A record is kept for each issue and its final disposition.

The policies and procedures for corrective actions are given in CPP-QA-022, which is included in this section.

**QUALITY ASSURANCE  
COMPANY POLICY AND PROCEDURE  
CPP-QA-022**

**Title:** Corrective Actions

**References:**

CPP-QA-008, Laboratory Notebooks

**Purpose:**

This policy establishes a process for correcting out-of-control events, systematic errors, and deficiencies within the laboratory. The process is also used for prevention activities for continuous quality improvement.

**Scope:**

This policy specifies the conditions and events that will require corrective action responses and establishes the requirements for initiating and completing corrective actions. Continuous quality improvement preventive actions will be initiated by the same procedure.

**Background Information:**

Without a formal process for correcting problems or deficiencies in the laboratory, some improvements might not be made and problems may be repeated. Corrective actions are often required by accrediting agencies and clients in resolution of deficiencies, audit findings, and incorrect proficiency evaluation results. Corrective action records demonstrate to clients that their concerns have been resolved. Corrective action records are useful for solving recurrent problems and for preventing potential problems.

**Policy/Procedure:**

Every MSAI employee is responsible for continuous quality improvement. Many improvement actions make an acceptable condition

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better. For these improvements, documentation is recommended but not required. When conditions exist that do not meet the requirements or expected levels of quality, formal corrective action procedures will be followed. Some items and conditions that require formal corrective actions are:

- Audit findings and client complaints
- Incorrect proficiency sample results
- Out-of-control quality control (QC) results
- Defective data deliverables (analysis reports, quality control summaries, data packages, and electronic data)
- Procedure, calibration, and equipment problems
- Receipt of unacceptable samples or materials

#### Initiating Corrective Action Requests.

Corrective action requests will begin at the point of detection. Accrediting agencies and clients will request corrective actions for audit deficiencies, unacceptable data deliverables, and missed proficiency samples. The QA Director also will request corrective actions for audit deficiencies and defective data deliverables plus out-of-control QC events and other operations problems. Any employee who discovers a situation that negatively affects data quality will correct the problem or request corrective action if the problem is not easily solved.

Requests for corrective action from accrediting agencies will usually be written as a letter. The QA Director will be responsible for responding to these requests. Client complaints and audits may be answered by a Project Manager, but answers to client audit findings will first be reviewed by the QA Director. Corrections made to notebooks will be done according to CPP-QA-008. Corrections made to data deliverables will be recorded and the record kept in the proper location, for example in the group folder or data package archives.

Internal corrective action requests for the Quality Improvement Team (QIT) may be initiated by any employee and will be documented from the time of the request to the final disposition. The QIT consists of representatives from each technical group and some support groups. The purpose of the QIT is to resolve general quality problems in the company. Use of the attached Form II, QIT Action Worksheet, will ensure that requests are investigated and brought to closure. If needed, additional forms may be created and used for documenting corrective actions not within the scope of Form I or Form II.

**Example:** A checklist might be used by data package reviewers to identify data package errors and by preparers to document that corrections were made.

The following list includes examples of internal corrective action requests and associated documentation.

- A sample is broken during shipment. MSAI documents this fact on the chain of custody. Corrective action is arranged between the client and Project Manager.
- An analyst finds that his instrument is often out of specification due to room temperature shifts. Thermostat adjustments do not correct the problem. A QIT action request is submitted to the Quality Improvement Team.
- While reviewing control chart data, the QA Director discovers an out-of-control event that is not annotated as having been corrected by the analyst. A corrective action request is submitted to the leader of the appropriate technical group.
- A data reviewer notices that method detection limits are used beyond the applicable date. The analyst is requested to take corrective action.

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- The QA Director reports proficiency sample performance results and requests corrective action for incorrect sample results.

Response to Corrective Action Requests.

Corrective action requests will be forwarded to the individual or group that is responsible, or that has the authority or ability to correct the problem. Copies of written requests will be distributed to affected members of the department, group, or team. Pertinent investigation findings and corrective actions taken or alternative actions will be written and returned to the request initiator. When the investigation and corrective action form (Form I) is used, the completed form will be returned to the Quality Assurance department for analysis, closure, and filing. The Quality Assurance department will also maintain a file of completed QIT Action Worksheets.

The following guidelines for correcting problems involving data quality issues (missed proficiency samples and out-of-control incidents) will produce the appropriate level of investigation and response.

1. Review the recorded result against the raw data for transcription, calculation, or dilution errors. Identify any of these causes, if valid, and include what steps are being taken to prevent a future occurrence of this error.
2. Review the corresponding quality control data. List the pertinent QC results and explain why they support or do not support the error condition.
3. Investigate other possible causes, such as instrument malfunctions, failure to follow the procedure, undesirable

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trends on control charts. Provide supporting evidence for any of these types of problem causes.

4. Once the cause of the problem is determined, or it is determined that thorough investigative efforts cannot reveal the cause, write the corrective action that is being taken to prevent recurrence of the problem.
5. It is recommended that corrective actions for data quality issues be verified with a proficiency sample having the concentration unknown to the analyst.

Written responses to the corrective action will include a summary of the problem, a brief explanation of known causes or a summary of investigative steps, and either the corrective action taken or the proposed corrective action with a completion date. Where possible, corrective actions will be supported by evidence. For example, the supportive evidence that an MDL study was completed is a copy of the MDL study summary. Responses to audit findings often involve multiple items, so each item must be identified in a manner recognizable to the originator of the audit finding or the recipient of the corrective action response. It is recommended that the finding statement also be written or paraphrased with the corrective action response.

The Quality Assurance Director will verify that corrective actions have been completed as proposed and that corrected procedures continue to be followed. Quarterly internal QA audits will include verification of past corrective actions. Long term issues will continue to be reviewed as long as needed.

**Forms, Tables, and Figures:**

**289225**

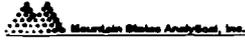
**Form I Investigation and Corrective Action Report**

**Note:** This form is used by QA for incorrect proficiency sample results, audit findings, and QC outliers.

**Form II QIT Action Worksheet**

**Note:** This form is used by all employees for requesting corrective actions or continuous improvement actions.

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Form I

## Investigation and Corrective Action Report

Number: \_\_\_\_\_

### Part I Description of the problem

1. Initiated by: \_\_\_\_\_ Date: \_\_\_\_\_
  2. MSAJ sample number(s) involved: \_\_\_\_\_
  3. Nature of the problem: (e.g., QC outlier, procedure deviation, client complaint, etc.)
  
  - \_\_\_ 4. Check if investigation must be complete before reporting further data to clients.
  - \_\_\_ 5. Check when closed.
- Approved by: \_\_\_\_\_ Date: \_\_\_\_\_

### Part II (Attach separate pages if necessary)

1. List steps taken to investigate the problem.
  
2. Explain the probable cause of the problem.
  
3. List steps taken to prevent recurrence of the problem.
  
4. Besides the sample(s) listed above, are there data sent to any clients also affected by this problem?  
If yes, please explain.
  
5. Completed by: \_\_\_\_\_ Date: \_\_\_\_\_

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Form II

# QIT Action Worksheet

Area Affected:  
 Data Quality  
 Client Requirement  
 Work Condition  
 System Efficiency

To: \_\_\_\_\_ / \_\_\_\_\_ / \_\_\_\_\_

Department or Quality Team	Leader	Individual
<b>Date</b>	<b>Applicable Sample/Group</b>	<b>Requested By</b>

Description of Problem / Desired Outcome

Corrective Action Taken

Date: \_\_\_\_\_

Init: \_\_\_\_\_

Date Required	Date Completed	TAT Performance

Corrective Action Item Closed: \_\_\_\_\_ Date: \_\_\_\_\_

Initiator's Signature

Distribute copies to affected parties and return the original to Quality Assurance when complete.

Quality Assurance Reports to Management

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Reports of quality status from the Quality Assurance Department to management are made frequently and in various forms. All results from internal or external performance evaluation samples are circulated to management. A report of each audit performed is prepared and copied to management. A monthly report is submitted to management, summarizing the current status of Quality Assurance Department matters and areas of concern. A list of deficiencies found during QA data package review is included with the monthly report. The QA Director has weekly meetings with laboratory management and is allowed time to discuss QA/QC activities. Through these channels, laboratory management is able to monitor data quality easily and effectively.

**Procurement**

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Mountain States Analytical, Inc. (MSAI) monitors the inventories of materials and supplies regularly to maintain a safety stock of important items. An established policy for requisitioning is followed, including review by the laboratory section leaders, department managers, and the financial manager. Refer to Company Policy and Procedure (CPP) SS-031 below. Vendors with favorable experience are typically used unless the item is not available from the normal vendors.

Internal policy CPP-QA-009, included below, ensures that chemicals, reagents, and standards are tested for suitability before use in analyses. Labels and documentation provide traceability for each lot and container. This policy also establishes that chemicals, reagents, and standards are replaced before their expiration dates.

Subcontract laboratory services are sometimes used by MSAI. The policy CPP-QA-007, included in this section, provides guidance for when to use a subcontractor and establishes the policy for approval of subcontract laboratories.

Procurement of Materials, Tools, and Supplies

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**SUPPORT SERVICES  
COMPANY POLICY DOCUMENT  
CPP-SS-031**

**Title:** Requisitioning Materials, Tools and Supplies

**References:** Not Applicable

**Purpose:**

The purpose of this procedure is to ensure timely procurement of such materials, tools and supplies.

**Scope:**

This document describes when and how to prepare and process internal requisitions for materials, tools and supplies.

**Background Information:**

Efficient laboratory operations depend upon the timely availability of materials, tools and supplies of the appropriate quality and quantity.

**Policy and Procedure:**

Each section of the laboratory will establish a location for storing a safety stock of the materials, tools and supply items needed. The location will be labeled to clearly identify the item, primary and secondary vendor, vendor catalog numbers and quantity of that item to be maintained in stock. Safety stock quantities will be established by section coordinators and approved by the group leader and by the laboratory director. (Due to infrequent use or high cost and reasonable availability, some items may not be carried in inventory.)

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Section coordinators will review backlogs and inspect safety stock locations weekly to determine which items need to be resupplied.

The section coordinator will prepare internal requisition forms listing the items needed to resupply inventory and meet production requirements including the quantity, preferred vendor, vendor's catalog number, unit price and extended price of each item. When the form is complete, it will be dated and signed then presented to the group leader for approval.

Group leaders will review the requisitions verifying that the items are required and that quantities and prices are correct. A comparison of the proposed purchase to budget should be made in order to verify need. When everything is in order, the group leader will date and sign the requisition and present it to purchasing in support services for processing.

The support services manager will review the requisition. If no financial consideration precludes authorization of the purchase authorization to make the purchase will be indicated by dating and signing the requisition and presenting it to the buyer for processing.

The buyer will compare requisitions to items on back order. If any of the requisitioned items are on back order, the buyer will consult the requisition originators to determine if the requisition should be voided or modified, otherwise the buyer will process a purchase order and arrange timely delivery of the items to MSAI.

**Accountability:**

The support services manager will update and distribute a weekly purchasing report to group leaders and section coordinators. This report will compare actual expenditures for materials, tools

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and supplies to planned expenditures on a month-to-date and fiscal year-to-date basis.

Group leaders and section coordinators may use this report to identify favorable and unfavorable spending variances. In order to improve laboratory efficiencies, these variances should be investigated and explained. Types of variances such as purchase price, use and volume variances should be identified and quantified if possible. The objective is to be within plan on a quarterly basis.

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**Procurement for the Procurement of Reagents, Chemicals, and Standards**

**QUALITY ASSURANCE  
COMPANY POLICY AND PROCEDURE  
CPP-QA-009**

**Title:** Reagents, Chemicals and Standards

**References:**

CPP-QA-008, "Laboratory Notebooks"

**Purpose:**

The purpose of this policy is to establish traceability of materials used for analysis and to ensure that they are of suitable quality.

**Scope:**

This policy covers methods for documenting inspection, preparation and storage of reagents, chemicals and standards.

**Background Information:**

The reliability of analytical results depends on the quality of reagents, chemicals and standards used in the analysis.

**Policy/Procedure:**

**Purchased reagents, chemicals and standards:**

All reagents, chemicals and standards received at the laboratory will be labeled with the **date of receipt** by the person receiving the materials and labeled with the **date of opening** and **date of expiration**. These dates should be placed on the container label or on a separate label that does not obscure the manufacturer's information. Figure 1 includes examples of labels used for

reagents, chemicals, and standards. The department using the material is responsible for these labeling requirements.

- Each container will be identified separately in notebook references to allow traceability. If multiple containers are received from one manufacturing lot, sequential numbers (for example, 1/3 {one of three}, 2/3 and 3/3) will be placed on the labels and used in notebook entries.
- Reagents of known stability, such as those bearing a manufacturer's expiration date or based on literature information, will not be used beyond the expiration date.
- Extremely stable reagents may be labeled with a **date of reevaluation** in place of the expiration date. This will prevent unnecessary disposal of useful materials. The reevaluation date is one year from the date of opening unless literature information justifies a longer period. If the reevaluation date is reached before the reagent is consumed, the reagent will be inspected by an experienced chemist for signs of degradation. Suitable analytical methods may be used to assess the continued usefulness of the reagent. The reevaluation will also include review of other indicators of continued chemical integrity, such as associated QC results and trends. If the reagent is suitable for further use, the reevaluation will be documented in a file or notebook, the old reevaluation date on the label will be canceled with a single line, and a new date (not to exceed one year) will be placed on the label.
- Reagents of unknown stability will be given an expiration date of one year or less.

The only exceptions to these labeling procedures are solutions used in high volume (for example, extraction solvents) which are

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used up in a very short time. However, these should also be labeled if possible.

Solvents, chemicals, and reagents used for extractions, digestions, and sample preparation will be analyzed before use by the methods for which they will be used. The analysis does not have to be done by MSAI if a complete certificate of analysis is supplied with the chemical. A record of manufacturer lot number and quantity will be maintained along with the analytical results validating adequate purity for their intended use. New shipments of solvents, chemicals, or reagents will not be used for clients' analyses until these steps have been followed.

Note: When possible, solvents and acids used in large volumes will be acquired from a given manufacturing lot to reduce acceptance testing and to enhance uniformity.

Many hazardous and nonhazardous reagents, chemicals and standards are shipped with a Material Safety Data Sheet (MSDS), which lists valuable safety information. All MSDS will be filed by the Safety Director in a three-ring binder placed in an accessible location for quick reference. Any employee may review this information.

Chemical solutions and reagents prepared in-house:

All solutions and reagents prepared in-house will be labeled with the name of the solution, the concentration, the date prepared, the expiration date, special storage conditions (if applicable) and the initials of the person who prepared the solution. If the shelf life is known or specified in an analytical method, the expiration date will correspond to the shelf life. If the shelf life is not known (that is, if the solution is assumed to be stable), an expiration date of one year from the date of

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preparation may be assumed unless a longer stability time can be documented. There are two exceptions to this labeling procedure.

- Solutions and reagents used for a single day or a single batch of analyses and are then discarded require only sufficient information to identify the material, and if necessary the hazard level. This labeling for identification also applies to containers of reagent water.
- Containers too small to list all information, such as autosampler vials, may be labeled with only the name of the contents if the label is traceable to the complete information written in a notebook.

All data pertinent to solution and reagent preparation and standardization will be logged in a bound notebook of the type specified in CPP-QA-008. Each entry must be initialed and dated by the analyst who did the preparation or standardization.

Standards prepared in-house will be given a unique identification code traceable to the preparation data and manufacturer of the stock standards. This identification code will be labeled on the working standard container and will be referenced in laboratory notebooks or instrument printouts.

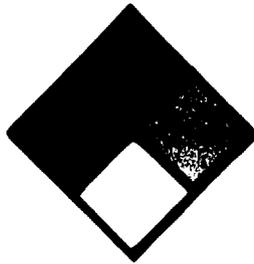
**Forms/Figures/Tables:**

Figure 1, Labels Used for Chemicals, Reagents, and Standards

Figure 1  
Labels Used for Chemicals, Reagents, and Standards

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Reagent \_\_\_\_\_  
Concentration \_\_\_\_\_  
Analysis \_\_\_\_\_  
Date Prepared \_\_\_\_\_  
Expiration Date \_\_\_\_\_  
Prepared By \_\_\_\_\_  
Storage & Preservative \_\_\_\_\_



289238

Procurement of Subcontract Laboratory Services

QUALITY ASSURANCE OPERATIONS MANUAL  
COMPANY POLICY DOCUMENT  
CPP-QA-007

**Title:** Subcontracting to Other Laboratories

**Purpose:**

To specify the standard protocol for approving qualified subcontract laboratories.

**Scope:**

This policy specifies the requirements for qualifying a laboratory as a subcontractor and for procedure for proper transfer of sample custody to subcontractors.

**Background Information:**

Occasionally clients request analyses that cannot be performed by MSAI due to a lack of personnel, equipment, or time. In these cases, a decision is made by the senior staff whether to refer the client to another qualified laboratory or accept the work for subcontracting. When work is accepted for subcontracting it is essential that the laboratory chosen to do the work is technically competent and that sample custody is transferred to the subcontractor properly.

**Policy:**

The senior staff is responsible for determining whether the client should be referred to another laboratory or whether the work should be accepted for subcontracting. In most cases work is accepted for subcontracting when most of the work submitted by a client can be performed in house.

1. Prior to a project or on acceptance of the samples, the client will be informed that the work will be subcontracted to another laboratory.
2. A verification of the samples submitted will be sent to the client by fax, unless the client requests that verification not be sent.

A laboratory used for subcontracting must be qualified by the Quality Assurance Director. The QA Director reviews the following information to determine whether a laboratory can be qualified.

- The laboratory's Quality Assurance/Quality Control plan.
- The laboratory's list of certifications.
- The laboratory's insurance certificates for workman's compensation and professional liability.
- The laboratory's standard terms and conditions.
- The laboratory's method references for the tests to be performed.

Upon qualification, the laboratory must sign a statement warranting the accuracy of the tests performed for MSAI. In most cases, the subcontract laboratory will be audited initially and as needed by the Quality Assurance Director or a technically qualified employee assigned by the QA Director.

The QA Director will maintain a file of qualified subcontract laboratories.

When samples are sent to a subcontract laboratory, a **289240** Subcontracting Chain of Custody form (see figure 18-1) is completed. The current date, requested TAT, requested analyses, sample identification (group and sample numbers), number of containers per sample, the unit cost of each analysis, the and name of the client contact will be written on the form.

1. The person relinquishing custody of the samples signs and dates the chain of custody.
2. The pink copy of the Subcontracting Chain of Custody is attached to the group report and filed. The remaining copies are sent with the samples to the subcontractor. The subcontractor will return a signed and dated copy of the Chain of Custody to MSAI with the final analytical reports.

Note: All documentation pertaining to the subcontracting of samples is filed in the group folder.

Each subcontracted analysis result appearing on MSAI reports must be marked with a statement notifying the client that the analysis was subcontracted (for example, "The analysis for (test name) was subcontracted to another qualified laboratory").

Figure 18-1

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**Mountain States Analytical** 8097  
**Sample Chain of Custody**

Client Name: _____ P.O. # _____		Analysis Required		Temp. of Samples Upon Receipt
Phone #: _____ Fax #: _____		Rush?		
Project Name/#: _____		Total of Containers		Remarks
Sampler: _____		Grab		
Sample Identification	Date Collected	Time Collected	Composite	Remarks
			Soil	
			Water	
			Other	
Name of Shipper		Airbill No.	Date	Time
Received By (Lab)		Date	Time	Seals Intact?
Turnaround Time Requested (please circle):		Normal	Rush	
<small>(Rush TAT is subject to MSAL approval and surcharge)</small>				
Report Results By: (Date)		Phone	Fax	
Rush results requested by (please circle):		Type of Disposal:		
Report Results to:		Date/Time of Disposal:		
		Sample relinquished by: _____ Date _____ Time _____		
		Sample received by: _____ Date _____ Time _____		
		Authorized for Disposal by: _____		
		Disposed of by: _____		

1645 West 2200 South, Salt Lake City, Utah 84119 (801) 973-0050 FAX (801) 972-6278

White Copy - Original Retain by Lab Yellow Copy - Return to Customer Pink Copy - Retain by Sampler

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## Waste Management

Mountain States Analytical, Inc. (MSAI) has a hazardous waste management plan (see CPP-LO-032 in this section) to ensure that hazardous wastes are managed in accordance with applicable regulations governing the generation, accumulation and disposal of hazardous wastes. Hazardous waste sources include unused portions of client samples and process wastes, such as acids, bases, and solvents used in sample preparation and testing. Samples that are not returned to the clients are collected according to waste classification and later sent out for disposal. Process wastes are also collected and stored according to waste type. SOP-SA-105 ensures the proper disposal of expired samples and gives instructions for the proper classification, treatment, storage, containment monitoring, and disposal through licensed waste contractors. The procedure for transferring laboratory process wastes to the containment area is given in SOP-LO-114.

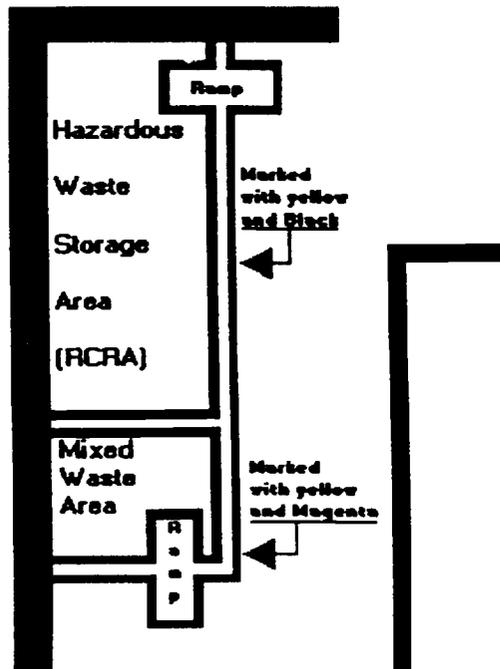
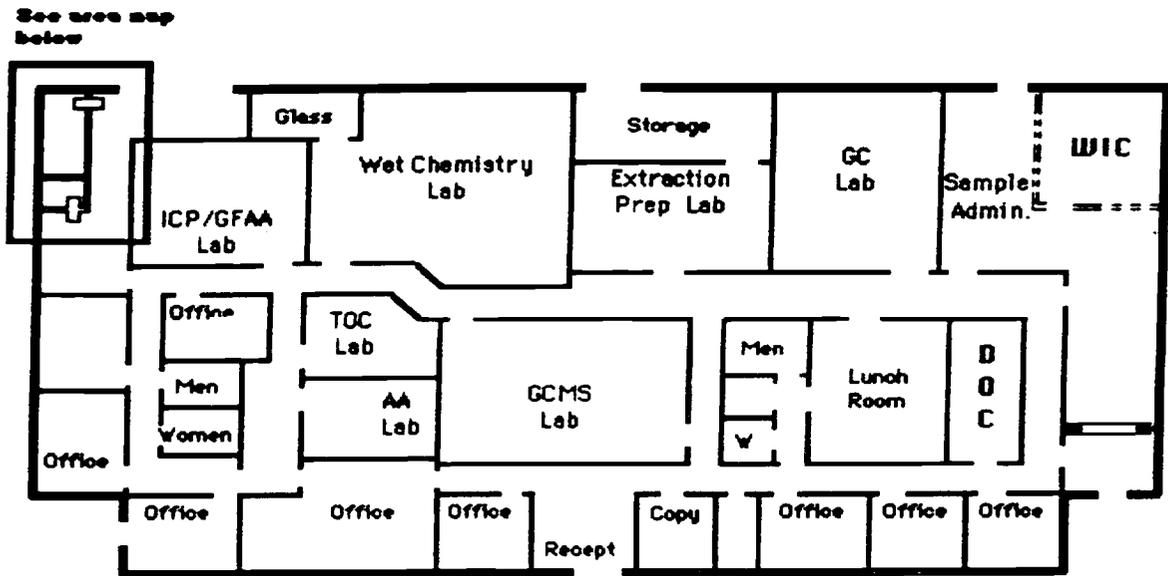
The waste containment area (See Figure 19-1) is located in the southeast corner of the main building. The area is bounded by a four-inch berm designed to hold the contents of one 55-gallon liquid waste drum should it lose its contents. Colored hazard tape is used to delineate the boundaries of the containment area.

Wastes are collected in separate containers according to waste classification. The general classifications for non-radioactive wastes are drinking water, basic, waste flammable liquid, soils/sludge/solid oils/grease, and water/wastewater. Radioactive and potentially radioactive wastes are stored separately as another class of waste.

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Wastes are monitored weekly and a record is kept to document the inspections. Only licensed contractors are employed for the transport and disposal of laboratory wastes.

Figure 19-1  
Waste Containment Area



LABORATORY OPERATIONS  
COMPANY POLICY AND PROCEDURE  
CPP-LO-032

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**Title:** Hazardous Waste Management Plan

**References:**

40 CFR, Parts 261, 262 & 263  
HM-181 DOT regulations (49 CFR)  
SOP-LO-114, Laboratory Waste Collection and Transfer to Storage  
CPP-LO-026, Emergency Response to Accidents Involving Hazardous Materials  
SOP-SA-105, Sample Discard/Monitoring of Hazardous Waste Containments

**Purpose:** To ensure that laboratory hazardous waste is managed in accordance with all applicable regulations governing the generation, accumulation and disposal of hazardous waste and to ensure a healthy and safe workplace for MSAI employees with respect to waste hazards.

**Scope:** This SOP outlines the various procedures necessary to comply with hazardous waste regulations.

**Definitions:** None

**Background:** Monetary penalties in the area of hazardous waste management can be significant, especially where human and environmental health is concerned. It is critical that the company conduct itself within the boundaries of existing regulations and scientifically-ethical principles.

**Policy/Procedure:**

**289245**

**1 Laboratory Waste Management**

**1.1 Samples and waste from sample analysis**

Many different types of samples are received for analysis at MSAI. Those that are not returned to Clients are eventually disposed. Sample Administration is responsible for the disposal of unused portions of samples pulled from the refrigerators for disposal according to SOP-SA-105. The return of samples to Clients is also covered in this SOP (for Clients who desire return and for samples which are deemed unacceptable for MSAI to dispose).

Each laboratory within the company is also responsible for maintaining their own temporary storage of wastes which are derived from sample analysis according to SOP-LO-114. These laboratory wastes are regularly taken from the individual laboratory and deposited in appropriate containers within the hazardous waste containment area located in the southeast corner of the west building according to SOP-SA-105.

**1.2 Associated Waste**

Waste derived from sample analysis (associated waste) must be handled as any other hazardous waste. This includes paper towels, rubber gloves, pipette tips, etc. These waste products should never be deposited in containers designed for municipal waste if there is any reason to believe they have been contaminated by a hazardous waste or sample.

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### **1.3 Low-level radioactive waste**

MSAI is currently developing our waste program in this area and low-level waste has recently begun to be accumulated in the hazardous waste containment area. Although a supplier has not yet been secured for disposal of our low-level radioactive waste, negotiations are underway to accomplish this requirement.

All radioactive waste is scanned for radioactivity according to the criteria listed in SOP-RA-005 before being deposited in the hazardous waste containment area. A radioactive disposal log is used to record the disposal of these types of samples. In this manner, MSAI maintains an inventory of radioactive waste which has been disposed.

## **2 Hazardous Waste Containment Area**

### **2.1 Physical description**

A hazardous waste containment area has been designated at MSAI in the southeast corner of the west building. This area is bounded by a four-inch containment berm designed to hold the contents of one 55-gallon liquid waste drum should it rupture and completely lose its contents. Magenta/yellow hazard tape (for radioactive hazardous waste) and black/yellow hazard tape (for non-radioactive hazardous waste) is used to delineate the boundaries of the hazardous waste containment areas. The berms and floor of the containment area are epoxy-coated to prevent any seepage from the containment area.

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## **2.2 Containers/Labeling**

There are four main types of non-radioactive hazardous waste generated at MSAI, hence, four wastestreams, identified by a WMDS (waste material data sheet) number are maintained within the laboratory: These include soils/sludges/oils/grease (WMDS 222268), wastewaters (WMDS 212950), oils/solvents/waste flammable liquids (WMDS 222269) and chromatographic vials (WMDS 217983). These wastestreams, as well as the specifications of the containers designated to hold each type of waste, are referenced in SOP-SA-105. All containers are labeled according to 40 CFR, Part 262 requirements. This includes the WMDS number for each wastestream, the accumulation start date (or, the date the first sample was deposited into the drum), and any hazard stickers required by DOT regulations (e.g., corrosive, flammable, etc.) according to HM-181. These wastestreams are profiled and analyzed by our waste disposal contractor every two years to assure that the type of waste has not changed significantly.

## **2.3 Weekly Monitoring**

Each week, an inspection of the containment area is performed. All containers are inspected for leakage according to SOP-SA-105. The inspector will log his findings in a bound notebook which is available for inspection in this area.

## **2.4 Leaking containers or spills**

Any spills found in the hazardous waste containment area or elsewhere in the laboratory will be attended to

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immediately upon discovery according to CPP-LO-026. Spill kits can be found within the containment area and throughout the laboratory facility. If a container is found to be leaking in the containment area, but has not lost its entire contents, it will be overpacked in an 85 gallon drum designed for this purpose. Spilled material which has been cleaned up is deposited in the appropriate waste drum.

#### **2.5 Maximum allowable quantities**

The maximum allowable quantity which can be stored at this facility is 6000 kg according to 40 CFR, Part 262.34. MSAI is also allowed to store up to this quantity of waste for no more than 270 days (this cumulative time for storage is allowed under 262.34 because MSAI ships its waste to a receiving facility which is over 200 miles away). MSAI typically ships hazardous waste off-site monthly so that the accumulated quantity of waste typically never reaches 2000 kg. In this manner, large quantities of waste are never maintained at this facility. Another responsibility we have as a hazardous waste generator is to post the name and telephone number of an employee who can respond quickly to a fire or other emergency in the containment area or other area of the facility. This list is in place in the hazardous waste containment area.

#### **2.6 Segregation of low-level radioactive waste from non-radio waste**

All low-level radioactive waste is segregated from non-radioactive waste at MSAI. Radioactive waste is deposited in drums located in a separate section of the bermed containment area (the left section) bounded by

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magenta/yellow hazard tape. Any leakage from either type of waste cannot contaminate the other because of a berm divider.

### **3 Manifest Operations**

#### **3.1 Contracting for shipping**

The hazardous waste contractor (receiving facility) for MSAI is ENSCO. All MSAI hazardous wastes are incinerated at their El Dorado, Arkansas hazardous waste incinerator. Shipments from MSAI's facilities are provided through ENSCO with only licensed haulers used for hazardous waste transport.

#### **3.2 Paperwork requirements**

All hazardous waste shipments are properly manifested according to DOT HM-181 regulations. All paperwork is properly completed before arrival of the hazardous waste transporter. In order to help prevent any transport violations, a Sample Administration employee and the driver of the transport vehicle verify that all data is correct and complete before the waste leaves MSAI's facility.

#### **Forms, Tables, and Figures:**

Hazardous Waste Containment Weekly Inspection Form (see SOP-SA-105).

## Appendix A

# Organizational Structure

Mountain States Analytical, Inc. currently has six main operating units: **Business Development, Client Services, Special Projects Group, Laboratory Operations (which includes the GC, GC/MS, Organic Extractions, Metals, and General Chemistry Groups), Support Services and Quality Assurance.**

The following pages are professional profiles for key technical and administrative personnel.

**Douglas W. Later, Ph.D.***President***Professional Experience**

Mountain States Analytical, Inc., 6/89 - Present  
*President and Laboratory Director*  
*Executive Vice President and Laboratory Director*  
 Dionex, Lee Scientific Division, 1988-1989  
*Vice President, Marketing and Sales*  
*Vice President, Operations*  
 Lee Scientific, 1985-1988  
*Vice President R&D and Co-founder*  
 Battelle Northwest Laboratories, 1982-1985  
*Research Scientist, Project Manager*

**Continuing Education**

Councilor Selling Series, Wilson Associates, 1984  
 Management Training, Western Leadership Group, Inc., 1986  
 Executive Excellence Series, Covey and Associates, 1987  
 Supercritical Fluid Chromatography and Extraction, ACS Short  
 Course, 1988, Instructor  
 Strategic and Marketing Planning, ACIL Educational Seminars,  
 1992  
 Leadership and Total Quality Management, ACIL Education  
 Institute, 1993  
 Ethical Fitness, Institute for Global Ethics, 1993  
 Leadership Utah, SLC Chamber of Commerce, 1993

**Education**

Ph.D., Analytical Chemistry, Brigham Young University, 1982  
 B.A., Chemistry, Brigham Young University, 1978

**Publications and Presentations**

Approximately 150 publications and presentations in the field of  
 analytical chemistry including 4 book chapters; 34 published  
 proceedings; 13 government reports; 40 conference, seminar, and  
 symposia presentations; and several journal publications.

**Awards and Citations**

John Einar Anderson Scholarship, 1979  
 Telford E. Wooley Cancer Research Award, 1981  
 Innovative Development Institute/Small Business Administration  
 Small Business Innovative Research of the Year Award, 1988

**Experience**

Instrumental Analytical Chemistry  
 Microcolumn Chromatography  
 High Resolution Gas Chromatography  
 Supercritical Fluid Chromatography and Extraction  
 Chromatographic Detection Systems  
 Mass Spectrometry

Organic Analytical Chemistry  
 Polycyclic Aromatic Compound  
 Chemistry  
 Coal and Fuel Chemistry  
 Industrial Applications of  
 Supercritical Fluid  
 Chromatography and  
 Extraction  
 Environmental Chemistry  
 Hazardous Waste Analyses  
 Compliance Monitoring  
 Analyses  
 Mixed Waste Analyses

**Memberships and  
Appointments**

American Chemical Society,  
 Member since 1979  
 Fuel Chemistry Division,  
 1982-1989  
 Analytical Chemistry/  
 Chromatography  
 Division, since 1987  
 Sigma Xi, 1981-1983  
 Association of Official  
 Analytical Chemists, since  
 1989  
 International Committee on  
 Polycyclic Aromatic  
 Compounds, since 1984  
 Executive Committee  
 Member, since 1984  
 Chromatography Subcommittee  
 Chairman, 1984-1988  
 Brigham Young University,  
 Chemistry Department  
 Adjunct Faculty  
 Appointment, 1985-1987  
 International Symposium on  
 Polycyclic Aromatic  
 Hydrocarbons  
 Editorial Committee, since  
 1987  
 Journal of Polycyclic Aromatic  
 Hydrocarbons  
 Topical Editor, since 1988-  
 1992

**Douglas W. Later, Ph.D.**  
**(Continued)**

Editorial Board, since 1992  
The Journal of Microcolumn Separations  
Editorial Advisory Board, 1988-1989  
American Council of Independent Laboratories, since 1989  
Environmental Section Executive Committee, since 1994  
Salt Lake City Chamber of Commerce, since 1989  
Environmental Issues Subcommittee, since 1990  
Utah Leadership, Class of 1993  
Air and Waste Management Member, since 1992  
Sectional Education Committee, 1993 - 1994  
Department of Defense, U.S. Army Armament, Munitions  
and Chemical Command, PEP Thermal Treatment Test  
and Evaluation Facility, Technical Steering Committee  
Member, since 1994  
National Environmental Laboratory Accreditation Conference  
Onsite Assessment Committee Member, since 1995  
Utah Independent Laboratory Association Chair and  
co-founder, since 1995

**Lee D. Eaton, Jr.**

*Vice President*

**Professional Experience**

Mountain States Analytical, Inc., 1991 - Present

*Support Services Leader and Chief Financial Officer*

Lee Scientific, 1986-1991

*Chief Accountant*

Amjacs Interwest, Inc., 1983-1984

*Controller*

Cottonwood Care Center, 1978-1983

*Administrator*

**Education**

B.S., Accounting, Brigham Young University, 1974

**Continuing Education**

Ethical Fitness, Institute for Global Ethics, 1993

**Service Operations Process optimization, Penn State, 1992**

**Awards and Citations**

Presidents Award, Mountain States Analytical, 1992

**Appointments**

Steering Committee, Environmental Testing Industry Compensation  
Survey, 1995 - Present

**Charles R. Seehafer**  
*Business Development Director*

**Professional Experience**

Mountain States Analytical, 1993 - Present  
*Business Development Director*  
FB&D Technologies, Inc. 1990-1993  
*Business Development Manager*  
Eaton-Kenway, Inc, 1986-1989  
*Systems Engineering Manager*  
*Project Engineering Manager*  
United States Steel Corporation, 1971-1986  
*Staff Supervisor*  
*Senior Systems Analyst*  
*Methods Engineer*  
*Systems Consultant*  
*Systems Design Supervisor*

**Experience**

Business Development  
Environmental Engineering  
Wastewater Treatment  
Systems  
Information Management  
Systems  
Quality Assurance  
Business Planning  
Industrial Engineering  
Marketing and Sales  
Systems Engineering  
Government Subcontracting

**Continuing Education**

TQM  
Crosby Quality  
Ethical Fitness, Institute for Global Ethics, 1993

**Education**

B.S., Electrical Engineering, University of New Mexico, 1971

**Memberships and Appointments**

Institute of Electrical and Electronics Engineers, Inc.  
Instrument Society of America  
Society of Manufacturing Engineers  
Water Environment Federation

**Lyle G. Covino***Project Manager/Proposal Manager***Professional Experience**

Mountain States Analytical, 11/93 - Present

*Proposal Manager/Project Manager**QC Associate Chemist/Project Manager**Extraction Laboratory Coordinator**Extraction Laboratory Technician*

Texas A&amp;M University, 1990-1992

*Technical Assistant**Computer Operator***Continuing Education**

OSHA 40 Hour Hazardous Materials Training, 1993

Ethical Fitness, Institute for Global Ethics, 1994

TQM, 1995

**Education**

B.S., Genetics, Texas A&amp;M University, 1992

Minor: Chemistry

MBA, Entrepreneurial Emphasis, University of Phoenix, April, 1997

**Memberships and Appointments**

Association of Former Students, Texas A&amp;M University

Leadership Training, Carlisle Group, 1996

Hewlett Packard, Mass Spectral Interpretation, 1995

**Experience**

Quantitative Analysis

Instrumental Analysis

Organic Chemistry

Biochemistry

Molecular Genetics

Organic Extractions

Gas Chromatography

Infrared and Fourier Transform

Infrared Spectrometries

Desktop Computer Applications

Fortran Programming

Groundwater Sampling

**Rolf E. Larsen**

*Client Services Manager*

**Professional Experience**

Mountain States Analytical, 1992 - Present

*Project Manager*

Huish Detergents, Inc., 1983-1991

*Quality Assurance Manager*

**Education**

B.A., Chemistry, University of Utah, 1982

**Awards and Citations**

Spirit of MSAI Award, Mountain States Analytical, 1993

Ethics Fitness Training, Lancaster Laboratories, 1993

**Experience**

Research and Development

New Product Specification

Performance Testing Customer

Support

Safety Program Development

TSCA, OSHA, CERCLA, and

SARA Title III Reporting

Statistical Quality Control

**Mark W. Bostrom***Project Manager***Professional Experience**

Mountain States Analytical, 6/94 - Present

*Project/Client Manager*

ACZ Laboratories, Inc., 1992 - 1994

*Marketing Manager*

ACZ Laboratories, Inc., 1990 - 1992

*Organic Extraction Lab Supervisor***Education**

B.S., Business Administration, Western State College, 1987

Mine Waste Minimization and Remediation Seminar, Fairmont Hot Springs, MT

Ethical Fitness, Institute for Global Ethics, 1994

**Memberships**Colorado Hazardous Waste Management Society  
(CHWMS) 1992-1994National Ground Water Association  
(NGWA) 1992-1994

Montana Mining Association (MMA) 1992-1994

Northwest Mining Association (NWMA) 1992-1994

**Experience**

Organic Extraction

- (SW-846, EPA 600)

General Chemistry

Business Development

Client Services

RCRA analytical methods and  
applicationsCWA analytical methods and  
applicationsSDWA analytical methods and  
applications

**W. Scott Fraser***Project Manager**Radiation Safety Officer**Chemist***Professional Experience**

Mountain States Analytical, 1992 - Present

*Project Manager/Radiation Safety Officer/Chemist*

Aptus, Inc., 1992

*Chemist*

Environmental Radiation &amp; Toxicology Laboratory, 1989-1992

*Chemist*

Department of Agricultural Sciences, Utah State University, 1987-1989

*Chemist***Education**

B.S., Chemistry, University of Utah, 1991

**Continuing Education**

OSHA 40 Hour Hazardous Materials Training, 1992

40 Hour Radiation Safety Officer Training, 1994

Ethical Fitness, Institute for Global Ethics, 1994

Total Quality Management, Mountain States Analytical, Inc., 1995

**Awards and Citations**

CRC Chemist of the Year Award, Utah State University, 1987

**Memberships and Appointments**

Utah State Radiation Safety, Responsible User

Great Salt Lake Health Physics Society, Member

**Experience**

Metals digestion and analysis

Gravimetric and Wet General

Chemistry Analyses

Gas Chromatography

Gas Chromatography/ Mass

Spectrometry

Sample Control

Data Entry and Validation

Standard Operating Procedure

Writing

Alpha, Beta, and Gamma

Spectrometry

Ion Exchange

Chromatography

Radiochemical Separation

Techniques

Radiochemical Health &amp;

Safety Monitoring

Radioactive Materials

Licensing

Radioactive Materials

Management

Neutron Activation Analysis

X-Ray Spectroscopy Analysis

Government Subcontracting

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**Pamela K. Olsen**

*Sample Administration Coordinator  
Client Manager*

**Professional Experience**

EG&G Idaho, Inc.

*Secretary, 1987*

*Document Control Coordinator, 1987-1989*

*Associate Technician II, 1989-1992*

Mountain States Analytical, since 1992

**Continuing Education**

Hazardous Material Shipper, EG&G Idaho, Inc., 1992

Radiation Worker trained, EG&G Idaho, Inc., 1987-1992

OSHA Training, EG&G Idaho, Inc., 1991

SARA Title III Report Training, EG&G Idaho, Inc., 1991

**Education**

Paralegal Certificate, Arizona State University, 1984

Associates Degree in Arts & Sciences, Ricks College, 1985

Beginning Chemistry, 1994

Leadership Skill for Women-1993

Ethical Fitness, Institute for Global Ethics, 1993

**Awards and Citations**

Presidents Award, Mountain States Analytical, 1993

**Experience**

Sample Management

Chemical Inventory

Requisition Coordinator

Document Control

Internal, EPA, and NEIC Audits

**Leon D. Ford***Client Services Laboratory Technician***Professional Experience**

Mountain States Analytical, Inc., 1992 - Present

*Client Services Laboratory Technician*

Transit Casualty Co., 1988 - 1990

*Claims Processor*

Core-Mark Distributing, 1990 - 1992

*Inventory Control Coordinator***Education**

Business Management, Utah Valley Community College, 1987-1988

**Continuing Education**

8 Hour Department of Transportation HM-181 Training, 1995

OSHA 40 hour Hazardous Materials Training, 1993;(Recertified, 1994, 1995)

Environmental Technology, Utah Valley Community College, 1993

State of Utah Groundwater and Soil Sampling, certified since 1993/ Certificate #GS0762, Expires 10/97

**Experience**Field Sampling, Organic,  
Inorganic

Hazardous Material Sampling

Hazardous Waste Shipping

Sample Preparation

Automated Sampling

Sample Administration

**Mathew L. Eden***General Chemistry Laboratory Technician***Professional Experience**

Mountain States Analytical, Inc. - Present  
*General Chemistry laboratory Technician*  
 On-site Environmental Staffing - 1995  
*Drilling Assistant*  
 Medical Physics, Inc. - 1989-1995  
*Assistant Research Scientist*  
 CompuSave/Micronet - 1988-1989  
*Computer Technician*  
 Professional Resources - 1986-1988  
*Computer Technician*

**Education**

B.A., Physics, University of Utah - 1992

**Continuing Education**

40 Hour OSHA Hazardous Waste Operations - 1995  
 AutoCAD v12 Proficiency - 1995  
 Personal Computer (Microsoft Windows and Word, Quattro Pro)  
 AutoCAD, Borland C, WordPerfect, Novell Local Area Networks

**Experience****Instrumentation**

Accelerated Solvent  
 Extractor  
 SFC/MS  
 SFC/TEA  
 Mellinckreelt Blood  
 Gas/Electolyte Analyzer

**Processes**

Soxhlet extraction  
 Extract concentration  
 by Rotary Evaporation  
 Drilling/sampling soils  
 Preparation and disposal of  
 hazardous materials used in  
 research  
 Membrane fabrication

**Technical :**

Customization of experimental  
 equipment, installation,  
 administration and  
 maintenance of Novell Local  
 Area Networks

**Software:**

Microsoft Windows, Word,  
 Quattro Pro, AutoCAD,  
 Borland C, WordPerfect,  
 Novell Local Area  
 Networks

Preparation and disposal of  
 hazardous material used for  
 research

Customized experimental  
 equipment

**Glenn A. Sorensen**  
*Laboratory Manager*

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**Professional Experience**

Mountain States Analytical, Inc., 12/88 - Present  
*Laboratory Operations Manager*  
*Inorganic Department Manager*  
United States Pollution Control, Inc., 1987-1988  
*Laboratory Manager*  
Bennett Paint Corporation, 1970-1987  
*Plant/Laboratory Manager*  
Hercules Incorporated, 1962-1970  
*Area Supervisor, Research Chemist*  
Sunkist Growers Association, 1959-1962  
*Research Chemist*

**Continuing Education**

Bomb Calorimeter Short Course, Leco Corp, 1987  
Gas Chromatography Analysis, Varian, 1987  
Management Training, Grow Group, 1985  
Instrumental Analysis, Utah Technical College, 1984-1985  
Computer Science, Utah Technical College, 1985-1986  
Atomic Absorption Spectrometry, Short Course, Perkin Elmer, 1982  
Hazardous Materials Training, Grow Group, 1987  
Safety Training, Hercules, 1963-1964  
OSHA 40 Hour Sampling Course, 1986  
First Aid Training Course, American Red Cross, 1987  
Ethical Fitness, Institute for Global Ethics, 1993

**Education**

B.A., Chemistry, University of Utah, 1959  
Minors—Mathematics and Physics

**Publications and Presentations**

Twenty scientific publications in organic and analytical chemistry

**Awards and Citations**

The Pauling Scholarship, 1955-1956  
Leading Researcher, Sunkist, 1960  
Employee of the Year, Bennett's Paint Corporation, 1986  
Spirit of MSAI, Mountain States Analytical, Inc., 1990

**Memberships and Appointments**

American Chemical Society, 1962-1970

**Experience**

Plant Management  
Laboratory Management  
Well Sampling and Monitoring  
Air Sampling and Monitoring  
Environmental Analysis  
Safety/Industrial Hygiene  
Total Organic Halide  
Wavelength Dispersive  
Analysis  
X-Ray Analysis Fluorescence  
Spectrometry  
Gas Chromatography/Mass  
Spectrometry  
Gas Chromatography  
Infrared Spectrophotometry  
Inductively Coupled Plasma  
Emission Atomic Absorption  
Emission, Flame Emission  
Data Processing/Computing

**Matthew S. Sorensen**  
*Organics Group Coordinator*

**Professional Experience**

Mountain States Analytical, Inc., 5/90 - Present  
*GC Coordinator*  
*Organic Coordinator*  
*GC Chemist*  
*GC Associate Chemist*

**Experience**

Gas Chromatography  
Gas Chromatography/Mass  
Spectrometry  
Infrared Spectrophotometry  
Environmental Analysis

**Education**

B.S., Chemistry, Weber State University, 1990

**Continuing Education**

Ethical Fitness, Institute for Global Ethics, 1993  
Mass Spectra Interpretation Course, 1996  
Total Quality Management Course, 1995

**Awards and Citations**

American Chemical Institution Outstanding Senior Chemist  
Award  
Spirit of MSAI Award, Mountain States Analytical, 1991

**Memberships and Appointments**

Sigma Xi Chemical Research Society

**John Y. Barton**  
*GC Laboratory Technician*

**Professional Experience**

Mountain States Analytical, 1991 - Present  
*Senior Laboratory Technician,*  
*Laboratory Technician II*  
*Laboratory Technician I*

**Education**

B.S., Psychology, Brigham Young University, 1995

**Continuing Education**

Ethical Fitness, Institute for Global Ethics, 1994  
Restek's Gas Chromatography Seminar, 1993

**Experience**

Pesticide, Herbicide, TPH,  
Extraction  
Preparation of Calibration  
Standards  
QC Charting  
Inventory Control  
GC Extractions Training for  
New Employees  
HP 5890 Series II Gas  
Chromatograph  
Tekmar ALS 2016  
Autosampler  
LSC 2000 Purge and Trap  
Concentrator  
Tracor 540 Gas  
Chromatograph  
Hewlett Packard 3393A  
Integrator  
Perkin Elmer Infrared  
Spectrophotometer  
Hewlett Packard Chemstation  
& (GC Enviroquant)  
Enviroquant

**Kelly P. Finnegan***GC Chemist***Professional Experience**

Mountain States Analytical, Inc.

*GC Chemist, 9/95 - Present**GC Associate Chemist, 9/91 - 9/95*Westminster College of Salt Lake City, Organic Chemistry Lab,  
1991-1992*Teaching Assistant*

Legacy Rare Coins, 1988-1990

*Co-owner and Manager***Continuing Education**

Capillary Chromatography Seminar, Restek, 1992

Ethical Fitness, Institute for Global Ethics, 1993

Radiation Safety Training, 1994

Total Quality Management, 1995

HP GC/MS Training Course, "Introduction to MS Interpretation",  
1995**Education**

B.S., Chemistry, Westminster College of Salt Lake City, 1992

**Awards and Citations**

Sterling Scholar, Kearns High School, 1980

Gore Math &amp; Science Endowment, 1991-1992

John Stauffer Memorial Scholarship, 1991-1992

MSAI Giant Award, 1995

**Memberships and Appointments**

President Utah Numismatic Society, 1989, 1996

**Experience**Organic Extraction and analysis  
of PCBs, Pesticides,  
Herbicides, and Petroleum  
Hydrocarbons

Air Quality analysis at

Lancaster Laboratories - Nov -  
Dec, 1993Chemistry, Physics, and  
Spanish Tutoring

**Troy K. Gunderson***Chemist***Professional Experience**

Mountain States Analytical, Inc., 1992 - Present

*General Chemistry Group Coordinator*

Nuclear Testing Services, 1992 - 1993

HCA St. Mark's Hospital, 1988 - 1992

*Patient Contact Representative**Assistant Dietician**Food/Nutritional Services, Supervisor***Education**

B.S., Biology, University of Utah, 1990

**Continuing Education**

Ethical Fitness, Institute for Global Ethics, 1993

**Awards and Citations**

Honors at Entrance, University of Utah, 1986

**Memberships and Appointments**

Phi Kappa Phi, 1990

Golden Key National Honor Society, 1990

**Experience**

General Chemistry

Total Organic Halide Analysis

Calibration and Service of

Toxler Moisture/Density

Gauges

ION Chromatography Dionex

DX 500

HP 5890 Series II Gas

Chromatography Tekmar ALS

2016

Archon 5100 Autosampler

LSC 2000 Purge and Trap

Concentrator

**Paul Kelly**  
*GC Laboratory Technician*

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**Professional Experience**

Mountain States Analytical, 1991 - Present  
*GC Laboratory Technician*  
DataChem Laboratories, 1990-1991  
*Technician*  
Granite School District, 1989-1990  
*Physics and Chemistry Teacher*  
Half Hollow Hills Central School District, 1989  
*Substitute Teacher*  
Half Hollow Hills Central School District, 1988  
*Student Teacher, Physics*

**Experience**

Preparation and documentation  
of analytical standards  
Gas Chromatography  
Gas Chromatography/ Mass  
Spectrometry  
Sample preparation  
Data interpretation

**Continuing Education**

Capillary Chromatography Seminar, Restek, 1992  
Ethical Fitness, Institute for Global Ethics, 1994

**Education**

Teacher Certification, Southampton College, Long Island  
University, 1988  
B.A., Economics, State University of New York—Stonybrook, 1985  
Undergraduate Studies, Physics, University of Utah,  
1991 - Present

**C. Michael Snyder**  
*GC/MS Associate Chemist*

**Professional Experience**

Mountain States Analytical, Inc., 12/88 - Present

*GC/MS Associate Chemist*

*GC/MS Sr. Technician*

*General Chemistry Coordinator*

*General Chemistry Technician*

**Continuing Education**

Ethical Fitness, Institute for Global Ethics, 1993

**Education**

Associates Degree, Physical Science, Salt Lake Community  
College, 1991

**Experience**

General Chemical Analysis

Gas Chromatography

Gas Chromatography/ Mass  
Spectrometry

Atomic Absorption  
Spectrometry

Infrared Spectrophotometry

Ion Selective Electrode Analysis

Total Organic Halide Analysis

**Victoria L. Phillips**

*Data Entry Clerk*

**Professional Experience**

Mountain States Analytical, Inc., 1995 - present

*Data Entry Clerk*

Holiday Inn Worldwide Reservations Cntr, 1992 - 1995

*Sales Agent*

LeParisien, 1990 - 1991

*Night Manager*

LeParisien, 1987 - 1990

*Cashier/Hostess*

**Experience**

Data Entry

Interpreter

**Education**

B..A., French, University of Utah , 1988

**Continuing Education**

On-going pursuit of Master's of Business Administration,

Westminster College of Salt Lake City - International Emphasis

**Honors**

**Awarded 2 scholarships:**

McKay French Scholarship, 1984

Honors-at-Entrance Scholarship to University of Utah

Phi Delta Phi - French Honor Society, 1986

**Golden Key Honor Society, 1985**

**Colleen K. Sidwell**

*Data Processor*

**Professional Experience**

Mountain States Analytical, Inc., November, 1995 - present

*Data Processor/Analyst*

Quanterra, Richland, Washington, May, 1992 - August, 1994

*Lab Technician/Data Processor*

**Education**

AA, General, Rick's College, Rexburg, Idaho, 1992

B.S., Business Management, Brigham Young University, 1994

**Continuing Education**

Total Quality Management, Mountain States Analytical, 1996

**Experience**

Data Packages

Data Processing

TPH Analysis

Radiation Safety Training

Electronic Deposition

Analysis

Bioassay Extractions

Sample Receiving Data

Entry

**Rachelle Anderson**  
*Metals Group Coordinator*

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**Professional Experience**

Mountain States Analytical, Inc., 1990 - Present  
*Metals Group Coordinator*

**Continuing Education**

Hazardous Materials Seminar, Salt Lake Community College, 1991  
Water Quality Seminar, Salt Lake Community College, 1991  
Ethical Fitness, Institute for Global Ethics, 1993

**Education**

B.S., Chemistry, Westminster College of Salt Lake City, 1990

**Awards and Citations**

John Stauffer Memorial Scholarship, 1989  
Mr. Mortensen Memorial Scholarship, 1989  
Eccles Scholarship, 1986  
Giant Award, Mountain States Analytical, 1992

**Experiences**

General Chemical Analysis  
Atomic Absorption  
Spectroscopy  
Environmental Analysis  
Data Processing  
Metals Digestions  
Data Packages

**Gary A. Krieger**  
*Inorganic Chemist*

**Professional Experience**

Mountain States Analytical, Inc., 1989 - Present  
*Inorganic Chemist*  
Hercules, Inc., 1979-1989  
Intermountain Lab, 1979  
LDS Hospital, 1978-1979

**Continuing Education**

Liquid Chromatography Course, Varian Instrument Co., October  
1985  
Ethical Fitness, Institute for Global Ethics, 1994

**Education**

B.S., Health Sciences, Brigham Young University, 1974

**Experience**

Gel Permeation  
Chromatography  
Liquid Chromatography  
Atomic Absorption  
Spectroscopy  
General Analytical Chemistry  
Environmental Chemical  
Analysis  
Microbiological Analysis

**Daryl J. Kent**  
*Inorganic Chemist*

289273

**Professional Experience**

Mountain States Analytical, 1992 - Present

*Inorganic Chemist*

Thermo Jarrell Ash, 1980-1992

*Senior Service Engineer*

I.A. Theatrical Stage Employees, 1978-1979

*Business Agent*

**Education**

Attended Boise State University

Major: Chemistry

Minor: Physics

**Continuing Education**

Radiation Safety Training Program-1994

Ethical Fitness, Institute for Global Ethics, 1994

**Memberships and**

**Appointments**

Utah State Aeromodelers

**Experience**

Atomic Absorption Inductively

Coupled Plasma

Spectrometry Plasma

Emission Spectrometry

Repair and Maintenance of

Atomic Absorption and

Emission Instruments

New User Training

Radiation Worker Training

Arc/Spark Emission

Spectrometry Theory and

Practice

**Beth Ebling***Group Leader***Professional Experience:**

Mountain States Analytical, 1995 - Present

*Group Leader*ACZ Laboratories, *Group Leader*, 1995

Lancaster Laboratories, Inc., 1989 - 1994

*Group Leader - 1990*Extrel Corporation, *QA/QC Specialist*, 1988 - 1989Carnegie Mellon University, *Environmental Engineering Laboratory Manager*, 1986 - 1988Princeton University, *Laboratory Technician*, 1983 - 1985Purdue University, *Laboratory Technician*, 1981 - 1982**Education:**B.S. International Agriculture, Purdue University  
(1981)**Continuing Education:**

Chrompack Inc. Basic HPLC course (1987)

Quality Education System, Philip, Crosby  
Associates(1990)Fundamentals of Groundwater Contamination,  
Geraghty & Miller, Inc. (1990)

Applied Statistics, Penn State Continuing Education (1990)

Service Operations Process Optimization, Penn State University  
(1992)

Presentation Skills, Lancaster Laboratories (1993)

**Memberships:**

Former member of American Chemical Society

Association of Official Analytical Chemists

**Katharine E. Nunn**  
*Senior Extraction Leader*

289275

**Professional Experience**

Mountain States Analytical, Inc. - 1992 - Present  
*Senior Extraction/Laboratory Technician*  
Westminster College - 1987-1992  
*Secretary*  
K Mart - 1988-1992  
*Clerk*

**Education**

Bachelor of Science, Westminster College of Salt Lake City,  
1993

**Awards and Citations:**

Spirit of MSAI, Mountain States, Analytical, Inc., 1995

**Continuing Education:**

TQM, Mountain States Analytical, 1995  
HP, Mass Spectral Interpretation, Mountain States Analytical,  
1995  
Ethical Fitness, Mountain States Analytical, 1995

**Experience**

Resource Coordinator  
Biology Departmental  
Assistant  
Lab Assistant  
Data Processing  
Organic Chemistry  
Infrared Spectrophotometry  
Desktop Computer Application

**Farlyn L. Smith**  
*Inorganic Laboratory Technician*

289276

**Professional Experience**

Mountain States Analytical, 1992 - Present  
*Inorganic Laboratory Technician*  
Newmont Gold, 1991  
*Laboratory Technician I*  
Hercules Aerospace, 1990  
*Laboratory Inspector*  
Unisys Corporation, 1989  
*Assistant Chemist*  
Gamma Electroplating, Taiwan, 1988  
*Laboratory Technician*

**Experience**

Atomic Absorption  
Spectrometry  
Ultra Violet Spectroscopy  
General Chemistry  
Fire Assay  
Mechanical and Physical  
Testing  
Sample Gathering and  
Preparation  
Statistical Process Control  
Methods

**Education**

Associate of Applied Science—Electronics Technology, Utah Valley  
Community College, 1988  
B.A., Mandarin Chinese, Brigham Young University, 1985  
A.S., Chemistry, Ricks College, Rexburg, Idaho, 1982

**Continuing Education**

Ethical Fitness, Institute for Global Ethics, 1994

**Nathan W.H. Ludwig***Associate Chemist***Professional Experience**

Mountain States Analytical, 1992 - Present

*General Chemistry Laboratory Technician/Associate Chemist*

Utah State Health Laboratory, 1992

*Laboratory Technician/Chemist*

Southern Utah University, 1989-1991

*Laboratory Assistant**Chemistry Tutor*

U.S. Forest Service, 1988-1989

*Surveyor***Experience**

General Chemistry

Sample Preparation and  
Digestion

Qualitative Analysis

Data Collection and  
Interpretation

Water Quality Analyses

QC Reporting

**Continuing Education**

Ethical Fitness, Institute for Global Ethics, 1994

TQM, Mountain States Analytical, 1995

**Education**

B.S., Chemistry, Southern Utah University, 1991

Minor: Mathematics

**Brooke Cline**  
*Data Package Assembler*

289278

**Professional Experience**

Mountain States Analytical, Inc., November ,1994 - present  
*Data Package Assembler processor/Analyst*  
Kentucky Fried Chicken, 1988 - 1994  
*Manager*

**Continuing Education**

Ethical Fitness, Institute for Global Ethics, 1995  
Total Quality Management Training, MSAI, 1995

**Experience**

Enter raw data into WARD  
Scientific Software to  
create data packages to  
meet holding times,  
TAT's and deadlines.  
Downloading instrument  
results into electronic  
files.  
Review work to meet stick  
requirements.  
Payroll  
Supervisor  
Cashier

**Holly C. Argyle**  
*QA Administrator I*

289279

**Professional Experience**

Mountain States Analytical, Inc., 9/92 - Present

QA Administrator

*Data Package Associate Coordinator*

Data Package Assembler

R.C. Willey, 1989 - 1992

*General Office*

Shopko, Inc.

*Sr. Sales Representative*

**Continuing Education**

High School Diploma, Cyprus High School, 1989

Salt Lake Community College

TQM Training

Ethical Fitness Training

**Experience**

QA validation of inorganic data

Enter raw data into WARD

Scientific Software to

create data packages to

meet holding times, TAT's  
and deadlines.

Downloading instrument

results into electronic files.

Review and validate work to

meet strict requirements.

PBX Operator

Inventory Control

General Office

**Thomas A. Adams**  
*Data Package Specialist*

289280

**Professional Experience**

Mountain States Analytical, 9/94 - Present  
*Data Package Specialist*  
Telecation, Inc., 1993 - 1994  
*Product Specialist*  
Southwest Research Institute - 1987 - 1993  
*Laboratory Technician*  
*Technician*  
*Data Technician*  
U.S. Army - 1978 - 1986  
*EW/SIGINT Systems Operator*  
*EW/SIGINT Intelligence Analyst*

**Experience**

Software and Data Validation  
Quality Assurance  
Gas Chromatography  
Field Sampling Supervision  
Chemical Alarm Response  
ACAMS Team Leadership  
Computer Programming  
CLP Document Control  
Data Entry

**Continuing Education**

Biology, Computer Programming, Solano Comm. College, 1976  
Leadership and Management Development, San Antonio, 1981  
Computer Programming, Misawa Japan, 1983  
Non-Commissioned Officer Academy, Korea, 1984  
Pascal Programming, Lowell University, 1985  
Front-End Analysis/Job Aids Development, Army Intelligence  
School, Ft. Devens, MA  
General Chemistry, Palo Alto Community College, 1987  
Chemical Surety Course, Johnston Atoll (JACADS), 1988  
OSHA HAZMAT Training, San Antonio Comm. College, 1992  
Good Automated Laboratory Practices, San Antonio, 1992

**Education**

G.C.Ed., Pacific Coast BBC, 1977

**Publications**

ENVIROFORMS/Organic CLP Manual, 1993.

**Awards and Citations**

Army Achievement Medal, 1985  
Army Achievement Medal (1 OLC), 1986

**Shirley Chandler***Document Control Administrator***Professional Experience**

Mountain States Analytical, Inc., Sept. 1990 - Present

*Document Control Clerk**Receptionist*

University of Utah, Center for Engineering Design

*Administrative Secretary , 4/88 - 8/90*

Evans &amp; Sutherland Computer Corporation, 8/85 - 4/88

*Secretary, 9/86 - 4/85**Clerk Typist, 3/86 - 9/86**Electronic Assembly, 8/85 - 3/86***Continuing Education**

High School Diploma, Bingham High, 1980

Mountainwest College of Business, Administrative Asst. Course,  
1986US West, Making the Most of Your Telephone Contacts, Jan,  
1992

Leadership &amp; Supervisory Skills for Women , Nov, 1993

Ethical Fitness Seminar, March 1994

**Experience**

Generate Daily Sales Report

Generate Daily Status Report

Monitor Daily Status of groups

Generate Daily Status Graphs

Send group reports to QC

Generate final report for clients

Maintain all Archives (short  
term & long term)Fax, mail, copy reports to  
clients

Create and mail invoices

**David H. Bunting**  
*Quality Assurance Director*

289232

**Professional Experience**

Mountain States Analytical, 6/92 - Present  
*Quality Assurance Director*  
*Data Package Validator*  
Signetics Company, A Division of North American Philips Corporation - 1979-1992  
*QA/Chemistry Lab Supervisor*  
*Technical Services Engineer*  
*Laboratory Technician*

**Continuing Education**

Basic Ion Chromatography, Dionex, 1984  
Flame AA, Graphite Furnace AA, ICP Short Course, Perkin Elmer, 1984  
Pascal Programming, Brigham Young University, 1984  
Crosby Quality College, Signetics adaptation, 1982, 1985, 1989  
Supervisor Development, Blanchard Training and Development, 1987  
Seven Basic Habits of Highly Effective People, Covey & Associates, 1988  
C Programming, Utah Valley Community College, 1992  
Weyant Communication Skills, 1992  
Beyond Quality, ACIL Education Institute, 1993  
Ethical Fitness, Institute for Global Ethics, 1993  
Quality Assurance for the Analytical Laboratory, AOAC, 1995

**Education**

B.S., Chemical Engineering, Brigham Young University, 1982

**Publications**

One paper accepted for presentation at INTEREX conference, Orlando, FL, 1988.

**Awards and Citations**

Signetics Orem Plant Support Department Recognition Award, 1988  
Giant Award, Mountain States Analytical, 1993  
Spirit of MSAI Award, Mountain States Analytical, 1994

**Memberships and Appointments**

ASQC, 1996  
American Chemical Society, since 1988  
American Institute of Chemical Engineers, 1978-1988  
Semiconductor Equipment and Materials International (SEMI),  
Chemical Reagents Subcommittee, 1987-1992

**Experience**

Statistical Quality Control and Measurement Systems Evaluation  
Quality Improvement Team Leadership  
Data Package Validator  
Inductively Coupled Plasma Emission and Atomic Absorption Spectrometries  
Fourier Transform Infrared and Ultraviolet Spectroscopies  
Gas Chromatography  
Ion Chromatography  
Mass Spectrometry  
Instrumental Liquids Particle Counting  
General Chemistry  
Computer Programming  
Data Base Management  
Instrument Design and Development

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APPENDIX B

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**APPENDIX B**

**THERMO NUTECH**

**LABORATORY QUALITY ASSURANCE PLAN**

Thermo NUtech

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Section No.: Title

QUALITY ASSURANCE PROGRAM MANUAL

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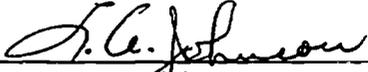
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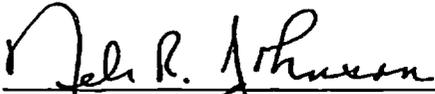
**AUTHORIZATION AND APPROVAL STATEMENT**

This Thermo NUtech Quality Assurance Program Manual,  
with all revisions, is authorized and approved in its entirety by:

  
\_\_\_\_\_  
Lawrence A. Johnson  
Q.A. Director

12-20-95  
Date

And Directed by:

  
\_\_\_\_\_  
Nels R. Johnson  
President

1-3-96  
Date

# Thermo NUtech

## QUALITY ASSURANCE PROGRAM MANUAL

### Thermo NUtech QUALITY ASSURANCE MISSION STATEMENT

*Our mission is to assure that all of the Thermo NUtech systems, services, processes, and deliverables are of a quality that meets or exceeds client requirements; and to foster a THERMO NUTECH culture in which there is a commitment to a rising standard of quality. This culture demands that the quality of those systems, services, processes, and deliverables and the methods used to achieve that quality be continuously improved.*

### FOREWORD

Quality Assurance essentially is a spirit that pervades all aspects of an organization. It is the quality attitude developed by a quality culture in an organization. It is the spirit in which the procedure, policy, or activity is written, implemented, and performed. This spirit produces empowerment and motivation in all employees to achieve the highest level of quality. This esprit de corps must start with the president of the Thermo NUtech and extend to all employees. The result of this attitude is "Quality Assurance."

This philosophy is realized and implemented through the policy guidelines presented in the Thermo NUtech Quality Assurance Program Manual, and is based on the premise that:

- People are our greatest asset and are ultimately responsible for the quality of the items and services we provide. Therefore, our most important objective is to treat each person with the greatest possible respect and consideration.
- Employees are inherently proud and want to produce top quality and on time services and deliverables. In order to do this they must be made aware of the quality requirements expected and they must be provided appropriate facilities, equipment, and proper training.
- A culture of quality embodied within the entire Thermo NUtech organization is the most effective way to provide support for the employee's commitment to quality.
- Management support is paramount and organizational responsibilities must assure integration of quality requirements in day to day operations.

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- All systems, services, processes, and deliverables can be planned, performed, assessed, and improved.
- Improvements allow operations to become more efficient and result in contractual requirements performed "on time" and done "right the first time."
- Quality improvements also lead to reduced costs and allow the ultimate objective of providing the highest quality items and services at the lowest costs to be a viable goal.

Quality is also a perception of our clients. Our actions in quality assurance must assure our clients that the Thermo NUtech organization provides the quality for systems, services, processes, and deliverables that will meet or exceed their requirements.

STATEMENT OF COMPLIANCE

This Quality Assurance Program Manual includes instructions outlined in ASME NQA-1-1989 "Quality Assurance Program Requirements for Nuclear Facilities," NRC 10 CFR Part 50, Appendix B "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," and QAMS 005/80 "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans" as elements that must be considered for inclusion in all Quality Assurance Project Plans. As illustrated below, the required element item numbers are listed on the right, appropriate coverage of that element is by the numbered section with title listed on the left. Item 3 (Design Control) from NQA-1 does not apply. Item III (Design Control) from 10 CFR 50 does not apply. Item 6 (Sampling Procedures) from QAMS 005/80 does not apply.

SECTION	TITLE	NQA-1	10 CFR 50	QAMS 005/80
	Title Page	N/A	N/A	1
	Table of Contents	N/A	N/A	2
1	Introduction and Description	N/A	N/A	3
2	Organization and Responsibility	1	I	4
3	Quality Assurance Objectives	2	II	5
4	Personnel Indoctrination and Training	2	II	N/A
5	Instructions and Procedures	5	V	14
6	Procurement Document Control	4	IV	N/A
7	Material Receipt and Control	7	VII	N/A
8	Material Storage and Control	8,13,15	VIII,XIII,XV	N/A
9	Control of Process	9	IX	7,9
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11	Control of Measurement and Test Equipment	12	XII	8
12	Data Reduction, Verification, and Reporting	N/A	N/A	10
13	Document Control	6	VI	N/A
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QUALITY ASSURANCE PROGRAM MANUAL

REVISION/REVIEW RECORD

<u>Page No.</u>	<u>Revision No.</u>	<u>Revision Date</u>	<u>Review Date</u>	<u>Reviewed By</u>
Entire Manual	Original	04-14-95	04-14-95	L. A. Johnson
Entire Manual	01	11-15-95	11-15-95	L. A. Johnson

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"quality nuclear services"

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## INTRODUCTION AND DESCRIPTION

### 1.1 PREFACE

The management of Thermo NUtech is committed to a rigorous Quality Assurance (Q.A.) Program. While this commitment is necessary for the normal conduct of business, our basic policies dictate the highest standards of ethics and integrity in the conduct of our affairs. This philosophy and the specific procedures to attain the objectives form the framework of our Q.A. Program. Thermo NUtech will provide only those services that are within our qualifications and with confidence that our Q.A. Program and all related operating procedures dictate reliable performance of those services.

### 1.2 PURPOSE

This manual outlines management's Q.A. policy and establishes a requirement that procedures be promulgated and used to accomplish all of the quality assurance elements necessary to fulfill the Thermo NUtech responsibility to meet or exceed client or regulatory specifications. It also provides a means for creating mutual understanding, regarding our Q.A. program and reliability techniques, with our subcontractors, suppliers, and clients.

### 1.3 SCOPE

This Quality Assurance Program Manual applies to all Thermo NUtech operations and provides guidance to meet operational requirements. The policy requirements, as listed herein, may not apply to every operational unit, however, each operational unit manager must assure compliance with those directions that are applicable to their unit.

*Note*

*From time to time, Thermo NUtech organizational units will commit by contract to follow procedures, including Quality Assurance procedures, that have been promulgated by the client. In those situations, this Quality Assurance Program Manual shall serve as a back-up to assure that all applicable elements of the THERMO NUTECH Q.A. Program are addressed. The operational unit manager is responsible to determine which section of the Thermo NUtech Q.A. Program Manual apply and shall assure implementation of those sections by the organizational unit.*

In addition to the documents listed in the Statement of Compliance, this Manual complies with applicable requirements of the following regulations:

- 1.3.1 NRC 10 CFR Part 21, "Reporting of Defects and Non-compliance."
- 1.3.2 DOE 10 CFR Part 830, "Nuclear Safety Management"
- 1.3.3 NRC Regulatory Guide 4.15, Rev. 1, "Quality Assurance for Radiological Monitoring Programs - Effluent Streams and the Environment."
- 1.3.4 ANSI Standard N413-1974, "Guidelines for the Documentation of Digital Computer Programs."
- 1.3.5 U.S. EPA QAMS-004/80, "Guidelines and Specifications for Preparing Quality Assurance Program Plans."
- 1.3.6 ANSI N13.11-1993, "Personnel Dosimetry Performance - Criteria for Testing."
- 1.3.7 U.S. DOE Order 5700.6C, "Quality Assurance."

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1.3.8 ANSI/ASQC E4-1994, "Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs."

1.3.9 Draft ANSI N13.30, "Performance Criteria for Radiobioassay."

1.4 INTRODUCTION

In order to provide consistency in job titles and for identification of organizational positions and personnel, and for understanding of responsibilities outlined in this manual, the following titled designations of positions are used:

**President, Thermo NUtech** Refers to the President of Thermo NUtech (Nels R. Johnson)

**President, Thermo Hanford** Refers to the President of Thermo Hanford (John D. Moroney)

**Vice President** Refers to the Vice President, Laboratory Operations (Ernest A. Sanchez), or the Vice President, Health Physics Operations (Jeffrey A. Brown).

**Technical Director** Refers to the individual who provides technical direction or advice for laboratory operations and/or special programs, projects, or activities (William McDowell, Ph.D., Thermo NUtech; Dave Rodgers, Richmond).

**Laboratory Manager** Refers to the Laboratory Manager (Facundo J. Garcia, Richmond; Mike McDougall, Oak Ridge; Ernest A. Sanchez, Albuquerque).

**Operations Manager** Refers to the individual within a laboratory who is responsible for the technical operations of the laboratory (Rod Melgard, Richmond; Harold Tso, Albuquerque; Mike McDougall, Oak Ridge).

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- Project Manager** Refers to the individual who is responsible for a specific operation or project (i.e. FUSRAP).
- Program Manager** Refers to the individual who is responsible for client service activities and is the single point of contact with a client for a laboratory.
- Department Manager** Refers to an individual who is responsible for the operations of a specific department.
- Supervisor** Refers to an individual within a laboratory or unit who is responsible for the operational functions of a group of personnel (e.g. Sample Control Supervisor, Instrument Calibration Supervisor, etc.).
- Q.A. Director** Refers to the Q.A. Director of Thermo NUtech (Lawrence A. Johnson).
- Q.A. Manager** Refers to an individual who is responsible for a company's Q.A. Program (Lawrence A. Johnson, Richmond; Kathy Burnham, Albuquerque, William Templeton, Oak Ridge; Bill Frisbee, Thermo Hanford).
- Q.C. Coordinator** Refers to an individual within a company who has been assigned responsibility for specific quality control functions or areas of the Q.A. Program. These individuals report to the Q.A. Manager on matters pertaining to quality assurance.

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Revision No.: 01Rev. Date: 11-15-95Page No.: 15 of 59Section No.: 01Quality Assurance Program Manual1.5 DESCRIPTION

This document outlines the organization of the Q.A. function, describes and depicts the lines of authority and lists the duties and responsibilities within the organization. It provides direction for the preparation of Procedure Manuals which provide the detailed methods of processes and analyses that accomplish the goal of quality data in terms of precision, accuracy and reproducibility.

1.6 CONFIDENTIAL AND PROPRIETARY INFORMATION

Thermo NUtech employees are exposed to confidential and/or proprietary information pertaining to the company and its clients. Information concerning the report of analysis, radiation dosimetry records, audit reports, calibration reports, and other documents relating to a project are considered confidential. This information is to be released only to the client or to the client's authorized representative. Each employee shall sign an agreement with the Thermo NUtech concerning the security of proprietary and confidential information. A copy of the agreement shall be retained in the employee's personnel file.

1.6 TECHNICAL COMPLAINTS

Technical complaints will be addressed by a technical director or staff member with the most expertise in the area of complaint. If the complaint is not valid, every attempt will be made to satisfy the client. If the complaint is determined to be valid, then the cause of the complaint shall be identified and corrected as soon as feasible. Verification that the cause for a valid complaint has been corrected is the responsibility of the individual addressing the complaint. Details of all technical complaints shall be recorded and maintained in the customer's project file.

SECTION 2.0  
ORGANIZATION AND RESPONSIBILITY

2.1 ORGANIZATIONAL STRUCTURE

The President of Thermo NUtech has overall responsibility for the Quality Assurance Program (Program). In his capacity, he has delegated the responsibility for design, implementation, and execution of the Program to the Thermo NUtech Q.A. Director. Assisting the Q.A. Director in the implementation and execution of the Program is a Q.A. Manager, with Program responsibility, at each of the organizational units.

Additional organizational structure, functional responsibilities, levels of authority, and lines of communication for management, direction, and execution of the Program are documented below:

2.2 RESPONSIBILITY

The delineation of authority and the responsibility of persons and organizations performing activities affecting quality are established as follows:

- 2.2.1 Each Q.A. Manager is responsible for the establishment and execution of the Q.A. Program as outlined herein and for defining and measuring the overall Program effectiveness for their area of responsibility.
- 2.2.2 The Q.A. Manager shall report to the appropriate vice president, president, or laboratory manager providing the required authority and organizational freedom to assure that appropriate action can be taken in implementing an effective Program. Q.A. Managers shall have sufficient independence from cost and scheduling considerations, and have the authority to control processing, delivery, installation, or use until proper disposition of a non-conformance, deficiency, or unsatisfactory condition that has occurred.

- 2.2.3 Each Q.A. Manager has direct access to the Q.A. Director who can defer to the authority of the President, Thermo NUtech on matters pertaining to quality assurance for resolving problems that cannot be resolved at company level.
- 2.2.4 Q.A. Managers are responsible for reviewing the Q.A. Program on a continuing basis and revising the Program as necessary to assure compliance with the latest revisions of applicable standards. A formal review of the Program shall be performed annually.
- 2.2.5 Quality related activities may be assigned to designated qualified personnel.
- 2.2.6 Responsibility for quality control functions resides with the Q.A. Manager and designated Quality Control (Q.C.) Coordinators.
- 2.2.7 The Q.C. Coordinators report directly to the Q.A. Manager on matters pertaining to quality assurance.
- 2.2.8 The Q.A. Manager and designated personnel are authorized to sign client related Certificates of Conformance and/or Compliance.
- 2.2.9 Q.C. Coordinators shall monitor the adequacy of the Program portions for which they are responsible and recommend improvements, additions, or deletions to the Program. Should a condition adverse to quality be observed, the Q.A. Manager and the responsible manager shall be advised. The responsible manager, or designee, shall investigate the cause and determine the action necessary to correct the condition and to prevent recurrence.

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- 2.2.10 Q.C. Coordinators are responsible for in house inspections of their areas of responsibility and for monthly quality control reports to the Q.A. Manager.
- 2.2.11 The responsibility for compliance to the general workmanship and standard practices is vested in the first line level of supervision. The supervisors shall indoctrinate and enforce employee compliance.
- 2.2.12 Every employee is responsible for supporting the Program in principle and in detail.
- 2.2.13 The vice presidents and the President, Thermo Hanford, with designated managers, shall annually assess the Q.A. Program for their area of responsibility to evaluate its adequacy and assure its effective implementation.

2.3 ORGANIZATIONAL CHARTS

- 2.3.1 The Thermo NUtech Corporate Organization is illustrated in Figure 1.
- 2.3.2 The Thermo NUtech Quality Assurance Organization is illustrated in Figure 2.

Figure 1

Thermo NUtech  
 CORPORATE ORGANIZATION

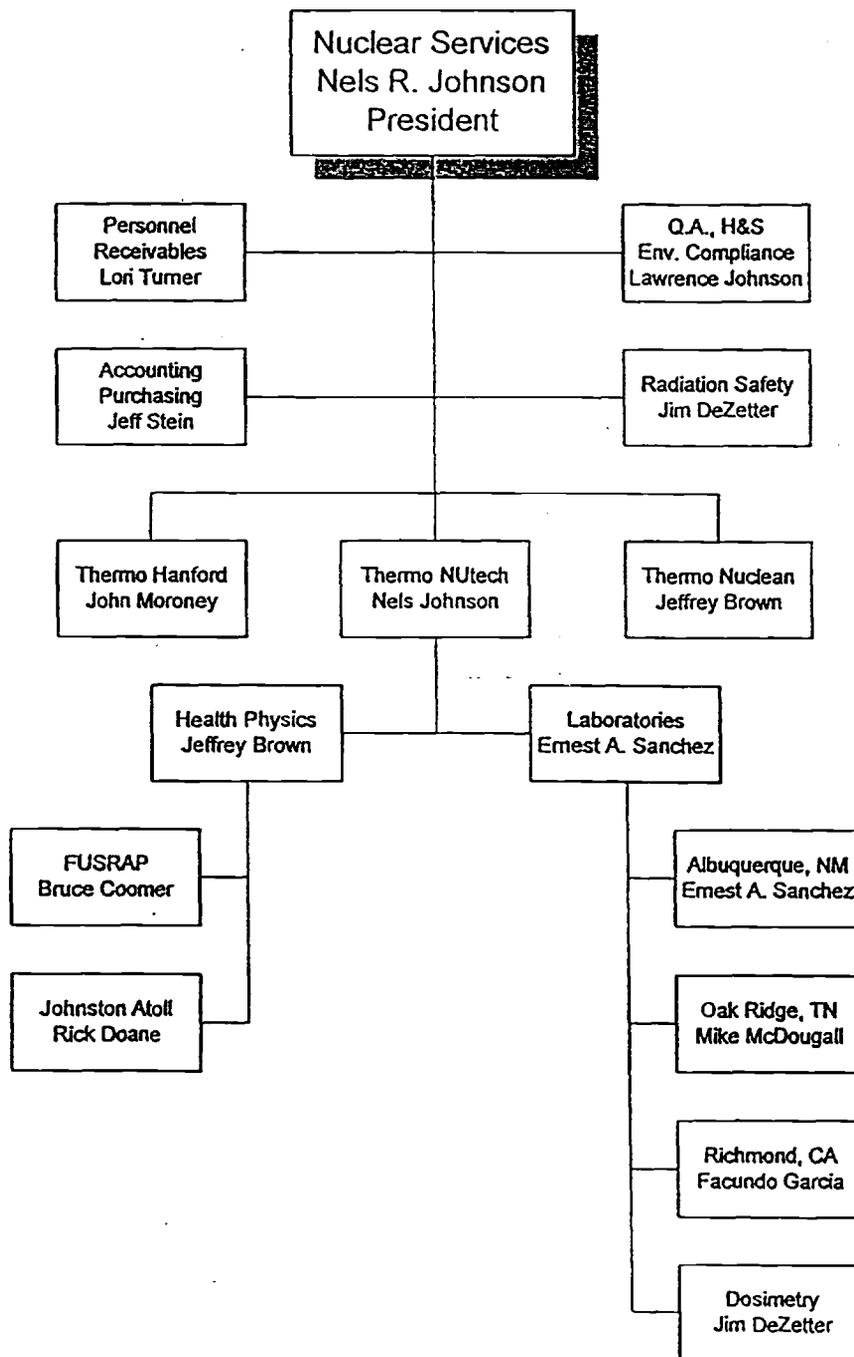
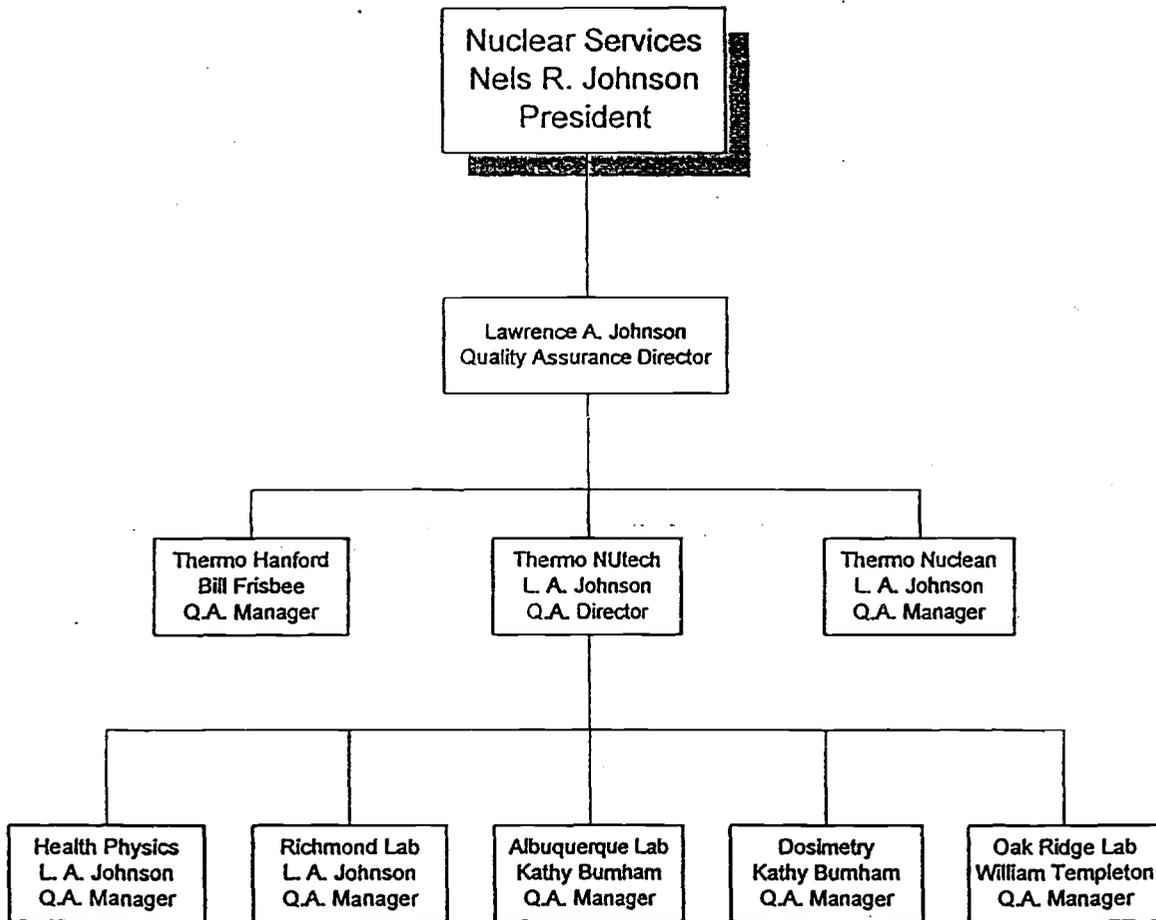


Figure 2

Thermo NUtech  
QUALITY ASSURANCE ORGANIZATION



## SECTION 3.0

## QUALITY ASSURANCE OBJECTIVES

3.1 OBJECTIVES

The Thermo NUtech Q.A. Program is organized to meet the following objectives:

- 3.1.1 To ensure performance of those actions that provide confidence that quality is achieved.
- 3.1.2 To provide an effective control for the verification of characteristics of all systems, services, and processes that produce data of known quality.
- 3.1.3 To ensure that systems, services, processes, and deliverables meet the rigid quality and reliability standards of the Thermo NUtech Also, to ensure that individual client criteria pursuant to these standards are met.
- 3.1.4 To provide a continuing monitoring service for review of operating procedures, and for overall effectiveness and evaluation of the Q.A. Program. And to provide observations and recommendations for improvement in all areas of laboratory operations where quality may be affected.
- 3.1.5 To assure the documents program provides valid records of the control measures applied to all factors bearing on the final results of investigations.
- 3.1.6 To assure the assessment of results provides feedback to improve the process.
- 3.1.7 To instill a culture in which there is a commitment to achieve a rising standard of quality, which demands that the quality for systems, services, processes, and deliverables, and the methods utilized to achieve that quality be continuously improved.

## SECTION 4.0

## PERSONNEL INDOCTRINATION AND TRAINING

4.1 QUALIFIED PERSONNEL

- 4.1.1 Personnel within Thermo NUtech who perform activities that will affect quality shall have indoctrination, training, and job evaluation conducted on an individual basis to assure that suitable proficiency is achieved and maintained.
- 4.1.2 Personnel performing technical functions or processes shall have known and documented related work experience and, if required, minimum qualifications of education.
- 4.1.3 Personnel performing dosimetry processes shall be able to record numbers accurately and legibly, should have the necessary manual dexterity to work at repetitive multistep tasks quickly, and shall be able to understand and follow written procedures and instructions.

4.2 RESPONSIBILITY

- 4.2.1 Supervisors are responsible for initial evaluation of capabilities and qualifications of assigned personnel and shall assign those personnel to perform functions based on the individual's qualifications and abilities.
- 4.2.2 Supervisors and managers are responsible for ~~quarterly performance verification~~ of assigned personnel. Documentation of ~~performance verification (form QAP 15.1) shall be retained in the training files~~

- 4.2.3           Appropriate training is the responsibility of the supervisors with support from management. Training shall address specific needs and will vary according to each job's requirements and previous experience of the employee, and shall assure:
  - 4.2.3.1           Understanding of the fundamentals of the work and its context.
  - 4.2.3.2           Understanding of the processes and tools being used, the extent and sources of variabilities in those processes and tools, and the degree to which control over the variability is maintained.
  - 4.2.3.3           Emphasis on correct performance of the work, understanding why quality requirements exist, and potential consequences of improper work.
  - 4.2.3.4           Emphasis on "doing it right the first time."
- 4.2.4           New employees shall receive detailed information concerning safety practices, security policies, and general corporate policies. A current copy of the safety manual shall be made available to employees who shall familiarize themselves with this document.
- 4.2.5           Milestone achievements or unique training shall be noted by the supervisors through entry to the training records. Available certificates of training, education, or awards shall also be maintained in the individual's training records.

- 4.2.6 Supervisors shall monitor individual work habits to assure proficiency is maintained; for progressive improvement; and to identify any needed supportive training. Additional training requirements will be developed by the individual's supervisor.
- 4.2.7 When applicable, employees shall be informed of the requirements of 10 CFR Part 21 "Reporting of Defects and Non-Compliance," and shall familiarize themselves with this regulation. Familiarization shall be made a matter of record.
- 4.2.8 Requirements for personnel training and the details for composition and maintenance of training records are outlined in the Thermo NUtech Quality Assurance Procedure, QAP-02 "Personnel Indoctrination and Training."

**SECTION 5.0**  
**INSTRUCTIONS AND PROCEDURES**

**5.1 POLICY**

The Thermo NUTech policy is to use written and approved procedures for routine activities and for analytical and operational processes. Applicable procedures are available to operating personnel and a current copy of the appropriate procedure is maintained in each laboratory/operating department.

**5.2 TECHNICAL PROCEDURES**

Technical procedures are descriptions of particular protocols for testing or operations. Technical procedures may be developed when no published reference procedure is the basis for a test or operation and the Operations Manager, Technical Director, or Q.A. Manager deem it necessary.

5.2.1 Each technical procedure shall define qualification requirements for personnel performing the operation and criteria used to determine the proficiency of the operator.

5.2.2 Each technical procedure shall include a list of Personal Protective Equipment (PPE) required for the operation being performed. Training to the identification, operation, use, limitations, and disposal of the PPE shall be conducted.

5.2.3 Each technical procedure shall identify any chemicals required to complete the operation. MSDSs for those chemicals shall be readily available and training applicable to the MSDSs shall be conducted.

5.2.4 Each technical procedure shall identify the hazardous wastes generated as a result of the operation. Training shall be conducted to the processes used for identification, marking, storage, and disposal of the hazardous wastes.

**5.3 PROCEDURE MANUALS**

Procedure manuals consist of the individual technical procedures for a laboratory area or for an operation combined into one document. The procedures within the manual define all parameters of the operations being performed to include required accuracy and completeness of specific measurement parameters involved. All procedures shall be incorporated into procedure manuals.

**5.4 FORMAT AND DISTRIBUTION**

5.4.1 All procedures will comply to the format prescribed in the company document control procedure and shall be approved by the relevant manager or designated cognizant technical personnel and the Q.A. Manager.

5.4.2 Distribution of the procedure manuals shall be in accordance with the company's document control procedure. The original copy of each department's procedure manual shall be maintained by the Q.A. staff.

**5.5 REVIEW**

Procedures shall be reviewed biennially and updated if required.

**5.6 REVISION**

5.6.1 The appropriate supervisor, or designated representative, is responsible for revisions or changes to the applicable procedure manuals.

5.6.2 Revisions are reviewed and approved by the organization(s) responsible for the original document. When possible, revisions or changes shall be accomplished on a page replacement basis.

5.6.3 The Q.A. Manager shall be advised of any changes in procedures required to satisfy specifications of the client.

5.6.4 A copy of each superseded procedure, marked "Revised" or "Obsolete" shall be retained by the Q.A. staff for five years and then processed ~~in accordance with the organization's document control procedure.~~

SECTION 6.0  
PROCUREMENT DOCUMENT CONTROL

6.1 PURCHASING

Procurement of material, components, supplies, reagents, equipment, and services necessary to carry on the business interests of Thermo NUtech organizations is initiated by purchase requisition and controlled by an authorized purchase order number. To the extent necessary, purchase orders shall require suppliers to have a Q.A. program consistent with the requirements of this document. Detailed information on procurement is outlined in the applicable organization's general purchasing policies and procedures manual.

6.2 PURCHASE REQUISITION REVIEW

Purchase requisitions or change orders are reviewed by purchasing department personnel to assure conformance to the procurement requirements. Quality related requisitions are reviewed by Q.A. personnel prior to being processed.

6.3 CERTIFICATION/CERTIFICATE OF CONFORMANCE

All materials and processes requiring certification and certificates of conformance are identified on the face of the purchase order or by attachment thereto. Adequate information is provided to assure supplier compliance to the required specifications. The Q.A. Manager is responsible for the retention, filing, and recall of material certification and certificates of conformance.

6.4 SUBCONTRACTS

When subcontracting analytical work Thermo NUtech personnel shall assure, to the extent necessary, that the subcontractor has a Q.A. program consistent with the requirements of this document. The Q.A. Manager is responsible for evaluation and acceptance of the subcontractor's Q.A. program.

**6.5 VENDORS**

- 6.5.1 For procurement of quality-related items or services the Q.A. Manager is responsible for vendor evaluation and approval. Vendor evaluation and qualification will be through a secondary calibration laboratory; an audit by Thermo NUtech personnel or an acceptable audit agency; or facility inspection, test reports, or receipt inspections, when the quality of the materials can be verified by these methods. Documentary evidence that products and services conform to procurement requirements shall be provided and retained.
- 6.5.2 The effectiveness of the control of quality by contractors and subcontractors shall be assessed at intervals consistent with the importance, complexity, and quantity of the product or services.
- 6.5.3 The purchasing department is responsible for maintaining a record of quality related materials received from vendors including any reports for non-conforming material.

**6.6 QUALITY RELATED SERVICES**

Q.A. personnel shall review the purchase requisitions for quality related services. Those services that are determined to be quality related will include the following statement, or similar wording, in the body of the purchase order or by attachment: "The pieces of equipment and/or services to be furnished under this purchase order are subject to the applicable requirements of NQA-1-1989 or MIL-STD 45662A" and, if applicable, "The provisions of 10 CFR Part 21 apply."

**SECTION 7.0**  
**MATERIAL RECEIPT AND CONTROL**

**7.1 POLICY**

Only material with acceptable quality characteristics shall be allowed into stock.

**7.2 RESPONSIBILITY**

Receipt and initial verification of all materials and equipment received by Thermo NUtech laboratories, either purchased or contract (client) supplied, is the responsibility of the receiving and stock control clerk or designated individual. Technical verification for materials and equipment shall be by the requisitioner or Q.A. personnel, whichever is applicable. Quality related purchase order items will be receipt inspected by Q.A. personnel.

**7.3 MATERIAL CONTROL**

Purchased material is controlled by the receiving and stock control clerk or designated individual.

7.3.1 The receiving and stock control clerk, or designated individual, is responsible for the expedient and correct routing of all initially accepted received materials to stock, or to the requisitioner.

7.3.2 Purchasing department personnel are responsible for maintaining a record of materials received from vendors, including Rejected Material Report (RMR), or equivalent form, for any non-conforming material.

**7.4 NON-CONFORMING MATERIAL**

When received material, affecting quality, has been determined to be non-conforming, the requisitioner, Q.A. Manager, or Q.C. Coordinator shall be responsible for initiating the following actions:

- 7.4.1 Determine if non-conformance requires reporting in accordance with 10 CFR Part 21 and record on RMR, or equivalent form.
- 7.4.2 Entering the non-conforming inspection data on the RMR and returning the RMR to the purchasing department.
- 7.4.3 Clearly marking the material as a rejected shipment and assuring it is moved to the receiving hold area pending disposition instructions.
- 7.4.4 The receiving and stock control clerk, or designated individual, is responsible to assure that non-conforming material or supplies are not issued to be utilized in service operations unless specifically approved, in writing, by the client.

**SECTION 8.0**  
**MATERIAL STORAGE AND CONTROL**

**8.1 POLICY**

All materials and supplies in storage shall have the necessary protection to preclude deterioration, corrosion, or damage during storage life and shall carry identification sufficiently clear to assure that only those materials specified by process instructions will be withdrawn from material storage and issued for processing.

**8.2 RESPONSIBILITY**

Only authorized personnel shall have access to, and the responsibility for, control and issue of materials or supplies. Materials and supplies shall be stored to allow for ready identification. Care shall be taken to preclude mixing of rejected material and supplies with those that are qualified for issue.

SECTION 9.0  
CONTROL OF PROCESS

9.1 STANDARD PRACTICES

Standard practices applicable to services provided by Thermo NUtech are contained in documented procedures and this Q.A. Program Manual. Every effort is made to fulfill requirements of the following generic sources of specific practices or factors affecting those practices.

9.1.1 Federal and State rules and regulations.

9.1.2 Consensus standards related to the services performed (e.g., American National Standards Institute).

9.1.3 Regulatory Guides published by the Nuclear Regulatory Commission, Department of Energy, or the Environmental Protection Agency.

9.1.4 Specific contractual agreements with clients.

9.1.5 Where conflict occurs among the above four items, or other appropriate authority, the client shall be notified and requested to specify the policy to be followed.

9.2 DOCUMENTED PROCEDURES

Routine operating procedures are documented. Each procedure includes quality control features which are unique to that process. As applicable, each laboratory shall develop and promulgate procedures for the operations performed in their laboratory. As a minimum, however, the following general procedures, if applicable, shall be developed:

9.2.1 Quality Assurance Procedures (QAP)

QUALITY ASSURANCE PROGRAM MANUAL
 

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- 9.2.2 Laboratory Safety Procedures (LSP)
- 9.2.3 Radiation Safety Procedures (RSP)
- 9.2.4 Sample Control Procedures (SCP)
- 9.2.5 General Purchasing Policies and Procedures (PP)
- 9.2.6 Billing Department Procedures (BDP)
- 9.2.7 Data Verification Procedures (DVP)
- 9.2.8 Nuclear Measurements Instruments Procedures (NMIP)

 9.3 RESPONSIBILITY

The operations manager, or designated representative, determines which instructions or procedures require quantitative or qualitative acceptance criteria and specifies the appropriate criteria on special contracts or projects.

 9.4 WORK POLICY

All work to be performed by Thermo NUtech on client samples is authorized by the client and controlled through a ~~Laboratory Information Management System~~ (LIMS) work order process, or other document deemed necessary by the program manager, which incorporates the client's requirements.

9.4.1 The work order specifies those analyses necessary to assure compliance with contractual obligations.

9.4.2 Program managers, or designated personnel, are responsible for notifying the Q.A. Manager and performing laboratory departments, through the appropriate supervisor, of all contract requirements including reporting and quality control obligations. This may be done by reference to other documents (e.g. Purchase Order) that contain the contract requirements.

9.4.3 ~~The Client Services Manager shall assure planning, scheduling, and resource considerations are considered when contracting for or accepting work.~~

**SECTION 10.0  
PREVENTIVE MAINTENANCE**

**10.1 POLICY**

Preventive maintenance is performed as required on instrumentation and equipment to prevent down time and to assure reliable performance.

**10.2 MAINTENANCE**

Preventive maintenance procedures have been developed for use where instructions are not provided in the manufacturer supplied operator's manual. A record of instrument maintenance, calibration, and repair is maintained. The supervisors and operating personnel are responsible for complying with the department maintenance schedule.

**10.3 SPARE PARTS**

Supervisors shall assure that an adequate inventory of spare parts and consumables is requisitioned and maintained for instrumentation in their area in order to prevent down time or compromised running conditions.

SECTION 11.0  
CONTROL OF MEASUREMENT AND TEST EQUIPMENT

11.1 MEASUREMENT AND TEST EQUIPMENT CALIBRATION POLICY

This section establishes the controls and calibration procedures for all analytical and nuclear measurement equipment.

- 11.1.1 All equipment, whose operation and function directly affect the quality of service, shall be inspected/calibrated at established intervals. As applicable, equipment shall be suitably identified to reflect calibration status. If an instrument is determined to be out-of-tolerance, it shall be segregated, or otherwise clearly identified as inoperable. Records of each calibration shall be kept in appropriate logbooks or files. Instruments whose calibrations are performed during method operations are calibrated and controlled in accordance with the method requirements. Run logs shall be maintained for this category of instrumentation.
- 11.1.2 The equipment used to determine the quality characteristics and accuracy of instruments shall be checked and verified either internally (dependent upon capability), or by qualified calibration services.
- 11.1.3 Frequency of inspection/calibration shall be based on use of the equipment or instrument, environmental conditions in which it is used, its inherent stability, manufacturer's recommendation, and the wear or deterioration resulting from its use.

- 11.1.4 Certified standards are used for all primary calibrations. National Institute of Standards and Technology (NIST) or NIST traceable, Environmental Protection Agency (EPA), New Brunswick Laboratory (NBL), or Department of Energy (DOE) standards are used, when available, for the primary calibrations or verification of primary calibrations.
- 11.1.5 All preparations of solution standards are recorded in a standards preparation logbook. Identities of standards are such that a secondary standard or dilution can be traced, through subsequent actions, back to the initial certification.
- 11.1.6 Quality control check standards are used to record instrument sensitivity and linearity and to verify proper response. Methods and calibration entries are dated, initialed, and documented by the analyst.
- 11.1.7 Measuring and test equipment are tagged as to calibration or operating status for periodic processes performed on a scheduled interval of greater than one month. For processes performed more frequently than this, separate documentation will be available for verification of operational status. Instruments that are too small to be tagged or are subject to a wide variety of calibrations shall have separate documentation of status available.

## 11.2 RESPONSIBILITY

Testing and/or calibration of equipment and instruments shall be performed under the direction of the supervisor, the department manager, or the operations manager and performed under suitable environmental conditions.

**11.3 PROCEDURES**

All tests and calibrations shall be performed in accordance with written procedures which contain provisions for assuring that all prerequisites for the given test have been met, including appropriate equipment to be used.

**11.4 CERTIFICATION AND CERTIFICATES OF CALIBRATION**

11.4.1 To the extent possible, calibration shall be traceable to NIST. Records of traceability shall be maintained along with records of routine calibrations of each instrument or measurement system. Where no NIST traceability exists, the basis used for calibration shall be documented.

11.4.2 Equipment records shall be maintained to indicate past and current status, and to provide reproducibility and traceability of results.

**11.5 RADIOACTIVE SOURCE CALIBRATION**

Radioactive sources used as calibration standards shall be periodically calibrated and controlled. Current calibration certificates shall be kept on file.

**11.6 CALIBRATION RECORDS**

Supervisors shall assure that calibration data for instruments and radioactive sources is recorded in the instrument logbook, on data work sheets, on computer files and/or control charts. Supervisors shall also assure that field/portable survey instruments are identified with the individual calibration labels. New calibration charts shall be prepared when there is measurable change in calibration effect on instruments or dosimeters that have been calibrated. If an instrument is determined to be out of tolerance, it will be segregated or otherwise clearly tagged as inoperable and not used until repaired.

**11.7 REPORTS GENERATED FROM USE OF A DEFICIENT INSTRUMENT**

If a major deficiency in an instrument or device is detected during periodic calibration procedures, the technician shall immediately notify the department manager, the operations manager, and the Q.A. Manager. A conference shall immediately be scheduled to investigate and decide what corrective action is to be taken on past data and reports resulting from the use of the deficient instrument or device. The action taken to prevent recurrence shall be documented on a corrective action request form. Instruments whose calibration is performed during a methods operation shall have deficiencies corrected and reported by use of non-conformance reports.

**11.8 PERFORMANCE CHECKS OF RADIATION SCREENING INSTRUMENTS**

Performance checks shall be made to assure the continuing capability of radiation screening instruments. Procedures include efficiency checks and background determinations. The procedure and frequency of each check is optimized for each detector system to provide assurance of the detector's performance. Documentation of the checks and the results are kept for all operations.

SECTION 12.0  
DATA REDUCTION, VERIFICATION, AND REPORTING

12.1 USE OF COMPUTER HARDWARE AND SOFTWARE

Computer programs used in the production or support of client data are either purchased, or developed using approved development methodology. Such programs are independently validated, verified, and documented. Changes are controlled to assess the potential impact of the change on the performance of the program.

12.2 DATA REDUCTION AND VERIFICATION

12.2.1 Results of analyses are generated by computer and are reviewed initially by the Counting Room staff. Additional review is provided by the data verification department. The program manager, or designated individual, performs the final review and approves the data.

12.2.2 Calculation methods, transcriptions, and data flow, plus times and locations of the various tiers of review are detailed in the specific procedure manual.

12.3 REPORTING

The program manager or designated individual is responsible for providing the client with the required analytical results. Reports to clients will be reviewed for accuracy and completeness and, where required, analytical methods and minimum/method detection limits (MDL) will be reported. Laboratory reports of analyses shall be signed by an authorized individual who, along with the person who signed the data sheets, can attest to the fact that the data was generated in accordance with established procedures.

**SECTION 13.0  
DOCUMENT CONTROL**

**13.1 POLICY**

The primary formal communication methods within Thermo NUtech laboratory departments are documents that inform or direct activities affecting purchasing, sample analyses, and instrument calibration and/or testing. These documents are controlled by the Q.A. Program Manual, Operating Procedure Manuals, other documented procedures, or by interoffice memorandums. Drawings and specifications are not controlled as separate documents but are included in controlled procedures as applicable.

**13.2 RESPONSIBILITY**

13.2.1 The Q.A. Manager is primarily responsible for maintaining files of all controlled documents and shall:

13.2.1.1 Annually review the Q.A. Program Manual and provide recommendations for updating.

13.2.1.2 Assure all holders of controlled documents receive copies of revisions to the documents.

13.2.1.3 Maintain files of controlled document distribution indicating document title, number, revision number, assigned date, and the name of the individual the document is assigned to.

- 13.2.1.4 Forward revisions of controlled documents to assigned individuals. An acknowledgement form shall accompany each document revision for verification of receipt and to provide disposition instructions for the superseded pages.
- 13.2.2 Uncontrolled copies of controlled documents shall be distributed only if marked "Uncontrolled."
- 13.2.3 Superseded and/or obsolete documents are isolated from use or destroyed.
- 13.2.4 Supervisors are responsible for revisions or changes to operating procedures for their area of responsibility.
- 13.2.5 The Q.A. Manager shall be advised of any changes in procedures required to satisfy specifications of the client.

SECTION 14.0  
INTERNAL QUALITY CONTROL

14.1 HEALTH PHYSICS SERVICES

Health physics services quality control is provided by independent peer review of all computations, reports, and related consulting services. Peer review will be for technical accuracy, approach, choice of assumptions, and conclusions drawn.

14.1.1 After peer review, reports will be reviewed and approved by the president or vice president or designated representative.

14.2 PERSONNEL DOSIMETRY SERVICES

Personnel dosimetry procedures are documented by and incorporated with many quality control features including the periodic reading of the internal light sources and reference dosimeters that have been carefully selected and irradiated to a calibrated gamma source.

14.2.1 In-House Quality Control - The program shall consist of controlled evaluation of exposed and unexposed dosimeters used to indicate the consistency of the annealing and reading process. These dosimeters shall be processed using the same routine procedure used for client dosimeters. Since they are representative of the current supply provided to the customers, the results obtained from these dosimeters indicate the consistency and accuracy of the total dosimetry program. Results shall be reviewed and summarized by the radiation dosimetrist and reported to the Q.A. Manager on a monthly basis.

14.2.2 Independent Performance Testing - TLD badges representative of the current supply, and routinely processed in the same manner as those shipped to clients, shall be sent monthly to Battelle Pacific Northwest Laboratories (BPNL) for additional performance testing. The type and quantity of each exposure shall be determined by testing protocol described in ANSI N13.11-1993 "Personnel Dosimetry Performance - Criteria for Testing." Upon receipt from BPNL, the TLD badges shall be read out using the current operating procedures. The exposures shall be reported by BPNL following receipt of the TNS exposure report. Results shall be reviewed by the radiation dosimetrist and reported to the Q.A. Manager for distribution to management. This program helps insure that accuracy, as well as the precision, is maintained.

14.2.3 National Voluntary Laboratory Accreditation Program (NVLAP) - A recertification of the laboratory is performed by NVLAP every two years. Accreditation is received in all eight categories described in ANSI N13.11-1993. A more detailed description of the scope of accreditation is described in the Statement of Qualifications document. The NVLAP logo is only displayed on the Radiation Exposure Report submitted to the client.

14.2.4 Department of Energy Laboratory Accreditation Program (DOELAP)

The Dosimetry Department maintains accreditation through DOELAP for certain clients and for client specific exposure categories.

### 14.3 LABORATORY ANALYTICAL SERVICES

Precautions are taken in the laboratories to avoid cross-contamination of samples and to assure the reporting of accurate results. Quality control samples are analyzed along with routine samples to indicate when results may be in error due to improper operation or calibration of equipment, inadequate training of personnel, a deficiency in the procedure, or cross-contamination from other samples.

- 14.3.1 Laboratory Precision - Laboratory management personnel are responsible to assure that analytical results are reproduced internally within acceptable limits.
  
- 14.3.2 Precision and Accuracy - Replicate standards and/or samples are used to estimate the precision of each analytical test procedure for a known matrix. Data control limits are established to satisfy the requirements of specific measurement projects based on prior knowledge of the measurement system and method validation studies. Certified standards and/or spiked samples are used to estimate chemical recovery for these procedures for known matrices.
  
- 14.3.3 Calibration and Performance Checks of Nuclear Measurement Systems - Reference standards are used for calibrating nuclear measurement systems. In addition to calibration of all instrumentation, performance checks are made to assure the continuing integrity of the instrument performance. These procedures include efficiency checks, background determinations, and energy calibrations. The procedure and frequency of each check is optimized for each detector system to provide assurance of the detector's performance. Documentation of the checks and the results are kept for all procedures. The supervisor is responsible for these calibration and performance checks.
  
- 14.3.4 Duplicate Analysis - Duplicate aliquots of randomly selected samples will be processed with each batch of samples (a batch is a set of 20 samples). The analyst will always process samples in accordance with routine operating procedures. The evaluation of the duplicate analysis will be based on examination of the difference between the duplicates. A statistical analysis of the data may be performed when a cursory evaluation indicates problems with the results. If the two results agree with the three standard deviation limits, more detailed evaluation will generally not be necessary. Results of duplicate analyses will be included in the monthly Q.C. report.

14.3.5 Detection and Elimination of Bias - Where possible, calibration will be with solutions that are traceable to NIST. However, traceability to NIST is not always possible and reliance on other suppliers may be necessary (e.g., Amersham-Searle, International Atomic Energy Agency, U.S. Department of Energy, U.S. Environmental Protection Agency, etc.). Standards in the appropriate geometry or form will be used to determine efficiency of instruments on a periodic basis. In the calibration process, the ideal standard will be a known quantity of the radionuclide to be measured, prepared in exactly the same geometry as the samples and counted under the same conditions. In this way, factors such as self-absorption, back-scattering, sample geometry, and detector efficiency will be accounted for empirically.

14.3.5.1 Spiked Samples - A known quantity of calibrated radioactive standard solution will be added to an aliquot of the sample or to a "blank" sample for replicate analysis. When the entire analytical system is operating properly, the laboratory record will demonstrate the accuracy and precision of the data. Divergent data from the spiked sample will point out problem areas. For example, if the data is consistently higher or lower than the known value, bias in the analytical procedure is indicated. This may require a search for personnel errors, restandardization of carriers or tracers, and/or recalibration of counting equipment.

14.3.5.2 Internal Tracer - The radioactive tracer will be added in a chemical and physical form appropriate to the analytical procedure to help assure uniform reproduction of the path followed by radionuclides present in the sample.

14.3.5.3 Replicate Analysis - Replicate spiked samples will be used, whenever practicable, when an internal tracer is not used as a routine part of the analytical procedure. Calibration standards will be periodically counted and calibration standard solutions will be used to spike blank samples, to allow for quality control, where replicates are impractical. Results of spiked samples will be included in the monthly Q.C. report.

14.3.6 Background Determination - A number of equipment and environmental factors contribute to variation in counting or instrument background. The background of each system instrument shall be determined and recorded with sufficient frequency to provide a firm statistical basis for that measurement and also to assure response to potential instrument problems or other artifacts such as controlled contamination.

14.3.6.1 These background determinations will include use of the items that most closely duplicate the analytical configuration in type, geometry, and with any associated fixtures. In some cases, true blanks are not available, but the closest practicable analog is used.

14.3.6.2 Some system are sufficiently stable to require no change in backgrounds used for data reduction (e.g., uranium daughter gamma-rays found in gamma spectra due to adjacent building materials and earth). In this case, backgrounds will be compared to historical data to insure sufficient stability. Other systems experience enough variability to require computed backgrounds based upon running averages.

14.3.6.3 Background data will be recorded in the logbook or computer file for that specific instrument along with calibration data and instrument maintenance records.

#### 14.3.7 Blanks

Blank samples are routinely analyzed with each sample batch to verify control of contamination and process. Results of blanks processed with batches of samples will be included in the monthly Q.C. report.

#### 14.3.8 Collaborative Testing

In addition to the internal quality control samples described above, TNS laboratories shall participate in collaborative testing or interlaboratory comparison programs. Natural or synthetic samples carefully prepared to contain known concentrations of the radionuclides are sent to participating laboratories by an independent referee group such as the Quality Assurance Branch of the National Radiation Assessment Division of the U.S. Environmental Protection Agency at Las Vegas, Nevada; the Environmental Measurements Laboratory, U.S. Department of Energy, at New York; and the Radiological and Environmental Sciences Laboratory, DOE, Idaho Falls, Idaho (MAPEP).

After statistically comparing the resulting data from triplicate analyses of the special standard sample, the degree of analytical validity of the results is reported and updated performance information is returned to each participant. The program thus enables each TNS laboratory to document the precision and accuracy of radioactivity measurements, identify instrumental and procedural problems, and compare performance with other laboratories.

### 14.4 QUALITY CONTROL AND DATA REPORTS

- 14.4.1 Quality Control Reports - Quality control results shall be summarized monthly with distribution to management and others upon request.

#### 14.4.2 Data Reports

14.4.2.1 Personnel Dosimetry Services - Dosimetry work sheets shall be the document of record and shall be signed or initialed by the person performing the work and initialed by the supervisor or designated representative after review. Dosimetry radiation exposure reports shall be computer generated and the name of the responsible person shall be printed on the reports. Work sheets will be filed by individual customer number along with all related pertinent information.

14.4.2.2 Analytical Laboratory Services - Routine performance requires documentation of all pertinent information with the basic documents dated and initialed or signed. A major document shall be the initial work order, or other document, that records all pertinent information such as the identity of the sample and analyses to be performed. Technical analysis notes and work sheets, utilized during the analytical procedure, shall be other major documents and include all raw data and other information used in performing the analysis. The report of analysis shall be the final report of the data to the client and is issued in accordance with the laboratory's procedure for review and processing.

#### 14.5 DATA VERIFICATION

Routine performance requires inclusion of all pertinent information with basic documents dated and initialed or signed. The work order has recorded such information as the identity of the samples and analyses to be performed. All raw data and other information used in performing the analyses is documented.

14.5.1 Electronic Deliverables Verification - Program managers, or designated individuals, are responsible for assuring that electronic deliverables are complete and accurate.

14.6 SAMPLE CUSTODY

All samples are assigned a unique laboratory identification number, marked directly on the container, which identifies the work order set number and the sample number. All sample control personnel are designated sample custodians for strict (legally defensible) Chain-of-Custody (CoC) samples. Locked buildings, refrigerators, freezers, and cabinets are available for strict CoC samples. Sample custody forms or technician analysis notes are used for tracking all samples through the analytical process. Details for radiological survey of samples, sample security, sample disposal, etc. are outlined in approved Sample Control Procedures. Sample chemistry requirements are assigned by the program manager, or designated individuals, after consultation with the operations manager, if necessary.

14.7 CLINICAL LABORATORY LICENSE (CLIA)

A license is issued every year by the U.S. Department of Health and Human Services to solicit and accept human specimens for the purpose of performing clinical laboratory examinations. This license applies to the Albuquerque laboratory only.

14.8 AMERICAN ASSOCIATION FOR LABORATORY ACCREDITATION (A2LA)

The laboratory has been approved for accreditation by the A2LA in the environmental field of testing for analyses identified in the scope of accreditation. This certification is renewed every two years and applies to the Albuquerque laboratory only.

## SECTION 15.0

## AUDITS

15.1 POLICY

Thermo NUtech has established a comprehensive system of planned and documented audits to verify compliance with all aspects of the Q.A. Program. An audit is defined as a documented activity performed in accordance with written procedures or checklists to verify, by examination and evaluation of objective evidence, that applicable elements of the Q.A. Program have been developed and effectively implemented in accordance with specific requirements. Audits shall be performed by persons not having direct responsibility for the areas being audited.

15.1.1 Customer Access to Thermo NUtech Facilities and Personnel - The client is frequently responsible for auditing Thermo NUtech performance relative to contractual requirements. The exact nature of this responsibility is relative to the nature of the regulatory or licensing requirements, the significance of the services, and the technical expertise available or inherent within the client's organization. The need for, and frequency of, client audits is dependent upon the above factors. A client may authorize an independent agency to perform an audit on his behalf. When possible, the facilities, equipment, and records (proprietary information excluded) of the Thermo NUtech organization will be made available for client inspection along with the necessary personnel to permit verification of quality characteristics.

15.1.1.1 The Q.A. Manager shall coordinate and participate in audits conducted by the client or the client's representative.

15.1.2 Internal Audits - The Q.A. Manager shall audit the Thermo NUtech operations to verify compliance with established procedures and requirements set forth in the Q.A. Program Manual. Use of a check list will insure items in compliance are noted as well as any requirements for improvement.

15.1.3 External Audits - External audits of organizations providing services to Thermo NUtech are scheduled at a frequency commensurate with the status and importance of the activity.

15.2 RESPONSIBILITY

Audits shall be directed by the Q.A. Manager with assistance from the designated Q.C. personnel or the operations manager.

15.2.1 The Q.A. Manager shall be responsible for an independent quality assurance audit of each department.

15.2.2 The Q.A. Manager shall be responsible for assuring that audits are performed by knowledgeable professionals.

15.2.3 An independent qualified auditor shall audit areas of responsibility assigned to the Q.A. Manager.

15.2.4 The individual assigned the responsibility of conducting an audit shall be certified to ASME NQA-1-1989 requirements.

15.3 DOCUMENTATION

Audit results, along with recommendations for corrective action, shall be documented by the Q.A. Manager.

15.3.1 The president, applicable vice president and the responsible manager shall be provided with a copy of the audit report.

15.3.2 Recipients shall review the audit report to determine responsibility and any corrective actions required.

15.4 DEFICIENT AREAS

15.4.1 The responsible manager shall assure correction of the identified deficiencies.

15.4.2 The Q.A. Manager shall verify that action is taken to correct any deficiency and shall take follow-up action to assure that corrections have been completed.

15.4.3 The Q.A. Manager shall assure close out, with documentation, of the audit after corrective actions have been completed.

15.5 FREQUENCY OF AUDITS

The Q.A. Manager shall assure internal audits are conducted on an annual basis. Additional selective audits shall be conducted when one or more of the following conditions exists:

15.5.1 When significant changes are made in functional areas of the Q.A. Program, including significant reorganization or procedure revisions.

15.5.2 When assessment of the Program's effectiveness is considered necessary.

## SECTION 16.0

## QUALITY ASSURANCE AND INSPECTION RECORDS

16.1 POLICY

Records that provide objective evidence of the quality of work and of associated activities conducted in all phases of project work or consulting services are generated and maintained. These records include sample analyses data sheets, the results of reviews, inspections, tests, audits, corrective actions, reports, and training records. Also included are related data such as personnel qualifications, procedures, and equipment records.

16.2 RESPONSIBILITY

Responsibility for initiation, completeness, and reliability of Q.A. records is vested in the appropriate supervisor with periodic verification checks by the Q.A. Manager. All company personnel performing processes or services for which controlling documentation is an associated part of the work being performed shall assist in the efforts.

16.3 RECORDS

16.3.1 Inspection and test records shall, as a minimum, identify the inspector or data recorder, the type of observation, the results, the action taken in connection with any deficiencies noted, and the date of the inspection or test.

16.3.2 All required records shall be legible and of a quality that can be copied. Records shall be completed using reproducible ink. Errors or incorrect entries, shall be lined through with a single line, dated, and initialed by the recorder.

- 16.3.3 Correspondence from clients may be made available for inspection at the discretion of the client representatives and authorization from the originating organization.
- 16.3.4 Q.A. records shall be identified and controlled by customer number and/or client identification as applicable.

#### 16.4 STORAGE OF RECORDS

Quality assurance records shall be firmly attached in binders, or placed in folders or envelopes, and, if applicable, cross referenced by client identification and stored in a secure area.

- 16.4.1 Q.A. records shall be properly stored and may be made available to the client upon request.
- 16.4.2 Records shall be maintained in a secured and protective storage area.
- 16.4.3 Records shall be identified so as to be retrievable at a later date.
- 16.4.4 CoC records are included with the sample set records.
- 16.4.5 Specific arrangements shall be made by the client for longer retention of records or for duplication of records to be stored by the client.
- 16.4.6 The Q.A. Manager or operations manager shall be responsible for governing access to, and control of these records.
- 16.4.7 Analytical reports and source calibration data will be retained for a minimum of five years after results are reported to the client.

- 16.4.8 Personnel dosimetry records such as work sheets and set-up calibration sheets will be retained indefinitely.
- 16.4.9 Procurement records shall be retained for a minimum of five years or as required by the contract.

SECTION 17.0  
CORRECTIVE ACTION17.1 POLICY

The Thermo NUtech policy is to assure continuous acceptable quality levels for services provided. The Corrective Action Request system has been established to assure that conditions adverse to quality are promptly identified and corrected.

17.2 CORRECTIVE ACTION REQUEST (CAR)

The Q.A. Manager shall initiate investigation and corrective action by issuing a CAR in any of the following situations:

17.2.1 When an audit reveals circumstances that may adversely affect quality as determined by the Q.A. Manager.

17.2.2 When the results of an intercomparison study program are out of control.

17.2.3 When procedural or technical problems arise and the Q.A. Manager determines that they may significantly affect quality.

17.3 RESPONSIBILITY

All laboratory personnel are responsible to communicate any evidence of unacceptable quality performance to their supervisor, the responsible manager, and the Q.A. Manager.

- 17.3.1 The responsible manager shall assure investigation of conditions adverse to quality, determination of assignable cause, and recommendations for the actions necessary for their correction.
- 17.3.2 The responsible manager shall assure action is initiated to correct the assignable cause of the adverse conditions and to determine and initiate the specific corrective actions necessary to preclude recurrence.
- 17.3.3 The Q.A. Manager shall review CARs and routine Q.C. reports for evidence of unacceptable quality.
- 17.3.4 All items requiring corrective action shall be clearly identified on the CAR Form for subsequent follow-up and close out actions. Copies of the completed CARs shall be kept on file by the Q.A. staff.

## SECTION 18.0

## QUALITY ASSURANCE REPORTS TO MANAGEMENT

18.1 POLICY

The Thermo NUtech policy is to keep management apprised of all quality assurance problems, actions taken to correct them, and any actions taken to prevent recurrence.

18.2 QUALITY CONTROL REPORTS

Q.C. Coordinators shall, on a monthly basis, summarize all quality control activities and provide a report of those activities to the Q.A. Manager.

18.3 QUALITY ASSURANCE REPORTS

18.3.1 Q.A. Managers shall provide management and the Thermo NUtech Q.A. Director with a monthly report, incorporating Q.C. Coordinator's reports, and detailing the quality related activities and performance summaries for their area of responsibility.

18.3.2 Special reports to management can be provided whenever results of intercomparison studies or tests are received and whenever CARs are initiated.

18.3.3 Q.A. Managers shall also report, to management, general or system audit results, problems, corrective actions, and replies.

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# TAB

APPENDIX C

**APPENDIX C**

**RADIOLOGICAL MONITORING EQUIPMENT DESCRIPTIONS  
AND CALIBRATION PROCEDURES**

## 1. GENERAL

The Model 3 is a portable radiation survey instrument with four linear ranges used in combination with dose rate or CPM meter dials. The instrument features a regulated high-voltage power supply adjustable from 400 to 1500 volts. The unit body is made of cast aluminum, including the meter housing. The case is 0.090" aluminum. Other operating features of the instrument include a unimorph speaker mounted to the instrument case with an audio ON-OFF capability, fast-slow meter response, meter reset button and a six-position switch for selecting battery check or scale multiples of X0.1, X1, X10 and X100. Each range multiplier has its own calibration potentiometer.

Any G-M probe offered by Ludlum Measurements will operate on this unit as well as many of the scintillator-type detectors. The instrument is typically set for 900-volts for G-M tube operation. For special requirements, it may be adjusted for operation with any G-M or scintillator tube between 400 and 1500 volts.

The unit is operated with two "D" cell flashlight batteries for operation from 32°F to 150°F. For temperature operation to 0°F, either very fresh alkaline or rechargeable NiCd batteries may be used. Typical Battery drain averages 17 milliamperes.

## 2. SPECIFICATIONS

- **POWER:** two standard "D" size batteries
- **RANGES:** four linear range multiples of X0.1, X1, X10, and X100; used in combination with the 0-2 mR/hr meter dial - 0-200 mR/hr is achieved with the range multiplier; for the 0-5k CPM meter dial - 0-500,000 CPM
- **INPUT SENSITIVITY:** 30 millivolts, ( $\pm 10$  mV)
- **AUDIO:** built-in unimorph speaker with an ON-OFF switch
- **HIGH VOLTAGE:** externally adjustable from 400 to 1500 volts
- **RESPONSE:** Four or twenty-two seconds for 90% of final meter reading
- **LINEARITY:** plus or minus 5% full scale
- **BATTERY LIFE:** exceeds 600 hours with a fresh set of alkaline "D" cell batteries

- **BATTERY DEPENDANCE:** Instrument calibration change less than 3% within battery check limits on meter

- **METER:** 1mA, 2 1/2-inch scale, with pivot-and-jewel suspension

- **METER COMPENSATION:** temperature compensation is provided by thermistors on the Main Board

- **CONNECTOR:** Series "C", 706 U/G; BNC or MHV may also be provided

- **SIZE:** 10.67cm (4.2")H X 8.9cm (3.5")W X 21.6cm (8.5")L, exclusive of handle

- **WEIGHT:** 1.36kg (3 lbs.) less detector and batteries

- **FINISH:** drawn-and-cast aluminum, with computer-beige polyurethane enamel and silk-screened nomenclature

## 3. DESCRIPTION OF CONTROLS AND FUNCTIONS

- **Range Multiplier Selector Switch:** A six-position switch marked OFF, BAT, X100, X10, X1, X0.1. Turning the range selector switch from OFF to BAT position provides the operator a battery check of the instrument. A BAT check scale on the meter provides a visual means of checking the battery status. Moving the range selector switch to one of the range multiplier positions (X0.1, X1, X10, X100) provides the operator with an overall range of 0-200 mR/hr or 0-500k CPM (typical meter dials are 0-2 mR/hr or 0-5k CPM). Multiply the scale reading by the multiplier for determining the actual reading.

- **AUD ON-OFF Toggle Switch:** In the ON position, the switch energizes the unimorph speaker, located on the left side of the instrument. The

frequency of the clicks is relative to the rate of the incoming pulses. The higher the rate, the higher the audio frequency. The audio should be turned OFF when not required to reduce battery drain.

- **F-S Toggle Switch:** Provides meter response. Selecting the fast, "F", position of the toggle switch provides 90% of the final meter reading in four seconds. In slow, "S", position, 90% of the final meter reading takes 22 seconds. In "F" position there is fast response and large meter deviation. In "S" position there is a slow response and damped meter deviation.

- **RESET Pushbutton:** When depressed, provides a rapid means to drive the meter to zero.

• **H.V. Adjustment:** Provides a means to vary the high voltage from 400 to 1500 volts. The high voltage setting may be checked at the probe connector with an appropriate voltmeter.

• **Range Calibration Adjustments:** Recessed potentiometers located under the calibration cover, on the right side of the front panel. These adjustment controls allow individual calibration for each range multiplier.

#### 4. OPERATING PROCEDURES

✓ **Note:** To open the Battery Lid, twist the lid button counterclockwise 1/4 turn. To close, twist clockwise 1/4 turn.

○ Open the Battery Lid and install two "D" size batteries. Note (+) (-) marks on the inside of the lid. Match the battery polarity to these marks.

✓ **NOTE:** Center post of flashlight battery is positive. Close the battery box lid.

○ Switch the range switch to BAT. The meter should deflect to the battery check portion of the meter scale. If the meter does not respond, recheck that the batteries have proper polarity.

○ Connect a detector to the M3.

○ Turn the instrument range switch to X100. Expose the detector to a check source. The speaker should click with the AUDIO ON-OFF switched to ON.

○ Move the range switch to the lower scales until a meter reading is indicated. The toggle switch labeled F-S should have fast response in "F" and slow response in "S".

○ Depress the RES switch. The meter should zero.

○ Proceed to use the instrument.

✓ **NOTE:** To assure proper operation of the instrument between calibrations, an instrument operational check should be performed prior to use. A reference reading with a check source should be obtained at the time of initial calibration or as soon as possible afterwards, for confirming correct operation. Confirm the proper reading on each scale.

If instrument fails to fall within  $\pm 20\%$  of proper reading, it should be sent in to a calibration facility for recalibration.

#### 5. CALIBRATION

##### 5.1 Detector Operating Point.

Adjust the HV control for 900 volts at the instrument connector for G-M detectors.

✓ **NOTE:** Measure High Voltage with a Model 500 pulser or a High Impedance voltmeter with a high meg probe. If one of these is not available, use a voltmeter with a minimum of 1000 megohm input resistance.

Switch the Range multiplier to the X100 position. Expose the instrument to a calibrated gamma field which corresponds to approximately 80% of full meter scale. Adjust the X100 range calibration control for proper reading. Position instrument in field which corresponds to approximately 20% of meter scale and confirm meter indicates within  $\pm 10\%$  of field. Repeat calibration for the X10-X0.1 ranges.

✓ **NOTE:** In the event that a calibration field is not available for the X0.1 range, the position will have to be electronically (pulser) calibrated. Connect a Ludlum Model 500 Pulser to the Model 3 and switch to the calibrated X1 range position. Adjust the pulser count rate until the meter reads approximately 80% of full meter scale. Note the count rate. Switch the Model 3 to the X0.1 position and decade the pulser to the next lowest range. Calibrate the X0.1 position to correspond to the 80% meter scale reading. Check the 20% scale indication by dividing the pulser count rate by 4.

##### 5.2 Special Use Calibration.

For special G-M detector applications, the power supply may be adjusted for 450-volt and 1200-volt G-M tubes. Follow the above procedure, only set the supply at the new operating voltage.

For scintillation counters, connect the scintillator. Expose the unit to a source and develop an operating

voltage versus count-rate plot. Set the operating voltage at the flattest portion of this curve; then proceed to adjust each calibration control for the desired meter reading.

### 5.3 Calibrating CPM Meter Dial.

To calibrate the CPM scale, a precision pulse generator is required. The pulse generator should be

capable of providing a 40-millivolt, or greater, negative pulse with a rise time of 1 microsecond and a pulse width of 5 microseconds.

Connect the pulse generator to the instrument and adjust the pulse frequency to provide a 4/5-scale deflection on the X100 range (400,000 CPM). Adjust the X100 range calibration potentiometer as required. Decrease the pulse frequency by decades and adjust each range calibration potentiometer accordingly.

## 6. MAINTENANCE

Instrument maintenance consists of keeping the instrument clean and periodically checking the batteries and the calibration.

An instrument operational check should be performed prior to each use by exposing the detector to a known source and confirming the proper reading on each scale.

Recalibration should be accomplished after any maintenance or adjustment of any kind has been performed on the instrument. Battery replacements are not considered to be maintenance and do not normally require the instrument to be recalibrated.

Ludlum Measurements recommends recalibration at intervals no greater than one year. Check the

appropriate regulatory agencies regulations to determine required recalibration intervals.

The batteries should be removed and the battery contacts cleaned of any corrosion at least every three months. If the instrument has been exposed to a very dusty or corrosive atmosphere, more frequent battery servicing should be used.

Use a spanner wrench to unscrew the battery contact insulators, exposing the internal contacts and battery springs. Removing the handle will facilitate access to these contacts.



### NOTE

NEVER STORE THE INSTRUMENT OVER 30 DAYS WITHOUT REMOVING BATTERIES. ALTHOUGH THIS INSTRUMENT WILL OPERATE AT VERY HIGH AMBIENT TEMPERATURES, BATTERY SEAL FAILURE CAN OCCUR AT TEMPERATURES AS LOW AS 100° FAHRENHEIT.

## 7. THEORY OF OPERATION

### 7.1 INPUT

Detector pulses are coupled from the detector through C57 to emitter follower Q96. R83, R89 provide bias. R137 protects Q96 from input shorts. R27 couples the detector to the high voltage supply.

### 7.2 AMPLIFIER

A self-biased amplifier provides gain in proportion to R63 divided by R70. Transistor (pin 6 of U1)

provides amplification. Pin 12,15 of U1 are coupled as current mirror to provide a load for pin 6 of U1. The output self-biases to 2 Vbe (approximately 1.4 volts) at pin 7 of U1. This provides just enough bias current through pin 6 of U1 to conduct all of the current from the current mirror.

Positive pulses from pin 7 of U1 are coupled to the discriminator.

7.3 DISCRIMINATOR

Comparator U2 provides discrimination. The discriminator is set by the voltage divider, R75 and R196, coupled to pin 3 of U2. These pulses are coupled to pin 5 of U3 for meter drive and pin 12 of U3 for audio.

7.4 AUDIO

Discriminator pulses are coupled to univibrator pin 13 of U3. Front panel audio ON-OFF selector controls the reset at pin 13 of U4. When ON, pulses from pin 10 of U3 turns on oscillator U5, which drives the can mounted unimorph. Speaker tone is set by R84, C112; duration by R86.

7.5 DIGITAL ANALOG CONVERTOR

Pin 12, 15 of U4 are coupled as a current mirror. For each pulse of current through R72, an equal current is delivered to C105. This charge is drained off by R74. The voltage across C105 is proportional to the incoming count rate.

7.6 SCALE RANGING

Detector pulses from the discriminator are coupled to univibrator pin 5 of U3. For each scale, the pulse width of pin 6 of U3 is increased by a factor of 10 with the actual pulse width being controlled by the front panel calibration controls and their related capacitors. This arrangement allows the same current to be delivered to C105 by one-tenth of a count on the X.1 range as 100 counts on X100 range.

7.7 METER DRIVE

The meter is driven by the emitter to Q6, coupled as a voltage follower in conjunction with pin 1 of U6. For ratemeter drive, the meter is coupled to C105 at P1-15.

For Battery Test, the voltage follower is bypassed and the meter movement is directly coupled to the battery through R150.

7.8 METER COMPENSATION

When the unit is provided with a high torque meter movement, with 1.2 volt drive, a temperature compensation circuit is provided on the Main Circuit board; components R181, R189 & R190.

7.9 FAST/SLOW TIME CONSTANT

For slow time constant, C104 is switched from the output of the meter drive to parallel C105.

7.10 LOW VOLTAGE SUPPLY

Battery voltage is coupled to U7 and associated components (a switching regulator) to provide 5 volts at pin 5 to power all logic circuits. Unregulated battery voltage is used to power the meter drive (Q6) and the high voltage blocking oscillator (Q145).

7.11 LOW VOLTAGE REFERENCE

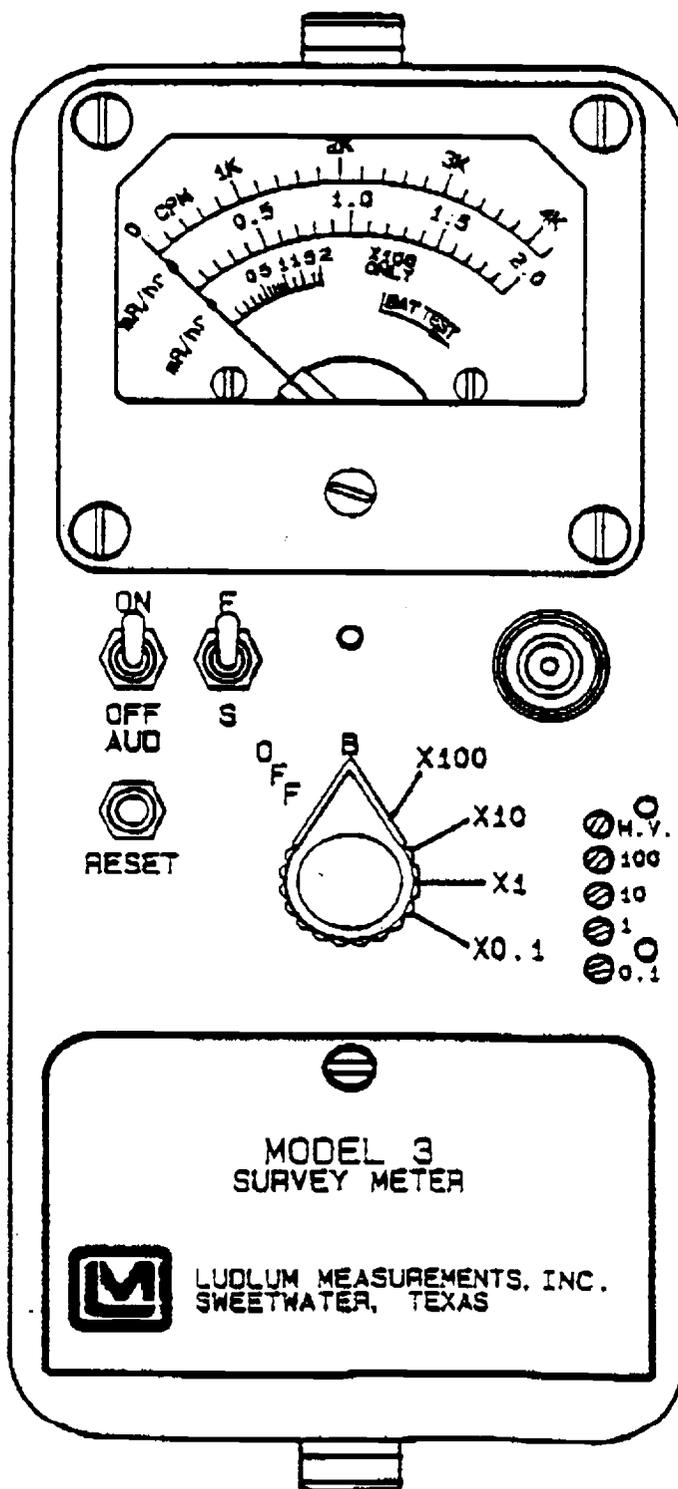
U101 provides a 1.22 volt precision reference for HV supply. This unit also biases Q96.

7.12 HIGH VOLTAGE SUPPLY

High voltage is developed by blocking oscillator Q145-T165 and rectified by voltage multiplier CR166, 167, 169 and 175. Output voltage increases as current through Q44 increases, with maximum output voltage with Q44 saturated.

High voltage is coupled back through R47 to opamp pin 6 of U6. R147 completes the high voltage circuit to ground. High voltage output is set by front panel control HV, which sets bias of pin 5 of U6. During stable operation, the voltage at pin 6 of U6 will equal the voltage at pin 5 of U6. Pin 7 of U6 will cause conduction of Q44 to increase or decrease until the high voltage seeks a level of stability.

289350



REV. NO.		REV. DATE	
REV. DATE	01-17-92	REV. NO.	
TITLE	MODEL 3 SURVEY METER	SCALE	ALL
TITLE MODEL 3 SURVEY METER			
LUDLUM MEASUREMENTS, INC.	383	SHEET	

## 1. GENERAL

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The Model 44-2 is a gamma detector used primarily for the detection of gamma radiation in the range of 60 keV to 1.25 meV. The scintillator consists of a 1 inch diameter by 1 inch thick NaI (TI) crystal coupled to a photomultiplier tube. The detector is housed in 0.062 thick aluminum tubing.

The Model 44-2 may be used with any of the Ludlum instruments or other equivalent instruments that can provide up to 1200 volts

and an input sensitivity range of 2 mV to 500 mV. Background count is approximately 200 cpm/ $\mu$ R/hr. The detector may also be used with single channel analysis instruments for determining specific energies of radiation isotopes.

The Model 44-2 is energy dependent, over responding by a factor of ten or greater in the 100 keV region and under responding by 0.5 above 1 meV when normalized to Cs-137.

## 2. SPECIFICATIONS:

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- Voltage Requirements: 400 volts to 1200 volts maximum

- Scintillator: 1 inch diameter by 1 inch thick NaI(Tl) crystal

- Photomultiplier Tube: 1½ diameter, 10 stage, head-on type

- Connector: Standard series "C", other types available upon request

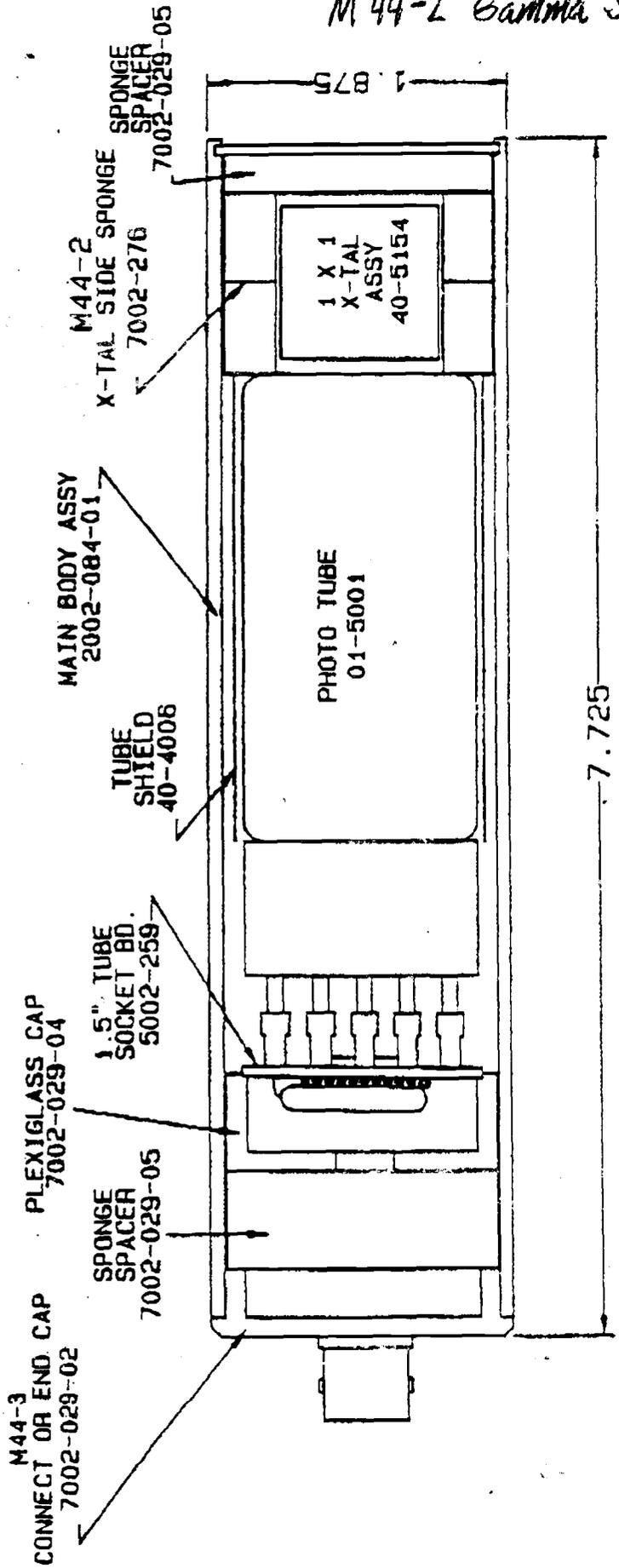
- Recommended energy range operation: 60 keV to 1.25 meV

- Size: 4.8 cm (1.875") diameter by 21.6 cm (8.5") long

- Construction: aluminum

- Weight: 0.5 kg (1 lb.)

# M 44-2 Gamma Scintillator



258682

DESC: ASSEMBLY VIEW	
MODEL: 44-2	
PART #: 4002-289	
DWN: BK	DATE: 2/19/92
DSGN:	DATE:

DATE	BY	CHK	DATE	APP	DATE
2-18-92					
TOL: 0.005		SCALE: FULL		D	
TITLE: M 44-2 GAMMA SCINTILLATOR					
LUCAS					

## 1. GENERAL

The Model 44-9 GM (Pancake) Detector will detect Alpha, Beta, and Gamma radiation. Its size and shape provides easy handling for surveying or personal monitoring. The detector is energy dependent, over responding by a factor of six in the 60 keV to 100 keV range when normalized to  $^{137}\text{Cs}$ .

The thin window is protected by an 79% open beryllium copper screen. The GM tube can easily be removed for repair. Refer to drawing for detail of construction and parts.

The GM detector operates at 850-1000 volts. The tube manufacturer recommends operation at 900V. The recommended

instrument input sensitivity is approximately 30 mV or higher to keep the detector from double pulsing. The double pulse is caused by the size of the after pulse exceeding the instrument threshold.

The GM tube face is also susceptible to rupture above 8000 feet altitude pressure. Consequently, detectors carried in unpresurized aircraft above this altitude would be subject to failure.

The Model 44-9 will operate with any of the Ludlum instruments or equivalent instruments that provide 900 V and an input sensitivity of approximately 30 mV or higher.

## 2. SPECIFICATIONS

- OPERATING VOLTAGE: 850-1000 volts (900 volts typical)
- WINDOW THICKNESS:  $1.7 \pm 0.3$  mg/cm<sup>2</sup> mica
- WINDOW AREA: 15.5 cm<sup>2</sup>
- WINDOW PROTECTIVE SCREEN: 79% open

- EFFICIENCY:

Alpha = 30 % ;  $^{14}\text{C}$  = 10 % ;  
 $^{90}\text{Sr}/^{90}\text{Y}$  = 45 % ;  $^{99}\text{Tc}$  38 %

(2 $\pi$  geometry)

Gamma = 3300 cpm/mR/hr

- WEIGHT: 1 lb.
- SIZE: 8.25" long X 2.75" diameter (head)

## 3. TUBE INSTALLATION

✓NOTE: When shipping a Model 44-9 by air, it is necessary to ship the tube in a sealed container to avoid sudden atmospheric changes.

To install the tube:

- Remove the back plate (3 screws).
- Loosen set screws (3).
- Push clip into anode housing. Do not flex wire when installing clip.

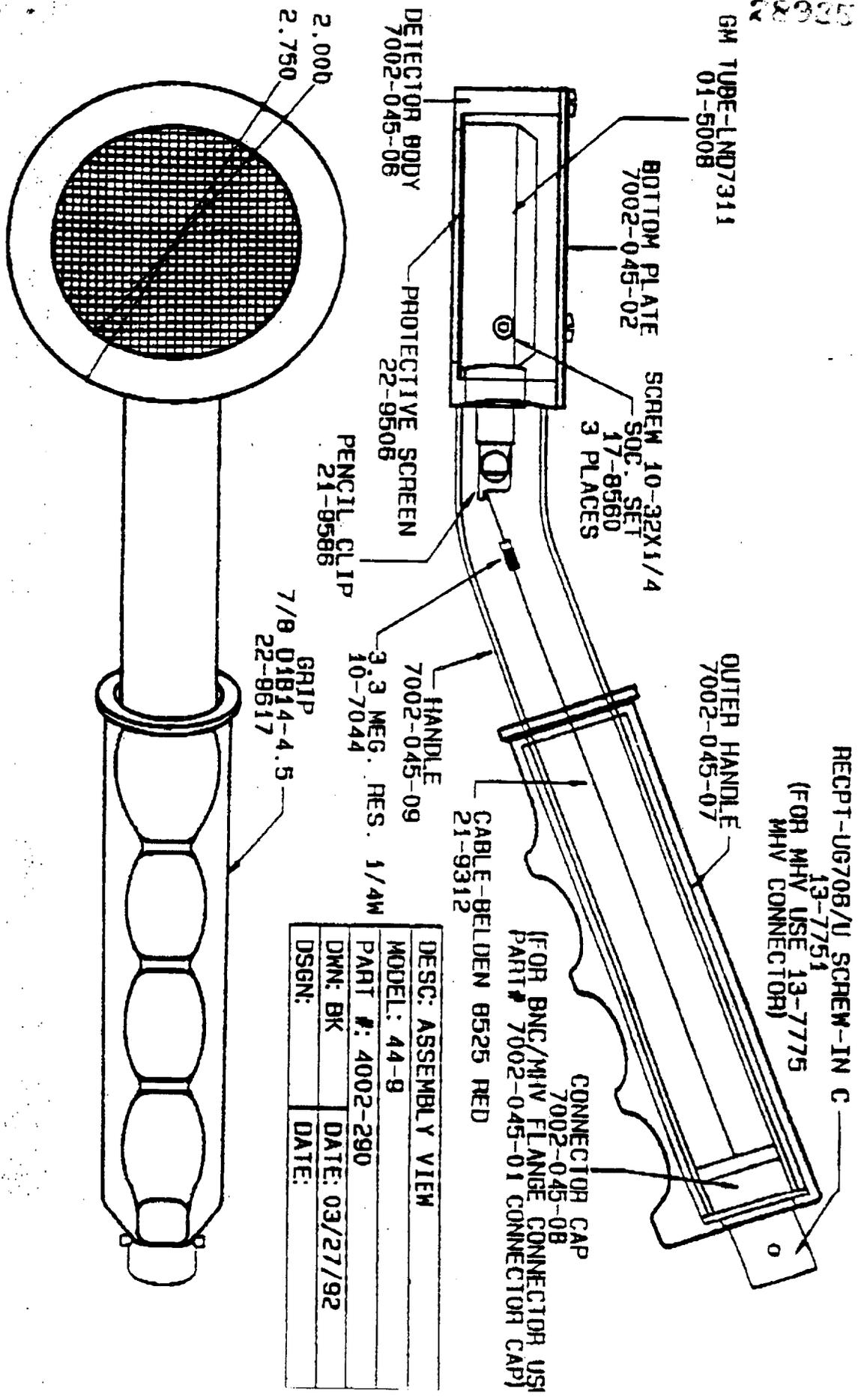
Carefully install tube with window facedown in housing and tighten set screws evenly. Tube should be flush against the screen.

Replace back plate.

✓CAUTION: Mica window is extremely thin and will easily break. Do not touch.

M44-9 A.B.G. Det.

GM TUBE-LND7311  
01-5008



DESC:	ASSEMBLY VIEW
MODEL:	44-9
PART #:	4002-290
DWN: BK	DATE: 03/27/92
DSGN:	DATE:

DATE	SCALE	BY	CHKD
TIME	NO. OF	NO. OF	NO. OF
TITLE: M008 44-9 PANCAKE PROBE			
SCALE: 1:1			
NO. OF SHEETS: 2			
SHEET NO: 204			

**FINAL PAGE**

**ADMINISTRATIVE RECORD**

**FINAL PAGE**

**FINAL PAGE**

**ADMINISTRATIVE RECORD**

**FINAL PAGE**